Report under the
Kyoto Protocol to the
United Nations
Framework Convention
on Climate Change

Fourth National Report
by the Government of the
Federal Republic of Germany

(4th National Communication)

July 2006

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I. Introduction

This report on climate protection in Germany is the fourth report by the Federal Republic of Germany to the Conference of the Parties in accordance with Article 12 of the Framework Convention on Climate Change. It continues the series of national reports already presented in September 1994, April 1997 and July 2002. The fourth national report on climate protection in Germany has been compiled on the basis of the “UNFCCC reporting guidelines on national communications” and the Federal Republic of Germany's national climate protection programme of 13 July 2005.

The Federal Republic of Germany developed a comprehensive climate protection strategy at an early stage:

The interministerial working group “CO_2 Reduction” was set up in accordance with a decision taken on 13 June 1990. Its task is to identify reduction potential for greenhouse gases (especially CO_2). Under this interministerial working group (IMA “CO_2 Reduction”), chaired by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, working committees were set up for the following fields: “Energy Supply” (chair: Federal Ministry of Economics and Technology), “Transport” (chair: Federal Ministry of Transport, Building and Urban Affairs), “Building Sector” (chair: Federal Ministry of Transport, Building and Urban Affairs), “New Technologies” (chair: Federal Ministry of Economics and Technology), “Agriculture and Forestry” (chair: Federal Ministry of Food, Agriculture and Consumer Protection), “Emission Inventories” (chair: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Federal Government decision of 18.10.2000), and “JI and CDM Projects” (chair: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety). The first meeting of the working committee on “Emission Inventories” was held on 15.01.2002.

The IMWG on “CO_2 Reduction” presented six reports on the National Climate Protection Strategy to the Federal Cabinet in November 1990, December 1991, September 1994, November 1997, October 2000 and July 2005.

In its National Climate Protection Programme of 18 October 2000 the Federal Government adopted extensive and coordinated packages of measures for the sectors energy, industry, private households, transport, and trade/commerce/services to safeguard its international promise to reduce greenhouse gas emissions by 21 percent by the period 2008/2012.

The climate protection programme of 13 July 2005 makes a detailed review of the past five years and describes in detail what specific measures were taken, what greenhouse gas emission reductions they resulted in and whether the sectoral objectives were achieved. On the basis of this analysis, the need for action that continues to exist especially in the sectors “Private Households”, “Transport” and “Trade/Commerce/Services” – in other words the sectors not affected by emissions trading – is identified and a corresponding list of measures is presented.

The Federal Government’s climate protection programme is updated at regular intervals and implemented continuously – on the basis of its existing reporting obligations the IMWG “CO_2 Reduction” will in future submit to the Cabinet an annual progress report on the national greenhouse gas situation, with a special focus on the achievement of climate protection objectives.

In addition the IMWG “CO_2 Reduction” is steadily continuing its work, and has received instructions from the Federal Cabinet to present its seventh report in 2008.

II. Background facts and figures

The background data given for the Fourth National Report essentially relate to the period 1990 – 2003. In a few exceptional cases there are records that are only available for shorter periods, and also some that include the year 2004 as well. The background data relate to the following sectors: legislation, population development, geography/land use, industry, energy, transport, agriculture and forestry, waste management and housing.

II.1. State framework conditions

II.1.1. Environmental protection as a state objective

Since 27.10.1994, protection of the natural basis for life (environmental protection) has been incorporated as a state objective in the Basic Law (constitution)of the Federal Republic of Germany (Art. 20a Basic Law). This specifies that the state, aware of its responsibility for future generations, safeguards the natural basis for life within the framework of the constitutional system by means of legislation and, in accordance with legislation and law, through executive powers and jurisprudence.

II.1.2. Structure of the state

The Federal Republic of Germany is a federal state. The Basic Law regulates the division of duties and responsibilities between the national and regional (*“Land”*) levels.

The *Laender* basically decide for themselves how their administration is to be organised. The administrative structure varies from one *Land* to another. Generally speaking, the *Laender* are subdivided into administrative districts, rural districts and individual communities, and also autonomous towns and cities. Within the framework of the law, the local authorities regulate all affairs of the local community on their own responsibility. Table II - 1 provides an overview of the administrative structures in Germany.

Table II - 1 Administrative structure of Germany as at 31.12.2004

Federal *Laender*	Administrative Districts	Rural Districts			Local Authorities
		Total	*of which: Autonomous towns*	*of which: Rural districts*	
16	29	439	116	323	16,429

II.1.3. Legislation

Legislative competence in Germany is divided between the national and regional levels. Basically the *Laender* are responsible for legislation. The Federal Government has exclusive powers of legislation in certain fields allocated to it under the Basic Law (e.g. foreign affairs, defence or currency system); it also has powers of concurrent legislation in certain areas if a uniform federal system is necessary in the national interest (e.g. waste disposal, air quality control and noise abatement), and powers of framework legislation in certain areas (e.g. in the fields of nature conservation, landscape maintenance and water resources management). In view of this allocation of responsibilities, the Federal Government is able to shape environmental legislation.

As part of a reform of the federal system there are plans to reallocate certain legislative competences between the federal and regional authorities. In this connection it is proposed to do away with framework legislation.

At federal level, draft legislation is tabled by the German Bundestag (lower house of parliament), the Bundesrat (upper house of parliament) or the Federal Government.

After an opinion has been expressed by the Bundesrat (in the case of government initiatives) and/or the Federal Government (in the case of Bundesrat initiatives), the draft legislation is sent in compliance with certain periods to the Bundestag for debate. Draft legislation arising from initiatives by parliamentary parties or by groups of members of parliament is placed directly on the agenda of the plenary sessions of the German Bundestag.

The Bundestag considers draft legislation in three readings. In the first reading the draft legislation is referred to the competent committees, often without further discussion. On the basis of the committee reports, a second reading is held (discussion of amendments), and the result is voted upon in the third reading.
If the bill is rejected by the Bundestag, the draft legislation has failed (it may be presented again at a later date).
If the Bundestag passes the bill, the Bundesrat still has to give its formal assent in specific cases where this is required. The Bundesrat can moreover decide to oppose acts passed by the Bundestag, but it can be overruled by the Bundesrat (opposable acts). In the case of both acts requiring assent and opposable acts, the Bundesrat may bring the matter before the mediating committee composed of members of the Bundestag and of the Bundesrat.

Once the act has been passed, it is signed by the Federal Chancellor and the ministers involved, and then passed to the Federal President for execution. On being signed by the Federal President, the act is deemed to be “executed”. After promulgation in the Federal Law Gazette, the law enters into force on the date stipulated in the act, or on the fourteenth day after the day on which the Federal Law Gazette was published.

The Federal Constitutional Court can, on application, scrutinise laws for conformity with the constitution.

The Federal Government or a federal ministry may be empowered by law to enact statutory ordinances regulating further details of the implementation of the law in question. The Federal Government may also issue general administrative guidelines. In certain cases statutory ordinances require the assent of the Bundesrat. Administrative guidelines require the assent of the Bundesrat in cases of a *Land*'s own administration and of administration by commission. In the environmental sector this is the rule.

Federal laws, statutory ordinances and administrative guidelines are usually implemented by the *Laender* on their own responsibility, and this also applies to the environmental sector. There are also areas of federal administration and areas where the *Laender* implement federal laws on behalf of the federal level; here they are supervised by the federal level.

Laender laws are implemented by the *Laender* themselves.

II.2. Population development

From 1990 to 2004 the population of Germany increased by 3.1 million. Since 2003, however, a downward trend in the population can be observed, and this will probably continue in the years ahead in view of the demographic structure and average fertility rates in the German population. Over the entire period, population figures in the old *Laender* (Western Germany) mostly display a slight upward trend, while in the new *Laender* (Eastern Germany) the trend is downward. (Cf. Table II - 2).

The increase in the old *Laender*, especially since the late eighties, is due to immigration from the new *Laender* and from other countries. Increasing life expectancy and the low birth rate have resulted in a shift in age structure.

Population density shows great regional variations. Densely populated urban and industrial regions, especially in the west of Germany with figures of over 1,200 inhabitants per km^2, contrast with rural areas, especially in the east and north of Germany, with fewer than 100 inhabitants per km^2.

Table II - 2 Population development in Germany from 1990 to 2004 (annual average in million inhabitants)[1]

Year	Old *Laender*	New *Laender*	**Total**
1990	63.3	16.1[2]	79.4
1991	64.1	15.9	80.0
1992	64.9	15.7	80.6
1993	65.5	15.6	81.2

[1] Figures rounded to one decimal place;
up to end of 2000: old Länder including West Berlin, new Länder including East Berlin;
from 2001: old Länder excluding West Berlin, new Länder excluding East Berlin

[2] Population on 3.10.1990

Year	Old *Laender*	New *Laender*	**Total**
1994	65.9	15.6	81.4
1995	66.2	15.5	81.7
1996	66.4	15.5	81.9
1997	66.6	15.4	82.1
1998	66.7	15.3	82.0
1999	67.8	15.3	82.1
2000	67.0	15.2	82.2
2001	65.2	13.8	79.0
2002	65.4	13.7	79.1
2003	65.6	13.6	79.2
2004	65.6	13.5	79.1

Source: Federal Statistical Office; population update

II.3. Geography and land use

According to the latest complete land census in 2004 (reference date 31 December), the total area of Germany is 357,050 km².

II.3.1. Land use

Agricultural land (including bog and heath land) accounted for 53.0 percent of the total area of Germany in 2004 (189,324 km^2). This was a reduction of 1.1 percentage points in agricultural land compared with 1996.

By contrast, the area under forest shows an increase – of 0.4 percent points compared with 1996 – covering an area of 29.8 percent in 2004 (106,488 km^2).

With a share of 2.3 percent, the area covered by water accounts for only 8,279 km^2 of the total area of Germany. Compared with 1996, the area covered by water has increased by 339 km², largely as a result of flooding and renaturing of former sand, gravel and lignite extraction sites.

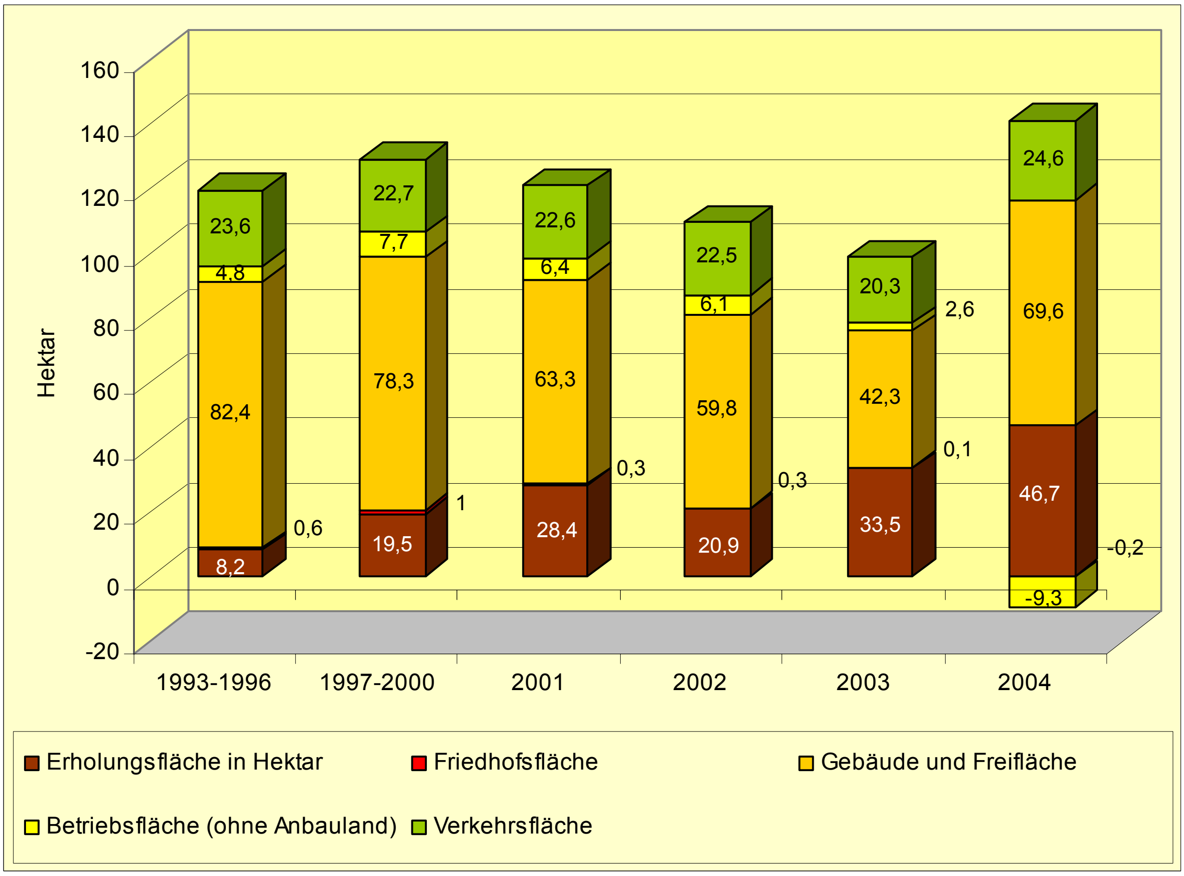
The share due to settlement and transport in 2004 amounted to 12.8 percent of the area of Germany (45,621 km^2).

II.3.2. Use of land for settlement and transport purposes

Land use trends in Germany are characterised mainly by constant growth of the area used for settlement and transport, usually at the expense of agricultural land. Recreation areas for people and habitats for plants and animals are being lost due to the increasing spread of settlement and fragmentation of the countryside. This also reduces the options for producing food or renewable raw materials or energy crops on fertile land. The growing number of buildings and the excessive spread of infrastructure not only generate traffic and climate-relevant pollution, but also have to be operated, heated and maintained. This increases our consumption of resources, and especially energy, and burdens the public sector with high consequential expenditure.

In its national sustainability strategy the Federal Government has set itself the target of limiting the appropriation of new land for settlement and transport to 30 ha per day by the year 2020. With the present daily rate of growth, the achievement of this objective is still a very distant goal.

Fig. II - 1 *Daily increase in land used for settlement and transport, breakdown by land use types in Germany (in hectares)*



Source: Federal Statistical Office; figures: 16.02.2006

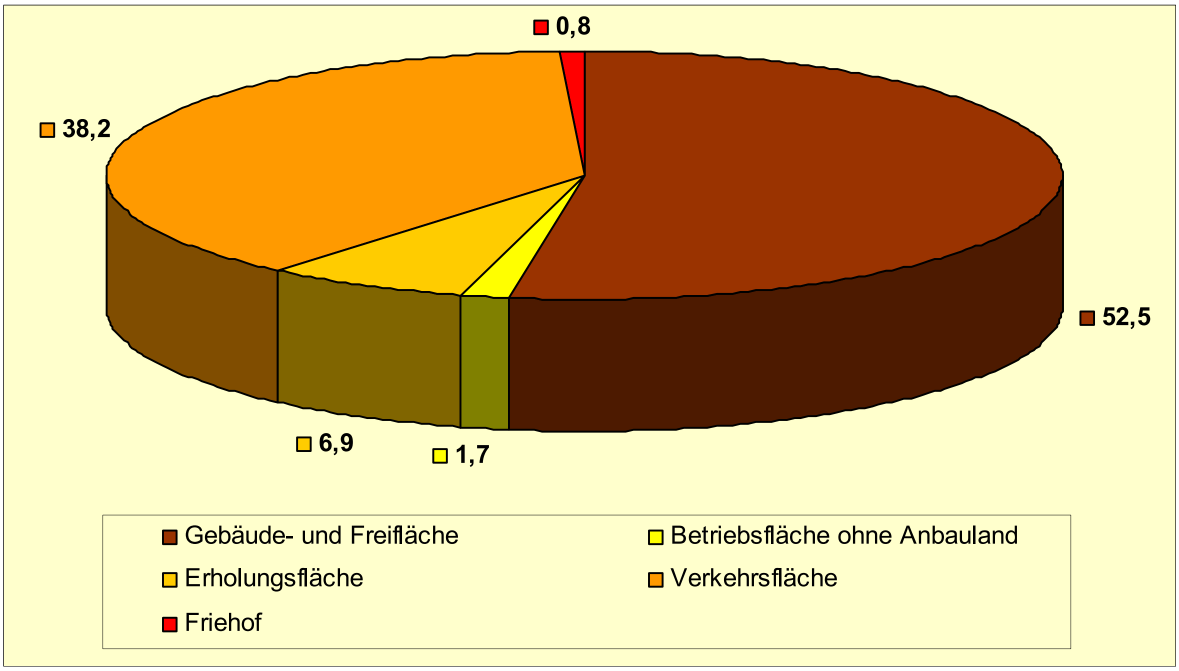
Results of land census broken down by actual use (reference date 31 December)
In some Laender the comparison over time is affected not only by genuine changes in land use types, but also by reclassifications and reallocations between the individual land use types in response to changes within the cadastral authorities.
“Settlement and transport areas” and “sealed land” are not identical, since settlement and transport areas also include land that is not sealed and not built on.
The federal figures for 2002 to 2004 include estimated figures for Schleswig-Holstein
The federal figures for 2003 include estimated figures for Schleswig-Holstein and Saxony-Anhalt.
1993-1996 and 1997-2000: Situation within the years specified

The area used for settlement and transport in Germany shows a further increase. In 2004 the area used for settlement and transport increased by a total of 480 km² (1.1 percent) to 45,621 km². This breaks down into 390 km² (1.4%) used for settlement and 90 km² (0.5%) used for transport. This means that in the year 2004, some 12.8

percent of the land area of Germany was being used for settlement and transport purposes. This breaks down into 28,175 km² (7.9%) for settlement and 17,446 km² (4.9%) for transport. The proportion of land used for settlement and transport is largest in the “city states” (Berlin 69.4%, Hamburg 58.6% and Bremen 56.5%) .

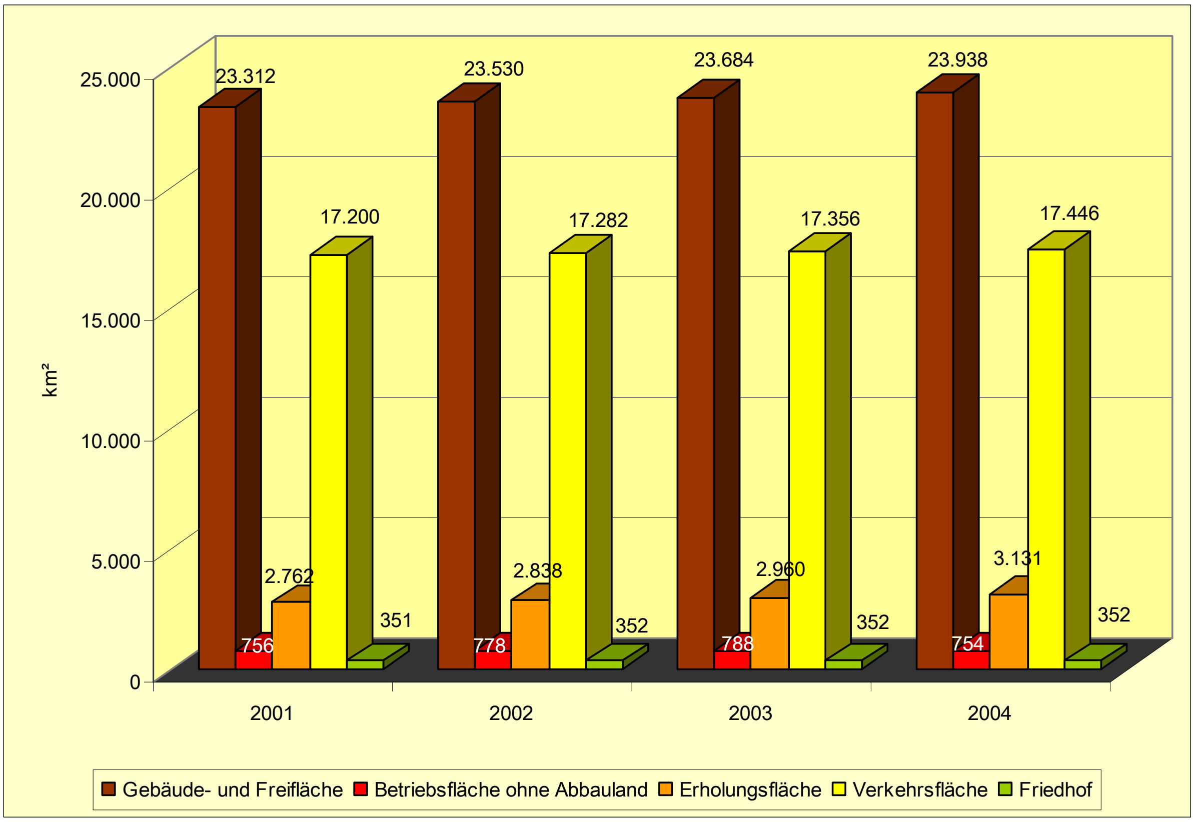
Thus compared with 1992, the first year for which figures are available for Germany within its present borders, the area used for settlement and transport has increased by 5,316 km² (13.2%).

Fig. II - 2 Percentages of land use types within settlement and transport areas in 2004



Source: Federal Statistical Office

Fig. II - 3 Settlement and transport areas broken down by actual use



Source: Federal Statistical Office, 2005
Reference date 31 December

BBR (Federal Agency for Construction and Regional Policy) trend forecast:

- the daily increase in land used for settlement and transport once again shows a slight rise
- rapid growth around the big cities, reaching well into the peripheral rural districts
- little growth in the central areas and net emigration areas

During the period 1997 to 2000 the area used for settlement and transport increased by 129.1 hectares per day, and in 2000 it accounted for 0.5 percent more land than in 1996. In 2002 the increase was 109.5 hectares per day. According to the latest land census, the area due to settlement and transport increased by 98.8 hectares per day in 2003 and 131.4 hectares per day in 2004.

Use of land for industrial estates, sport and leisure increased by 40 hectares per day in 2003. Building of new and improved railways and roads, e.g. for developing industrial estates, consumes a further 15 hectares per day, of which 3.5 hectares per day are accounted for by federal highways.

II.3.3. Agriculture

II.3.3.1. Land use by the agricultural sector

In 2004, some 17.02 million hectares in Germany were used for agricultural purposes; 11.899 million hectares were used as arable land. At the end of 2003 approximately 4.3 percent of the land under cultivation was being farmed in accordance with organic farming principles. In terms of the share of its total area, Germany thus occupies a middle ranking above the EU average, but behind countries such as Italy, Austria, Switzerland, Sweden, Denmark or Finland.

II.3.3.2. Fertiliser and livestock

In the agricultural sector the use of mineral fertilisers (cf. Table II - 3) and livestock farming (cf. Table II - 5) are the most important parameters for emissions of the climate-relevant gases CH_4 and N_2O.

In the case of fertilisers it is above all those containing nitrogen that have an impact on climate due to the release of a small proportion of the nitrogen applied (about 1.25% on average) in the form of the greenhouse gas nitrous oxide (laughing gas, N_2O). In the early 1990s there was a sharp drop in sales of commercial fertilisers containing nitrogen, compared with the late 1980s. After a decline of roughly a quarter in the long-term average, there was a renewed marked rise in sales in 1998/99 and 1999/2000, followed by a slight downward trend in the succeeding years.

However, the medium-term trend in sales of commercial fertilisers is also influenced by the economic framework conditions and by agricultural and environmental policy aspects, e.g. the scale of set-aside programmes and the design of extensification programmes.

Table II - 3 Domestic sales of fertilisers in Germany (in ’000 t nutrient)

Year	Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Lime (CaO)
1990/91	1 885.3	672.2	1 031.7	2 407.6
1993/94	1 612.2	415.4	644.7	1 560.3
1994/95	1 787.4	450.7	667.5	1 831.6
1995/96	1 769.2	401.7	652.2	1 886.5
1996/97	1 758.0	415.1	645.8	1 979.1
1997/98	1 788.4	409.6	658.9	2 248.5
1998/99	1 903.0	406.8	628.7	2 264.6
1999/00	2 014.4	420.3	599.2	2 508.3
2000/01	1 847.6	351.3	544.0	2 171.1
2001/02	1 791.7	314.6	505.9	2 310.5
2002/03	1 787.8	327.4	479.7	2 153.7
2003/04	1 827.8	284.1	486.5	2 098.8
2004/05	1 778.4	302.7	478.4	1 855.5

Source: Statistisches Jahrbuch (über Ernährung, Landwirtschaft und Forsten) 2004

Livestock affects the emission of greenhouse gases in two ways. The climate-relevant trace gas methane (CH_4) forms during the digestion (fermentation) processes of farm ruminants (cattle and sheep), and through storage of organic fertilisers. Organic fertiliser is at the same time a source of climate-relevant laughing gas (N_20) and its precursor substances (NOx and N_2), and this is particularly true of organic fertiliser from litter management (solid manure).

Some 94 percent of methane emissions are due to cattle farming, with dairy cattle being the most important emitters. The decrease in emissions since 1990 (with increasing emission factors for dairy cattle and constant emission factors for all other animals) is a consequence of declining livestock numbers due to changes in consumer habits.[3]

Table II - 4 *CH_4 emissions E_{CH4} from livestock farming (fermentation during digestion)*

Year	E_{CH_4}
[Tg CH_4 a^{-1}]	
1990	1.16
1991	1.03
1992	1.00
1993	1.00
1994	1.00
1995	1.00
1996	0.99
1997	0.96
1998	0.95
1999	0.95
2000	0.94
2001	0.95
2002	0.92
2003	0.91
2004	0.88

Source: NIR 2006

Emissions of nitrous oxide (N_2O) and nitrogen oxide (NO_x) from organic fertiliser also decreased as a result of German reunification, but have remained roughly constant since 1994.

[3] Source: NIR 2005

Moreover, under certain conditions N_2O can also be formed from animal excrement.

Table II - 5 Livestock numbers in Germany, figures in thousands

Type of animal	1990	1995	1999	2000	2001	2002	2003	2004
Calves, younger than ½ year	3,012	2,555	2,393	2,331	2,302	2,204	2,135	2,048
Young cows, ½ - 1 year	3,701	2,661	2,398	2,295	2,225	2,111	2,053	1,993
Cattle, 1 – 2 years	4,731	3,818	3,452	3,403	3,432	3,333	3,214	3,077
Cattle, over 2 years, female	7,827	6,889	6,498	6,342	6,468	6,195	6,111	5,954
Cattle, over 2 years, male	218	176	155	166	1765	144	131	124
Total cattle	**19,488**	**16,098**	**14,896**	**14,538**	**14,603**	**13,988**	**13,644**	**13,196**
Pigs	**30,819**	**24,516**	**26,101**	**25,633**	**25,784**	**26,103**	**26,334**	**25,659**
Sheep	**3,239**	**2,437**	**2,724**	**2,743**	**2,671**	**2,722**	**2,697**	**2,713**
Horses	**491**	**599**[4]	**476**		**506**		**525**	
Poultry	**113,879**	**109,878**	**118,303**		**122,056**		**123,408**	

Source: BMELV, Statistisches Jahrbuch 2004
The livestock figures are taken from the agricultural statistics. Since May 1999 a total census has been conducted at the beginning of May in all odd years for cattle, pigs, sheep, horses and poultry. In even years a representative survey of cattle, pigs and sheep is conducted at the beginning of May.

II.4. Climate

Germany lies in a temperate climate zone. The prevailing climate is modified by distance from the sea and by height above sea level. Winds from a predominantly westerly direction and precipitation at all times of the year are characteristic.

From the northwest to the east and southeast there is a progressive transition from a more oceanic to a more continental climate, i.e. the temperature range between summer and winter and between day and night gradually increases in this direction. The mean annual temperature in Germany is +8.3°C. Mean temperatures in January, the coldest month of the year, are around +1.5°C to –1.5°C in lowland areas; in the mountains they may reach –6.0°C or less. In July, the hottest month of the year, mean temperatures on the North German plain rise to about +17°C to +18°C, while in the Upper Rhine rift valley (warmest region of Germany) they may be up to +20°C.

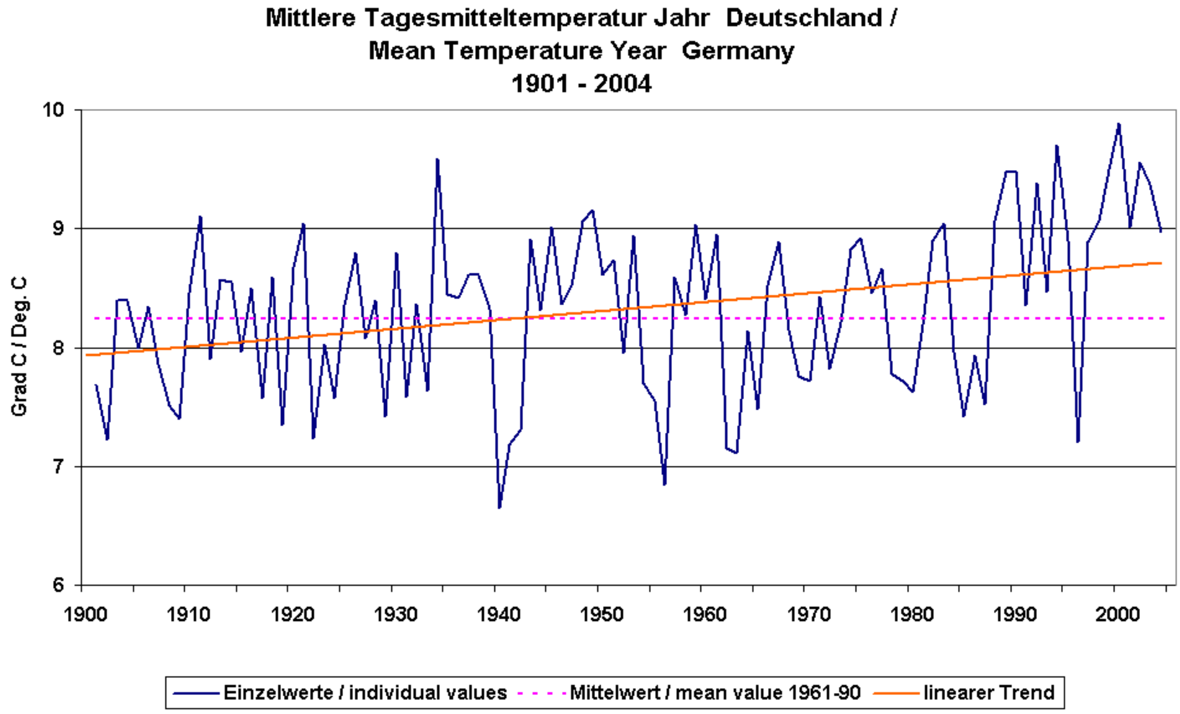
II.4.1. Climate change to date

In line with worldwide observations, the last ten years of the twentieth century were the warmest decade. Since 1990 the average temperatures for all years except one have been above the long-term average of 8.3°C. Seven of the ten warmest years recorded since the start of the twentieth century also fall in this period. The warmest year during this period was 2000, with a figure of 9.9°C.

[4] Previous year's figures, as no census in 1995

A marked warming has taken place during the period 1901 to 2004. In these approximately 100 years the average temperature in Germany increased by about 0.8°C (cf. Table II - 4).

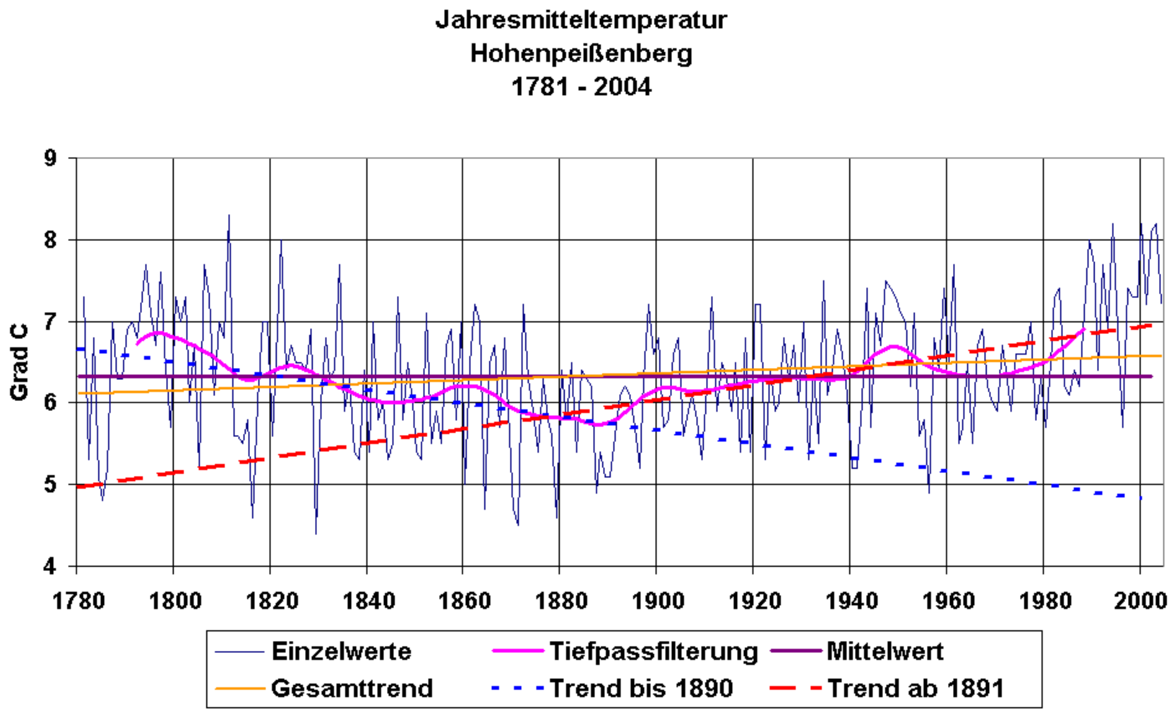
Fig. II - 4 *Mean annual temperature in Germany, 1901 to 2004*



Source: DWD (German Weather Service), 2005

As an example of a particularly long series, the mean annual temperature at the Hohenpeissenberg measuring station from 1781 to 2004 is also shown (cf. Table II - 5).

Fig. II - 5 Mean annual temperature at Hohenpeissenberg, 1781 to 2004



Source: DWD (German Weather Service), 2005

The temperature increase was not uniform over the whole period. Until 1940 the mean annual temperature first showed a rapid rise, but after that there was a slight decline until about 1970.

It is striking to note the sharp increase in mean annual temperature since the beginning of the 1980s. This shows a distinct increase in the warming trend by a factor of about 2.5 compared with the preceding decades.

The temperature increase was also different at different times of the year. The spring shows only a relatively slight increase. Here too the years since 1980 have been particularly warm.

The summer contributed considerably more than the spring to the upward trend in mean annual temperatures. The statistically significant rise of around 0.9°C is due above all to a rise in temperatures since 1955. 2003 recorded the hottest summer to date. In this “heatwave summer 2003”, temperatures were more than 1°C higher than the preceding years since the beginning of the twentieth century.

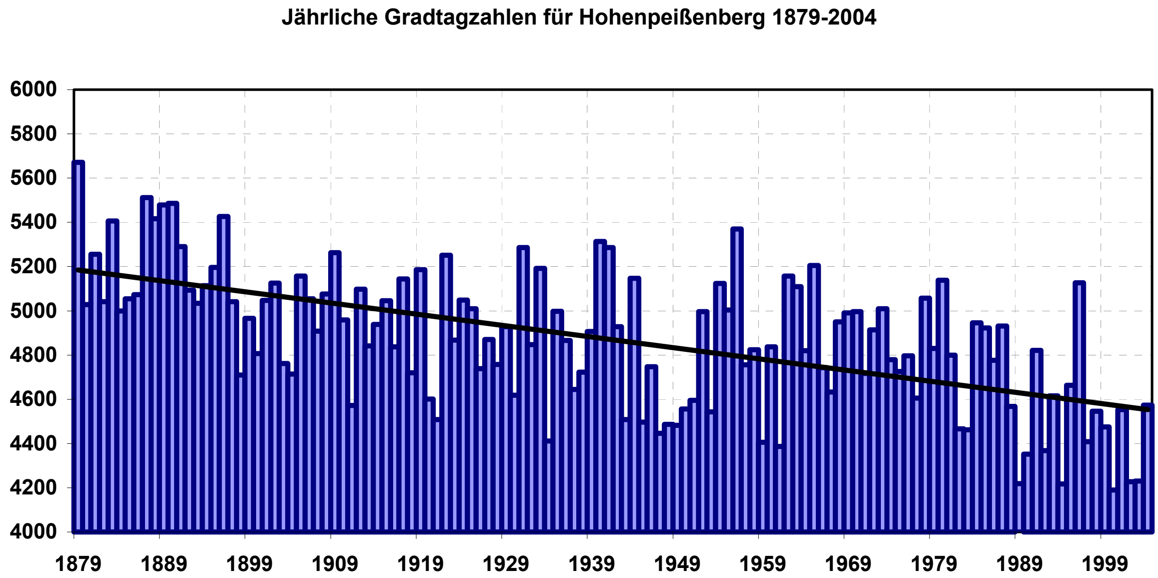
The autumn also shows a marked, statistically significant temperature increase, though this was largely due to a rapid warming phase from 1922 to 1929. Since then, autumn temperatures have been quite constant.

As far as the winter is concerned, there is no clear trend for the entire period. The reason for this is a preponderance of particularly cold winters and a lack of very mild winters in the middle of the twentieth century. However, the winters of the years since 1990 have also been very mild. 11 of these 15 winters were above the average, and four were among the ten warmest of the century.

The winter warming can also be seen from the trend in degree day figures.

The degree day figure is an indicator used in the energy industry to determine heating needs. Only days with a mean daily temperature of less than 15°C are taken into account. The degree day figure represents the sum of the daily differences between the mean daily temperature and 15°C. The long-term average for Germany is around 4,000. In the winter half year (October to March) alone, the figure reaches 3,000.

Fig. II - 6 Annual degree days figure for Hohenpeissenberg, 1879 – 2004



Source: DWD (German Weather Service), 2005

In line with the rise in mean annual temperatures at Hohenpeissenberg, the degree day figures measured there, and hence the heating requirement, display a marked downward trend.

Annual precipitation figures show variations depending on region and altitude. In the North German plain the mean annual figure is around 500 to 700 mm, in the central uplands around 700 to over 1,500 mm, and in the Alps up to more than 2,000 mm. Precipitation of more than 10 mm per day occurs on 10 to 20 days at the coast and in low-lying inland areas, on 20 to 30 days in the central uplands, and on 50 to 70 days in high mountain regions (Zugspitze).

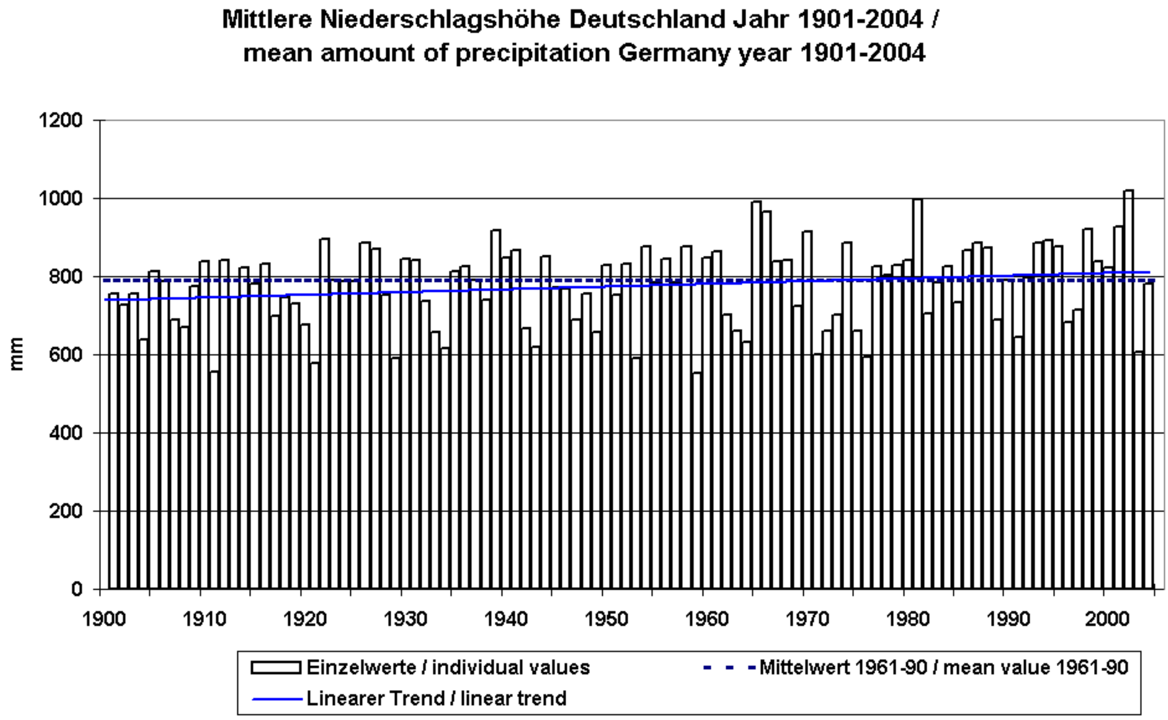
The time series of mean regional figures for annual rainfall in Germany displays only a slight, statistically insignificant increase, which is essentially due to the lack of years with particularly heavy rainfall in the first 20 years of the twentieth century. The long-term mean of the annual totals is 790 mm.

Since 1990, however, the years 2002, 2001 and 1998 and 1994 have been among the 10 with the heaviest rainfall in the last 100 years.

Like temperature, precipitation trends also display seasonal differences. The mean regional figures for annual precipitation show a clear increase in winter precipitation. Spring and autumn also exhibit slight rises, whereas in summer there is evidence of a slight decrease in precipitation. The regional distribution reveals that there tended to be a marked increase in precipitation in the west of Germany, but a decrease in the east.

The year with the heaviest rainfall was 2002 with 1018 mm, while the year with the least rainfall was 1959 with 552 mm.

Fig. II - 7 Annual precipitation in Germany, 1991 – 2004



Strong winds (in excess of 8 on the Beaufort scale) occur on only 1 to 6 days a year in low-lying inland areas, on 10 to 20 days at the coast and offshore islands and in the central uplands, and on about 50 days in the Alps.

Over the last 20 years the frequency of wind storms has been relatively high, and some storms have been particularly fierce, such as “Lothar” and “Martin” in December 1999.

The frequency of wind storms can be associated with the prevailing westerly wind situations with a positive constellation of the North Atlantic oscillation (i.e. relatively well developed areas of high pressure over the Azores/Portugal and depression in the region of Iceland). As yet, there is no conclusive evidence of the extent to which this positive constellation of the NAO is linked to global climate change (though this is indicated by a number of model calculations).

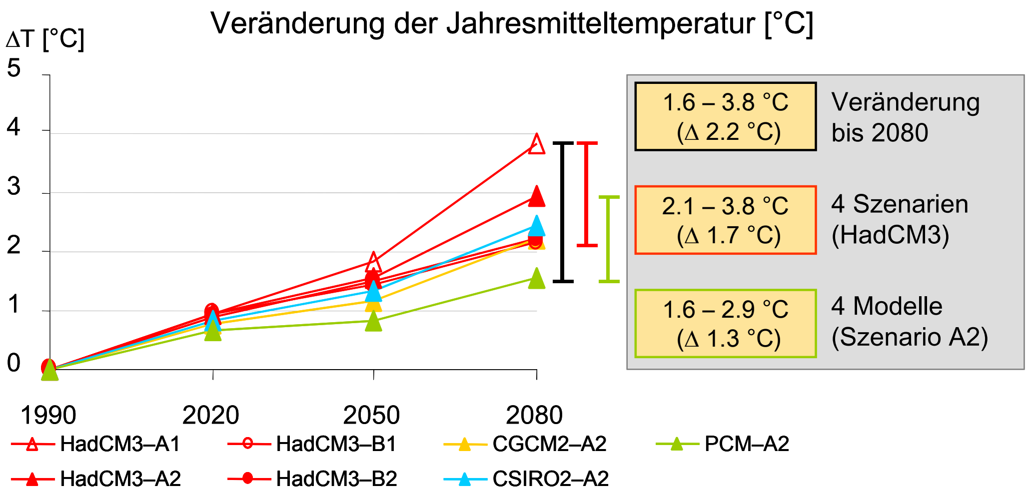
In view of the great damage potential of extreme events, there have been detailed investigations of changes in the probability of such events occurring. These show that in recent decades the occurrence of extremely warm months and seasons (with the exception of the autumn) has become distinctly more probable than at the beginning of the twentieth century. At the same time, extremely cold months and seasons have become less probable. It is also clear that extremely warm days, especially in winter in the south of Germany in particular, have become much more probable.

In the case of precipitation there are marked seasonal differences: the probability of extremely high monthly and seasonal totals shows a marked increase in the winter and a decrease in the summer. Accordingly, days with high and extremely high rainfall show a widespread decrease in the summer, but an increase in the other seasons (especially in the winter and in the west of Germany).

II.4.2. Future climate change in Germany

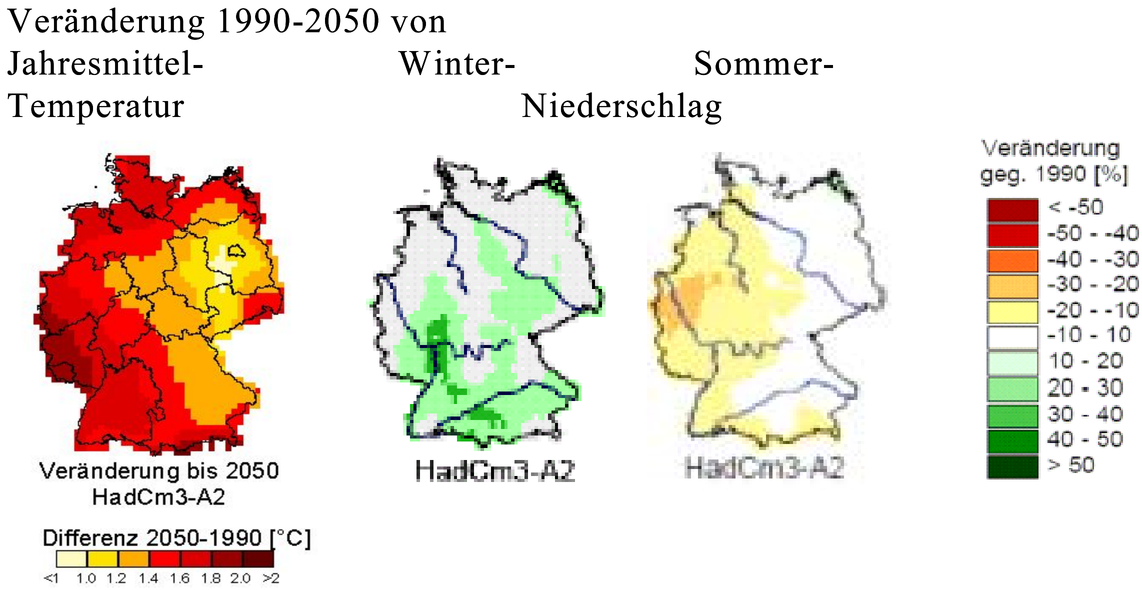
In spite of ambitious climate protection measures already set in motion, scientists today are agreed that the greenhouse gases released to date and future emissions will cause temperatures in Germany to rise by a further 1.6 - 3.8°C by 2080 (cf. Fig. II - 8). The forecasts depend on the climate model used and the emissions scenario considered. This warming will be more marked in the southwest of Germany than in the northeast, and stronger in the winter than in the summer. For example, the following illustration shows the change in mean annual air temperature up to 2050 for the climate model HadCm3 and the SRES emissions scenario A2 (cf. Fig. II - 9).

Fig. II - 8 *Probable change in mean annual temperature in Germany up to 2080 compared with 1990, calculated with 4 different climate models and 4 different emission scenarios*



Source: Cramer, W. et al.: Vulnerables Deutschland. UFOPLAN Abschlussbericht FKZ 201 41 253 (2005), Berlin.

Fig. II - 9 *Probable change in mean annual temperature and winter and summer precipitation in Germany up to 2050 compared with 1990, calculated using climate model Had Cm3 and IPCC emission scenario A2*



Source: Cramer, W. et al.: Vulnerables Deutschland. UFOPLAN Abschlussbericht FKZ 201 41 253 (2005), Berlin.

Regional precipitation patterns will also probably change, though there is great uncertainty about how they will differ from one region to another. Many of the scenarios investigated indicate that while there might be only very slight changes in total annual precipitation on average for the region, winter precipitation is likely to increase by up to 30 percent depending on the emissions scenario in question. Summer precipitation, by contrast, will probably fall by up to 30 percent. In addition to this shift of precipitation from summer to winter (cf. Fig. II - 9), the precipitation will probably fall increasingly as rain, with a decrease in the amount of snow. In general, this indicates that winters will in future be milder and wetter, while summers will be drier. Summer run-off could by down by as much as 40 percent. There is thus a distinct danger that there will be less water available in the summer in future.

As regards extreme weather events, it seems very likely that there will be an increase in heatwaves and a reduction in days of frost. An increase in “cloudbursts”, especially in the winter, and an increase in wind storms are also regarded as probable.

II.5. Economic situation

The average economic growth of the gross domestic product (GDP) in Germany from 1991 to 2005 was 1.4 percent per annum in real terms. At the same time there has been a slight reduction in primary energy consumption in recent years (see also Chapter II.6). According to provisional calculations by the Energy Accounting Association (AGEB), primary energy consumption in 2004 was down by about 0.3 percent on the previous year’s level, despite real economic growth of 1.6 percent. Germany has thus clearly succeeded in breaking the link between economic growth and energy consumption, as can be seen from Table II - 7.

II.5.1. Overall economic indicators

The gross domestic product (GDP) is the monetary result of the national economic production process, i.e. the sum of all goods and services – less the value of the goods and services used as inputs in the production process – that are produced by residents or non-residents within the geographical boundaries of a country.

The GDP is the sum of the gross value added (GVA) of all economic sectors plus non-deductible sales tax and import duties. The GVA measures the net result of production activities. As a rule it is defined as the difference between the gross production values and the inputs of the individual economic sectors. Where it is necessary to establish a relationship between the environmental burdens arising from economic processes, the GDP is the right reference quantity, because it describes the overall economic activity of a national economy.

Table II - 6 shows the development of GVA for individual aggregated economic sectors in euros (EUR) and, taking account of the exchange rate, in US dollars (USD). All the figures are inflation adjusted and chained in order to demonstrate their real development. The GVA for Germany in 2004 totalled EUR 1,928.0 billion: On the basis of the total population, this represents a figure of EUR 23,400 per head. Explanatory notes on the 2005 revision of the basis for calculation of GDP, GVA and gainful employment will be found in the box at the end of Chapter II.5.

Table II - 6 Gross value added (GVA) by sectors – inflation-adjusted and chained figures (in billion EUR) 5

Sector	1991	1995	1999	2000	2001	2002	2003	2004	Sectoral shares of GVA 2004
Agriculture and forestry, fisheries	22.78	20.67	23.56	23.46	24.37	22.89	23.32	21.7	1.1 %
Manufacturing industry, excluding construction industry	451.94	419.46	437.88	465.34	470.60	464.46	464.64	500.3	25.0 %
Construction industry	104.35	111.50	99.50	96.21	91.04	87.16	82.91	80.3	4.0 %
Distributive trade, hotels/restaurants and transport	276.90	293.53	322.33	337.27	342.94	342.97	340.34	361.2	18.1 %
Finance, leasing and business service providers	366.91	435.93	492.85	510.94	529.03	536.79	543.03	581.4	29.2 %

[5] For explanatory notes on the revised calculation of GVA, see box at end of Chapter II.5

Sector	1991	1995	1999	2000	2001	2002	2003	2004	Sectoral shares of GVA 2004
Public and private service providers	349.25	386.60	414.65	422.98	424.84	436.81	439.18	450.0	22.6 %
Total GVA	**1574.43**	**1.667.05**	**1790.30**	**1856.20**	**1882.74**	**1891.10**	**1893.51**	**1994.84**	100 %
Total GVA (in billion USD)	*1849.2*	*2267.0*	*1908.1*	*1714.4*	*1686.2*	*1788.2*	*2141.9*	*2481.38*	
Translation factor 1 EUR = USD[6]	*1.1745*	*1.3599*	*1.0658*	*0.9236*	*0.8956*	*0.9456*	*1.1312*	*1.2439*	

Source: Federal Statistical Office, "Fachserie 18, Reihe 1.3, 2004, Reihe S. 26, May 2005" and "Statistisches Jahrbuch 2005"
The sum of the individual aggregates (in this case the sectors) differs slightly from the grand total.

	1991	1993	1995	1997	1999	2000	2001	2002	2003	2004
GDP (in billion EUR)	1760.6	1785.3	1867.4	1920.0	1998.4	2062.5	2087.0	2090.3	2090.4	2123.1
Primary energy consumption (in petajoules [PJ])	14,611	14,310	14,269	14,614	14,324	14,356	14,602	14,325	14,335	14,408*

Table II - 7 Development of gross domestic product (GDP) – inflation-adjusted

Source: Federal Statistical Office, Umweltökonomische Gesamtrechnungen 2004; Fachserie 18, Reihe S. 26 (revised annual figures 1991 – 2004), DIW 2004.

II.5.2. Gross domestic product per head

Table II - 8 Development of gross domestic product per head – inflation-adjusted as chained volume figures 1991 to 2004 (in 1000 EUR per head)

	1991	1993	1995	1997	1998	1999	2000	2001	2002	2003	2004
Germany	22.0	22.0	22.9	23.4	23.9	24.3	25.1	25.3	25.3	25.3	25.7

Source: Federal Statistical Office, Fachserie 18, Reihe S. 26, and Fachserie 18, Reihe 1.3

6 Based on euro exchange rates from 1999, Deutsche Bundesbank, monthly report, January 2006

Table II - 8 shows the development of real gross domestic product per head in Germany from 1991 to 2004. Over the entire period, GDP per head grew by nearly 17 percent. This corresponds to an average annual growth of 1.3 percent.

II.5.3. Gainful employment by economic sectors

Table II - 9 sets out the development of gainful employment in the individual economic sectors in Germany from 1991 to 2004. Over the entire period one can observe marked reductions in agriculture, forestry and fisheries and in the manufacturing industry and construction industry. These reductions were largely offset by steadily increasing employment in the service sectors, with the result that the level of employment reached in 2004 was roughly the same as in 1991.

Table II - 9 Gainfully employed persons in Germany by economic sectors, 1991 - 2004 (in 1000 persons)

	1991	**1994**	**1997**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**Sectoral share of gainfully employed in 2004 in %**
Agriculture and forestry, fisheries	1,515	1,143	952	946	936	925	905	881	886	2.3
Manufacturing industry (excl. construction)	11,331	9,242	8,596	8,491	8,534	8,544	8,355	8,139	8,018	20.6
Construction industry	2,805	3,172	3,009	2,859	2,769	2,598	2,439	2,322	2,250	5.8
Trade, hotels/restaurants, transport	9,318	9,306	9,307	9,589	9,824	9,885	9,836	9,717	9,770	25.1
Finance, leasing and business service providers	3,736	4,280	4,793	5,429	5,802	5,985	6,060	6,128	6,304	16.2
Public and private service providers	9,916	10,373	10,806	11,110	11,279	11,379	11,501	11,535	11,632	29.9
Total gainfully employed	**38,621**	**37,516**	**37,463**	**38,424**	**39,144**	**39,316**	**39,096**	**38,722**	**38,860**	**100**

Source: Federal Statistical Office, Fachserie 18, Reihe S. 26 (2005).

The major revision of the National Accounts in 2005 resulted in the following three changes in particular:

- Inflation adjustment of **GDP**, for example, or **GVA** is **no longer** performed **on the basis of prices for a fixed reference year** (most recently 1995), but always **in prices for the preceding year** (for example, figures for 2004 on the basis of 2003 prices). This is in line with the binding European legal requirements and makes a contribution to international harmonisation of price and volume measurements.
- The change in the calculation and allocation of imputed bank charges (FISIM) to users is also a consequence of a binding new legal requirement by the EU Commission.
- In addition, new and hitherto unused initial data were integrated in the calculations.

The new method always takes account of the latest ratios, which ensures more accurate calculation of the "real" rates of change:

Following the 2005 revision, most inflation-adjusted GDP figures are higher. The annual rates of change for most years are higher than the previous figures. The annual average for the whole period from 1991 to 2004 shows only a slightly faster increase in the inflation-adjusted GDP figures.

Gross domestic product, inflation-adjusted, chained (change from previous year in %)

	1992	1995	2000	2001	2002	2003	2004
New result	2.2	1.9	3.2	1.2	0.2	0.0	1.6
Previous result	2.2	1.7	2.9	0.8	0.1	-0.1	1.6
Difference in % points	0.0	0.2	0.3	0.4	0.1	0.1	0.0

The **number of gainfully employed** was revised in connection with the introduction of internationally comparable labour market statistics by the Federal Statistical Office. Comparisons with previous publications are therefore of limited value.

II.6. Energy

II.6.1. Primary energy consumption by sectors and energy sources

Consumption of energy, especially energy generated from fossil fuels, almost invariably creates burdens on the environment (e.g. emission of greenhouse and pollutant gases). To be able to reduce or prevent energy-induced environmental burdens, it is necessary to have a detailed overview of where energy is used.

End-use energy consumption – in other words the energy available to end users – is broken down into the sectors "Industry", "Households", "Trade/Commerce/Services", "Road transport" and "Other transport". The figures also show "Non-energy consumption" – for example petroleum for the production of plastics – and consumption and losses in the "Energy conversion sector" – in other words essentially electricity generation and automotive fuel production. The energy consumption and losses of all sectors together make up primary energy consumption, represented by the fuels used.

Consumption of primary energy in Germany in 2004 came to 14,408 PJ. This is a drop of 3.4 percent compared with 1990.

It may be assumed that, given more or less constant population figures in Germany, the growing demand for energy services can probably be wholly or partially offset by technological progress, and that primary energy consumption could well stagnate.

The sectoral structure of end-use energy consumption has undergone substantial changes in recent decades: within the end-use energy sectors the importance of the industrial sector has diminished considerably. Its share of total end-use energy consumption fell from a good two fifths in 1970 to a mere 25.9 percent in 2004. By contrast, there has been an increase in the shares due to households (from 25% in 1970 to 29.4% in 2004) and transport (from 12% in 1970 to 28.4% in 2004). Of the total consumption of primary energy, about two thirds is due to the end-use energy sectors and 7.4 percent to consumption for non-energy purposes. About 29 percent of primary energy consumption is due to losses and internal consumption in the energy conversion sector itself during the generation and provision of electricity and other secondary energy sources, e.g. automotive fuels.

In 2004 some 36% petroleum, 23% natural gas, 13.5% coal and 11.4% lignite were used to meet energy requirements. Nuclear power supplies about 13 percent of primary energy requirements. Renewable energy sources – which include hydro power, wind energy, biomass, geothermal energy and solar energy – are making a small but steadily growing contribution, with about 4.6 percent in 2005[7]. Since 1990 the biggest shifts in the shares of the energy sources have taken place in the field of lignite, with a drop of 49 percent, and natural gas, with an increase of 41 percent.

Table II - 10 Primary energy consumption[8] in Germany 1990-2004 by sectors (figures in PJ)

Energy sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000[10]	2001[10]	2002[10]	2003[9]	2004[10]
End-use energy sectors															
Transport	2,379	2,428	2,522	2,596	2,554	2,614	2,625	2,643	2,691	2,781	2,751	2,693	2,673	2,595	2,636
Households	2,383	2,516	2,436	2,617	2,558	2,655	2,890	2,854	2,782	2,613	2,584	2,822	2,690	2,792	2,712
Trade, Commerce, Services[10]	1,749	1,728	1,609	1,588	1,535	1,579	1,748	1,598	1,588	1,523	1,478	1,571	1,544	1,531	1,502
Industry[11]	2,977	2,694	2,560	2,432	2,463	2,473	2,424	2,440	2,397	2,384	2,421	2,365	2,322	2,348	2,387
Conversion sector															
Losses and internal con-sumption[12]	4,470	4,354	4,281	4,190	4,110	3,985	4,106	4,067	4,017	3,988	4,099	4,192	4,157	4,183	4,107
Non-energy consump-tion[13]	958	891	911	887	964	963	953	1,012	1,046	1,035	1,068	1,031	1,029	1,008	1,064
Total	14,916	14,611	14,319	14,310	14,184	14,269	14,746	14,614	14,521	14,324	14,401	14,679	14,414	14,457	14,408

Source: Deutsches Institut für Wirtschaftsforschung, Berlin (DIW), AG Energiebilanzen: Auswertungstabellen zur Energiebilanz, Stand: 11/.2005.

7 BMU-Daten EE 2005, figures 2006
8 Primary energy consumption calculated on the basis of the efficiency approach
9 Provisional figures
10 Including military units; 1990 to 1994 including the statistical differences for electricity shown in the energy accounts.
11 Other mining and manufacturing sector
12 Losses during energy conversion, e.g. in power plants, refineries, briquette factories, including transmission losses and statistical differences
13 e.g. energy source used as raw material in the chemical industry

Table II - 11 Primary energy consumption[14] in PJ in Germany, by energy sources 1990-2004

Energy sources	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000[15*]	2001[16*]	2002[16*]	2003[16*]	2004[16]
Coal	2306	2330	2196	2139	2139	2060	2090	2065	2059	1967	2021	1949	1912	2013	1940
Lignite	3201	2507	2176	1983	1861	1734	1688	1595	1514	1473	1550	1633	1664	1639	1647
Petroleum	5238	5547	5628	5746	5693	5689	5808	5753	5775	5599	5499	5577	5381	5280	5214
Natural gases[16]	2316	2433	2408	2546	2592	2826	3161	3022	3048	3038	3015	3180	3180	3263	3280
Hydro power, Wind power[17]	58	53	62	64	67	83	73	78	80	91	127	146	146	140	164
Foreign trade balance Electricity	3	-2	-19	3	8	17	-19	-9	-2	4	11	10	3	-29	-26
Nuclear energy	1668	1609	1733	1675	1650	1682	1764	1859	1764	1855	1851	1868	1802	1802	1823
Miscellaneous Energy sources[18]	126	134	135	154	174	178	181	251	283	297	327	338	330	349	366
Total	**14916**	**14611**	**14319**	**14310**	**14184**	**14269**	**14746**	**14614**	**14521**	**14324**	**14401**	**14679**	**14414**	**14457**	**14408**

Source: Deutsches Institut für Wirtschaftsforschung, Berlin (DIW), AG Energiebilanzen: Auswertungstabellen zur Energiebilanz, Stand: 11/2005.

For methodological reasons, the Energy Accounting Association (AGEB) shows only the renewable energies water and wind separately; the category “Other energy sources” includes bio energy, solar energy and geothermal energy. According to calculations by the working group on renewable energy statistics (AG EE Stat) [19] the renewable energies have accounted for the following shares of primary energy consumption since 1998:

14 Primary energy consumption calculated on the basis of the efficiency approach
15 Provisional figures
16 Natural gas, petroleum, mine gas, sewage gas
17 1990 including foreign trade balance for electricity; wind energy from 1995
18 Fuel and waste wood, peat, refuse, sewage sludge, other gases and waste heat for generation of electricity and district heating
19 Arbeitsgruppe Erneuerbare-Energien-Statistik

Table II - 12 Shares of primary energy consumption in Germany due to renewable energies, from 1998 to 2005[20]

	1998	1999	2000	2001	2002	2003	2004	2005
in percent								
Renewable energies as share of total PEC	2.1	2.2	2.6	2.7	3.0	3.5	4.0	4.6

Sources: according to Working Group on Renewable Energy Statistics (AGEE-Stat), using data from the Energy Accounting Association (AGEB); Baden-Württemberg Centre for Solar Energy and Hydrogen Research (ZSW); Federal Statistical Office, Leipzig Institute for Energy Systems and the Environment (IE); Federal Solar Industry Association (BSi); Electricity Industry Association (VdEW); Association of German Network Operators (VdN)

II.6.2. Electricity generation and consumption

Electricity consumption in Germany increased by about 10 percent between 1990 and 2004. Whereas the fuels used in electricity generation showed a drop of 14 percent in the case of lignite and about 36 percent in the case of oil, nuclear power recorded a slight increase and gas, water and wind power a substantial increase. The share due to renewable energies went up from 5.4 percent in 1999 to about 10.2 percent in 2005. However, the overall picture is that of all energy sources coal still accounts for the largest share of electricity generation, with about 47 percent, and the share due to lignite has been on the increase again since 1999. Primary energy consumption for electricity generation fell by 4 percent from 1990 to 1999, then rose again by about 6 percent until 2004, with the result that consumption stands about 1.8 percent higher than in 1990. There are several superimposed factors responsible for this development of primary energy consumption: Efficiency improvements in the power station sector are helping to reduce primary energy consumption, while the increase in the share of electricity generation due to lignite has the opposite effect, as does the increase in electricity consumption. In 2004, net electricity consumption rose by 0.9 percent compared with 2003, from 1802 to 1819 PJ (Table II - 13).

Table II - 13 Electricity generation, energy losses and electricity consumption in Germany from 1990 to 2004 in PJ

Energy sources	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**[21*]	**2001**[20*]	**2002**[20*]	**2003**[20*]	**2004**[20]
Energy consumption in PJ															
Coal	1270	1354	1285	1323	1308	1332	1370	1281	1365	1273	1269	1231	1199	1298	1246
Lignite	1795	1678	1617	1532	1506	1455	1433	1392	1346	1335	1424	1506	1565	1539	1536
Other solid fuels	65	63	67	69	82	60	63	68	86	84	85	88	91	91	88

20 Share of primary energy consumption calculated by the efficiency method
From 2003 provisional figures, in some cases estimated, figures February 2006
From 2003 onward: reassessment of heat supplies from renewable energies as a result of improved data situation (survey under the Energy Statistics Act (EnStatG))

21 Provisional figures

Energy sources	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000[21*]	2001[20*]	2002[20*]	2003[20*]	2004[20]
Heating oil	109	125	113	81	79	82	78	68	66	62	38	41	64	73	70
Gases	435	416	368	362	414	433	457	479	493	492	472	498	489	510	569
of which: Natural gases	*336*	*326*	*282*	*282*	*327*	*348*	*377*	*387*	*398*	*399*	*369*	*402*	*399*	*416*	*416*
Hydro power/ Wind energy[22],[23]	89	85	94	95	100	105	94	98	99	110	126	138	161	158	193
Nuclear energy	1663	1608	1732	1674	1649	1681	1763	1858	1763	1855	1849	1867	1799	1802	1823
Total primary energy consumption for electricity generation	**5426**	**5329**	**5276**	**5136**	**5138**	**5148**	**5258**	**5244**	**5218**	**5211**	**5263**	**5369**	**5374**	**5471**	**5525**
Losses and internal consumption in electricity generation and distribution, statistical differences	**4470**	**4354**	**4281**	**4190**	**4110**	**3985**	**4106**	**4067**	**4017**	**3988**	**4099**	**4192**	**4157**	**4183**	**4107**
Total electricity consumption	**1653**	**1615**	**1602**	**1586**	**1605**	**1648**	**1675**	**1691**	**1709**	**1718**	**1779**	**1778**	**1801**	**1802**	**1819**
By sectors															
Industry	748	698	681	649	666	685	677	701	716	723	748	750	752	756	768
Trade, Commerce, Services[24]	434	422	425	430	435	447	455	458	465	465	504	486	500	487	489
Households	422	440	442	453	448	458	483	471	470	473	470	484	491	501	504
Transport	49	55	54	54	56	58	60	61	58	57	57	56	58	58	58

Source: Deutsches Institut für Wirtschaftsforschung, Berlin (DIW), AG Energiebilanzen: Auswertungstabellen zur Energiebilanz, Stand: 11/2005.

For methodological reasons, the Energy Accounting Association (AGEB) shows only the renewable energies water and wind separately; the category “Other energy sources” includes bio energy, solar energy and geothermal energy. According to calculations by the working group on renewable energy statistics (AG EE Stat) [25] the renewable energies have accounted for the following shares of electricity generation since 1998:

22 Calculations based on the efficiency method
23 Wind energy from 1995 onwards
24 Including the statistical differences shown in the energy accounts from 1990 to 1994
25 Arbeitsgruppe Erneuerbare-Energien-Statistik

Table II - 14 Gross electricity consumption in Germany and shares due to renewable energies[26]

	1998	1999	2000	2001	2002	2003	2004
Gross electricity consumption (in billion kWh)	556.7	557.3	578.1	584.8	587.4	599.4	608.6
Electricity generated from renewable energy sources							
End-use energy (in GWh)	26,321	29,890	38,629	39,020	45,830	47,387	57,573
Primary energy equivalent (in PJ)	110	124	162	168	198	213	257
End-use energy consumption: Share of electricity generation due to renewable energies (as % of total gross electricity consumption)	4.7	5.4	6.7	6.7	7.8	8.0	9.4
Primary energy consumption: Share of electricity generation due to renewable energies (as % of total primary energy consumption)	0.8	0.9	1.1	1.2	1.4	1.5	1.8

Sources: according to Working Group on Renewable Energy Statistics (AGEE-Stat), using data from the Energy Accounting Association (AGEB); Baden-Württemberg Centre for Solar Energy and Hydrogen Research (ZSW); Federal Statistical Office, Leipzig Institute for Energy Systems and the Environment (IE); Federal Solar Industry Association (BSi); Electricity Industry Association (VdEW); Association of German Network Operators (VdN)

II.6.3. Energy use efficiency

Energy efficiency considerations are generally concerned with the relationship between primary energy consumption (PEC) and economic output (GDP) (see Table II - 7).

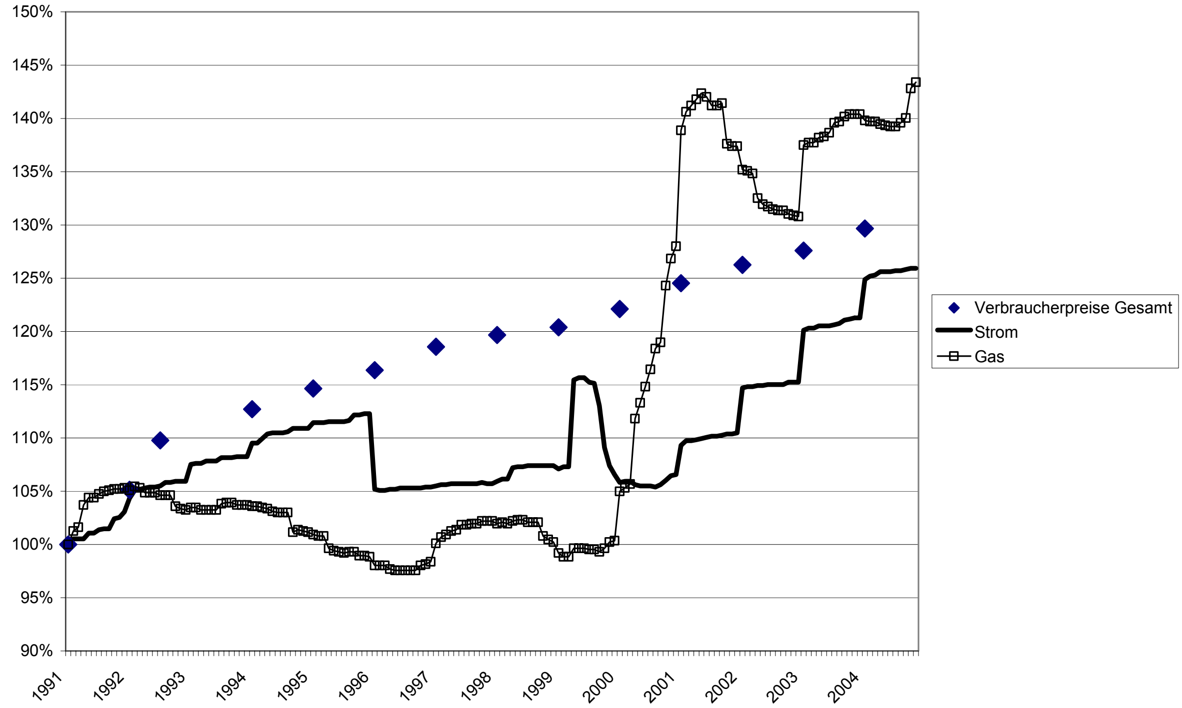
Energy productivity (unit GDP per unit PEC) in Germany has been steadily improving since 1991. Over the period 1990 to 2005 it increased by an average of 1.8 percent. Thus the link between primary energy consumption and GDP growth has been broken. On the other hand the increase in energy productivity has shown a marked slackening in the course of time. For example, the annual average increase since 2000 has been only about 0.9 percent.

II.6.4. Energy prices

The deciding factor for the long-term development of energy consumption is energy prices. In Germany these have undergone considerable changes since 1991, as the following Fig. II - 10 shows.

[26] Share of primary energy consumption calculated by the efficiency method
Figures for 2003 and 2004 are provisional; in some cases estimates; figures February 2006

Fig. II - 10 *Development of electricity and gas prices and general consumer prices in Germany 1991-2004, 1991=100*



Source: *Federal Statistical Office: Consumer price index from data series 5.1 "Preisindizes für die Lebenshaltung und Index der Einzelhandelspreise", published on 04.02.2005, article number: 5611104047004; electricity and gas price index from time series in 61111BM004 "Verbraucherpreisindex für Deutschland" of 7.1.2005.*

Diagram: *Federal Environmental Agency*

Fig. II - 10 provides an overview of the administrative structures in Germany.

Until 1996 electricity prices displayed an almost parallel trend. The marked drop in electricity prices seen in 1996 coincided with the deregulation of the German electricity market, in the wake of which electricity prices, apart from a break in 2000, stabilised at this level until 2001. By the end of 2004 the steady rise in electricity prices since 2001 had almost reached the level of general consumer prices.

On average, the trend in gas prices from 1992 to 2000 remained relatively stable, with variations averaging +/- 5%, and for this reason the level of gas prices in 2000 was lagging about 20 percent behind the general price trend. Starting in 2001, however, gas prices increased sharply by about 40 points in that year. In the following years they then stabilised at a level well above general consumer prices.

The trend figures show that in the 1990s there were only limited price-induced incentives to consume less energy. The marked price rises since 2000 succeed in providing a stronger incentive.

II.7. Transport

II.7.1. Traffic figures

Traffic figures in recent years have been characterised by a slight rise in passenger traffic and a marked rise in freight traffic.

Between 1994 and 2003 there was an increase of 6.4 percent in passenger traffic. Motorised private transport increased by 5.5 percent and maintained its dominant position. Its share of total passenger traffic showed a slight drop from 1994 (82.7%) to 2003 (82.1%).

Air traffic recorded by far the fastest growth of all passenger carriers. From 1994 to 2003 traffic in the air transport sector over Germany rose by 44.3 percent.

During the same period the traffic carried by public road and rail transport increased by 3.1 percent. Thus the share of total traffic accounted for by these comparatively low-pollution carriers remained at a level of around 14 percent.

Table II - 15 Motorised private passenger traffic (1994-2003) in Germany

Year	Rail (bn. pass.-km)	%	Public passenger road traffic (bn. pass.-km)	%	Air traffic (bn. pass.-km)	%	MPT (bn. pass.-km)	%	Total traffic (bn. pass.-km)
1994	65.2	6.5	77.5	7.8	30.0	3.0	826.6	82.7	999.2
1995	71.0	7.0	77.0	7.6	32.5	3.2	835.9	82.2	1016.3
1996	71.7	7.0	76.7	7.5	33.6	3.3	837.3	82.1	1019.3
1997	72.4	7.1	76.2	7.4	35.8	3.5	838.8	82.0	1023.2
1998	72.7	7.0	75.7	7.3	37.5	3.6	850.9	82.1	1036.8
1999	73.8	6.9	76.2	7.2	39.9	3.8	872.3	82.1	1062.2
2000	75.4	7.2	77.3	7.4	42.7	4.1	855.1	81.4	1050.6
2001	75.8	7.1	77.0	7.2	41.9	3.9	876.2	81.8	1070.8
2002	71.4	6.7	75.7	7.1	40.8	3.8	884.2	82.5	1072.1
2003	71.3	6.7	75.8	7.1	43.3	4.1	872.3	82.1	1062.7

Source: Verkehr in Zahlen 2004/2005; Ed.: BMVBS

Goods traffic increased by 22.4 percent from 1994 to 2003. The largest increases, albeit starting from a low level, were recorded by air traffic (+65.7%) and road transport (+33.2%). The share of goods traffic carried by road transport thus increased from 64.3% (1994) to 70.2% (2003). This increase was at the expense of rail and inland waterway transport. The share due to rail and inland waterways, as more energy-efficient carriers, which in 1980 was still approximately the same size as the share due to road transport, fell to around 27 percent.

Table II - 16 Freight traffic (1994-2003) in Germany

Year	Rail (bn. ton-km)	%	Road (bn. ton-km)	%	Inland waterway (bn. ton-km)	%	Long-distance pipelines[27] (bn. ton-km)	%	Air[28] (mill. ton-km)	%	Total traffic (bn. ton-km)
1994	70.7	16.7	272.5	64.5	61.8	14.6	16.8	4.0	503.3	0.1	422.3
1995	70.5	16.3	279.7	64.9	64.0	14.8	16.6	3.8	522.4	0.1	431.3
1996	70.0	16.4	280.7	65.7	61.3	14.4	14.5	3.4	544.5	0.1	427.1
1997	73.9	16.4	301.8	66.8	62.2	13.8	13.2	2.9	565.0	0.1	451.5
1998	74.2	15.8	315.9	67.2	64.3	13.7	14.8	3.1	657.7	0.1	469.9
1999	71.9	14.6	341.7	69.5	62.7	12.7	15.0	3.0	696.0	0.1	492.0
2000	77.5	15.3	346.3	68.4	66.5	13.1	15.0	3.0	763.3	0.2	506.1
2001	76.2	14.9	353.0	69.2	64.8	12.7	15.8	3.1	736.0	0.1	510.4
2002	76.3	14.9	354.5	69.4	64.2	12.6	15.2	3.0	781.1	0.2	511.0
2003	79.8	15.4	362.9	70.2	58.2	11.3	15.4	3.0	834.2	0.2	517.1

Source: Verkehr in Zahlen 2004/2005; Ed.: BMVBS

II.7.2. Motor vehicle numbers

The trends in vehicle numbers can be seen from Table II - 17.

The number of vehicles on the roads in Germany is steadily increasing. In 2004 there were around 45 million passenger cars, 2.8 million trucks and 5.4 million motorised two-wheeled vehicles.

From 1991 to 2004 the number of cars rose by 22 percent. The motorisation density increased from 460 cars per 1000 of the population to 545 cars per 1000. Germany thus has one of the highest motorisation densities in the world.

18.4 percent of vehicles in the passenger car sector are powered by a diesel engine. The share of the total accounted for by diesel cars will continue to increase in the years ahead, since the share of new registrations due to diesel cars has grown sharply (1998: 18%; 2004: 44%) and there are no signs of any reversal of this trend.

The share of emission-controlled cars has grown to 97.5 percent.

Over the period 1991-2004 the number of trucks increased by 57 percent. In view of their powerful engines, trucks account for a disproportionate amount of the emissions due to motor vehicles. The number of motorised two-wheelers also rose sharply in the same period (+ 44%).

27 From 1996 only crude oil transport
28 From 1998 new kilometre basis for air transport

Table II - 17 Trends in motor vehicle numbers including emission-controlled cars

Year (as of 1 July)	Cars and light vans Total	of which: emission-controlled		Trucks and tractor units	Motorised two-wheelers	Other motor vehicles
	million	million	%	million	million	million
1991	36.8			1.8	3.7	2.6
1992	37.9	17.8	47.0	2.0	4.0	2.5
1993	38.9	25.3	65.0	2.1	3.9	2.4
1994	39.8	28.0	70.5	2.2	3.8	2.4
1995	40.4	30.8	76.2	2.3	3.9	2.5
1996	41.0	33.0	80.6	2.4	4.2	2.5
1997	41.4	35.0	84.7	2.5	4.4	2.5
1998	41.7	37.0	88.8	2.5	4.6	2.5
1999	42.3	39.0	92.1	2.6	4.9	2.5
2000	42.8	40.5	94.6	2.7	5.1	2.5
2001	43.8	41.5	94.7	2.8	5.0	2.5
2002	44.4	42.7	96.1	2.8	5.2	2.5
2003	44.7	43.3	97.0	2.8	5.2	2.5
2004	45.0	43.9	97.5	2.8	5.4	2.5

II.7.3. Fuel consumption

Until 1999 the transport sector was the only sector to display increases in absolute energy consumption compared with 1991. Although certain reductions in the specific fuel consumption of vehicles were recorded, the increase in distance travelled (especially in the road freight sector) and the trend towards bigger and more powerful vehicles outweighed this effect, resulting in an overall increase in energy consumption.

Since 1999 there has been a steady decline in fuel quantities sold in Germany. In 2004 the amount of sold in Germany was 7.2 percent less than in 1999. The various fuels have made widely differing contributions to this drop in sales. Whereas sales of diesel fuel in 2004 showed an increase of 0.5 percent over 1999, petrol (gasoline) recorded a sharp drop of 16.8 percent. There was an overall decrease of 8.4 percent in sales of fuels used in the road traffic sector. The main reasons for this are reductions in the consumption of new cars as a result of optimised drive trains and vehicle technologies, in accordance with the voluntary undertaking given by the automobile industry, and the sharp increase in the share of new cars accounted for by diesel-engined vehicles with their lower consumption. The ecological tax reform also made a major contribution to the greater focus on fuel-economy vehicles. Moreover, it led to an increase in refuelling outside Germany and hence to a drop in fuel sales in Germany.

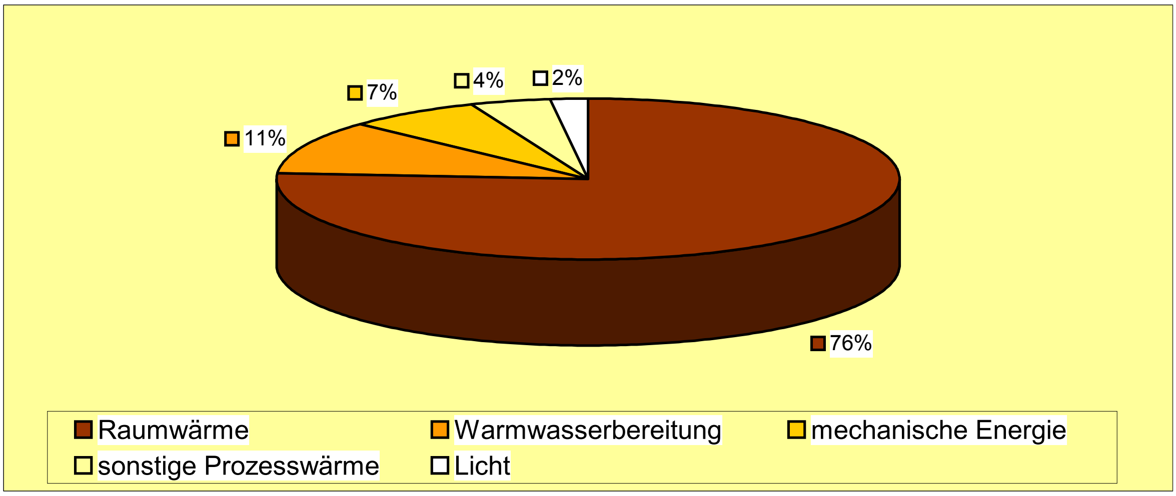
By contrast with the trend in consumption of fuels used for road traffic, consumption of jet fuel (kerosene) showed an increase of 3.4 percent during the period 1999 to 2004. The increase in kerosene consumption, which has been observed for decades and which was briefly interrupted by the slump in air traffic following 11 September 2001, is continuing.

Over the entire period 1991-2003, sales of fuels for the road traffic sector fell slightly (-0.7%). At the same time sales of jet fuel rose sharply (+52%).

II.8. Housing

End-use energy consumption by households (figures: 2000), broken down by uses (Fig. II - 11), is clearly dominated by the use of energy for space heating (76%), followed by hot water supply (11%), mechanical energy (7%), other process heat (4%) and lighting (2%). Thus more than three quarters of all household end-use energy consumption is dependent on external temperatures.

Fig. II - 11 End-use energy consumption in the household sector, broken down by uses (figures 2000)



Source: Commission of Inquiry 2002

The heating structure of residential buildings (figures 2002, Table II - 18) is dominated by the two fuels natural gas (nearly 48%) and light heating oil (nearly 32%). The upward trend in the share of space heating due to natural gas continues, while in particular the use of coal as a fuel for this purpose is declining.

Table II - 18 Heating structure of occupied dwellings (figures 2002)

By heating system (%)	
Block/central heating	69.3
District heating	13.7
Single or multi-room stove	9.1
Apartment-based central heating	7.9
By energy source (%)	
Gas	47.7
Heating oil	31.9
District heating	13.7
Electricity	4.1
Briquettes, lignite	1.3
Coke, coal	0.3
Wood and other renewable energies	1.0

Source: Statistisches Jahrbuch 2004

Compared with 1990 and 1998 there has been a further increase in the average living space per dwelling and occupant. The number of households has continued to rise. Whereas the number of one-person and two-person households has increased, the figures for households with three or more persons remain more or less constant. The reasons for this are greater life expectancy and the unbroken trend towards single-person households. Other factors are the fact that children are leaving home earlier and that divorces are on the increase. The number of homes is growing much faster than the number of households, and this is due to the growing number of second homes for working commuters and the growing number of pensioner households. Average living space requirements per person have also continued to increase (Table II - 19). This trend too is closely connected with the increase in the number of pensioner households, resulting from an increasingly ageing society, and the increase in one-person and two-person households.
An overview of overall living space and numbers of homes in Germany is provided by Table II - 20 (figures 2002).

Table II - 19 Trends in home sizes

	1990	**1994**	**1998**	**2002**
Living space in m^2				
per home	81.9	83.5	84.0	85.1
per occupant	34.8	36.2	38.4	40.1
Number of rooms				
per home	4.3	4.4	4.4	4.4
per occupant	1.8	1.9	2.0	2.1

Source: Statistisches Jahrbuch 2004, figures for 1990 from Statistisches Jahrbuch 2000

Table II - 20 Numbers of residential buildings and homes (figures 2002)

	No. of buildings (million)	**Living area (million m²)**	**No. of homes (million)**
of which:			
with 1 home	10.7	1,270	10.7
with 2 homes	3.5	611	6.9
with 3 or more homes	3.0	1,363	20.6
Total	**17.2**	**3,244**	**38.2**

Source: Statistisches Jahrbuch 2004

Nearly 75 percent of the residential buildings in Germany were built before 1978 (Table II - 21). Measures for exploiting the very great energy saving potential in existing buildings should concentrate primarily on these buildings, as this group has the largest deficits when it comes to heat insulation.

Table II - 21 Year built: homes in residential buildings (figures 2002)

	Number (thousands)	**Share (%)**	**Cumulative share (%)**
up to 1900	3,267	8.4	8.4
1901 - 1918	2,629	6.8	15.2
1919 - 1948	4,971	12.8	28.1
1949 - 1978	18,095	46.8	74.9
1979 - 1986	4,190	10.8	85.7
1987 - 1990	1,237	3.2	88.9
1991 - 2000	4,004	10.3	99.2
2001 and later	297	0.8	100.0
Total	**38,690**	**100**	

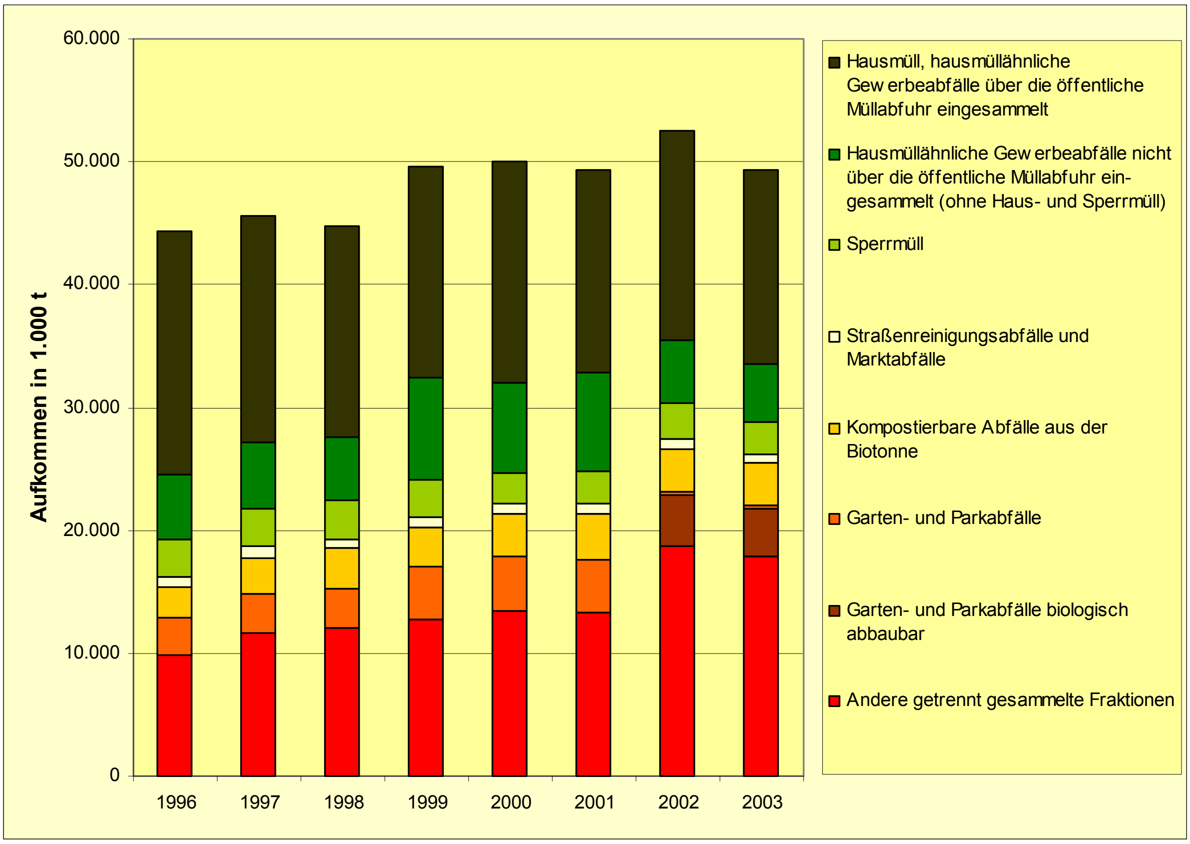
Source: Statistisches Jahrbuch 2004

II.9. Waste management

II.9.1. Waste quantities

Roughly 50 million tonnes of municipal waste was produced in Germany in 2003 (Federal Statistical Office 2005). On this definition, municipal waste includes in particular household waste, household-type commercial waste and bulky waste. However, this also includes the separately collected materials for recovery, such as waste paper, waste glass, bio waste and packaging material, which are processed by a wide variety of methods. Fig. II - 12 provides an overview of the development of municipal waste quantities in Germany. The quantity of waste requiring disposal has steadily decreased since 1999, and in 2003 the figure was around 21 million tonnes. In recent years there has been a sharp increase in the total quantity of waste recovered. In 2003 this figure, at 29 million tonnes, exceeded the quantity of waste for disposal.

Fig. II - 12 Development of municipal waste quantities in Germany



1998: Hamburg with data from 1997
1999, 2002: Owing to the change from the LAGA waste categories catalogue to the European Waste Catalogue there were shifts in waste quantities for certain sub-items. This applied especially to miscellaneous municipal waste, waste from production and industry, and construction and demolition waste. The figures for 2002 show shifts due to the introduction of the European Waste Catalogue, in particular between waste not subject to special monitoring and waste subject to special monitoring, and within municipal waste.
2000: Some figures for Hamburg are from 1999
With regard to "Household-type commercial waste not collected via public refuse collection system (excluding household waste and bulky waste)": includes other municipal waste (e.g. until 2001 waste for shredder units, waste from mechanical-biological pre-treatment, etc. From 2002, e.g., faecal sludge, waste from sewer cleaning)
With regard to "garden and park waste": until 2001 includes biodegradable garden and park waste. From 2002 onwards, non-biodegradable garden and park waste is classified under other municipal waste, and biodegradable garden and park waste under household waste
Source: Federal Statistical Office, 2005

In addition to municipal waste, the following types of waste occurred in 2003: approx. 47 million tonnes of waste from the manufacturing industry, approx. 47 million tonnes of rubble from the mining industry, and approx. 223 million tonnes of construction and demolition waste, including road construction rubble and excavated material (Federal Statistical Office 2005).

II.9.2. Legal basis and objectives of waste management

The underlying law regulating waste management is the Closed Substance Cycle and Waste Management Act (KrW-/AbfG), as most recently amended on 25 January 2004. Section 4 of the Act states the following hierarchy of objectives: Waste is in the first instance to be avoided. Secondly, it is to be recovered in the form of material or energy. Only if this is not possible is it to be disposed of by environmentally friendly means.

Various acts and ordinances on the taking back and recovery of individual product groups or materials have been enacted with the aim of recovering specific waste fractions (packaging, batteries, waste wood, end-of-life vehicles or electrical and electronic devices).

Documents of major importance for the disposal of waste are the Waste Deposition Ordinance (AbfAblV) of 20 February 2001 and the Technical Instructions on Municipal Waste (TASi) of 14 May 1993. The legal requirements lay down the objective of totally discontinuing landfill of untreated municipal waste by 31 May 2005 (objective 2005), in order to prevent harmful emissions (landfill gas, polluted leachate) from landfill sites. This means that in Germany, as from 1.6.2005, all non-recovered household waste and other organic-rich or biodegradable waste from industry and commerce must be treated either in waste incineration plants or in mechanical-biological treatment plants.

Another objective of waste management in Germany is the total discontinuation of landfill by 2020 (objective 2020). This means that by the year 2020 all surface landfill sites must be closed, and all waste occurring thereafter must be completely recovered. The only items requiring deposition would then be filter ash and other polluted residues. In addition to the familiar methods for individual materials for recovery, other recovery options include use in mining backfill for certain types of waste, and incineration of waste in energy-optimised incineration plants.

II.9.3. Waste incineration

At the end of 2005 there were some 67 incineration plants for municipal waste operating in Germany, with a total capacity of about 16.3 million tonnes. In eight of these plants, local sewage sludge was incinerated together with municipal waste.

In order to achieve the objective of treating all municipal waste before landfill, more plants are under construction and at an advanced stage of planning. One estimate indicates that in 2007 there will be 72 municipal waste incineration plants with a total annual capacity of nearly 18 million tonnes. Table II - 22 provides an overview of the development of municipal waste incineration.

Table II - 22 Development of municipal waste incineration 1990–2005, with estimated figures for 2007

	Number of plants	**Waste throughput capacity ('000 t/a)**	**Average plant throughput ('000 t/a)**
1990	48	9,200	191
1992	50	9,500	190
1993	49	9,420	192
1995	52	10, 870	202
1998	53	11,900	225
2000	61	13,999	230
2005	67	16,300	252
2007	72	17,800	247

In recent years various processes have been developed for processing municipal waste or individual high-calorific fractions thereof to produce substitute fuels. The resulting substitute fuels can be used as a source of energy either in existing power stations and industrial plants or in special purpose-built systems. This is a field where there will have to be capacity increases in the future.

All plants in which waste undergoes thermal treatment have to meet the requirements of the 17th Ordinance implementing the Federal Immission Control Act (17. BImschV), which among other things lays down ambitious limits for atmospheric emissions. For this reason waste incineration plants have highly efficient flue gas purification systems. Most systems operate without producing any wastewater.

All waste incineration plants in Germany use the energy released from the waste. Most plants produce both electricity and heat, or supply steam to power stations or industrial operations. The overall efficiency for all plants averages around 47 percent. The total electricity output of all waste incineration plants represents about 0.7 percent of gross electricity generation in Germany.

The total capacity of the roughly 30 plants for the incineration of special waste is around 1.25 million tonnes. At present, however, only about 0.8 million tonnes of this capacity is utilised. Instead, combustible special waste is frequently co-incinerated in suitable industrial plants (cement works, blast furnaces), where it substitutes for primary fuels.

II.9.4. Mechanical-biological waste treatment

Mechanical-biological waste treatment is an important cornerstone in the treatment of residual waste.

In 2001 there were already 30 facilities for mechanical-biological treatment of municipal waste operating in Germany. However, it was not possible to modify more than a small number of these existing plants with mostly very simple process technology to meet the requirements of the Waste Deposition Ordinance (AbfAblV), the 30th Ordinance implementing the Federal Immission Control Act (30. BImSchV), and Annex 23 to the Wastewater Ordinance. These ordinances demand very high standards with regard to plant operating emissions and the quality of the treated products. They also lay down requirements for the way in which the treated products are used as landfill.

For this reason there was a sharp increase in mechanical-biological treatment capacity by 2005, mainly due to construction of new facilities, but also as a result of upgrading and expanding existing plants. At the end of 2005 there were around 50 mechanical-biological treatment facilities in operation with a total capacity of some 5 million tonnes a year.

II.9.5. Landfills

In 2003 the quantity of municipal waste requiring treatment that was disposed of as landfill in Germany was still as high as 10 million tonnes. It was deposited on approximately 300 landfill sites. Under the Waste Deposition Ordinance, such waste can longer be used as landfill from 1.6.2005 onwards, but must be treated.

However, the Technical Instructions on Municipal Waste (TASi) and the Waste Deposition Ordinance (AbfAblV) lay down requirements regarding not only the waste for deposition, but also the technical facilities of landfill sites. These requirements too had to be implemented by 31.5.2005. As a result, landfill sites either had to be adapted to comply with the new technical requirements or had to close down on 31.5.2005. Estimates indicate that today there are about 162 former household waste landfill sites still operating in Germany as class II sites. These sites are now used only for landfill of residues from mechanical-biological or thermal treatment of waste and other mineral waste that does not contribute to the formation of landfill gas.

Table II - 23 shows the development of landfill site numbers, including an estimate of the number of sites still operating after 2005, and the quantity of waste deposited.

Table II - 23 Development of the number of household waste landfill sites operating in Germany and the waste quantities deposited there, with estimates for 2006

	1990	1993	1999	2003	2006
New *Laender*	7,983	292	137	no data	no data
Old *Laender*	290	270	239	no data	no data
Germany total	8,273	562	376	302	approx. 160
Deposited waste quantity contributing to landfill gas formation (in million tonnes)[29]	44.3	27.8	15.5	10.0	0

II.9.6. Waste management contribution to climate and resource conservation

Pre-treatment of waste before use as landfill results in a substantial reduction in landfill gas emissions. A further reduction in emissions is achieved by collecting and recovering the residual amount of landfill gas that still forms. The two factors together have brought about a considerable reduction in methane emissions from landfill sites in Germany in recent years. Latest calculations indicate that landfill-induced methane emissions fell by around two thirds, from at least 1.5 million tonnes in 1990 to 0.5 million tonnes in 2004. This corresponds to a reduction of about 21 million tonnes CO_2 equivalent.

The complete discontinuation of landfill of untreated biodegradable waste since1 June 2005 will bring a further reduction in methane emissions from landfill sites. The waste deposited from now on will no longer contribute to landfill gas formation. Methane emissions from landfill sites will then result solely from the diminishing amount of landfill gas produced by the waste that was deposited before 1.6.2005. By 2012, methane emissions from landfill sites will therefore fall by a further 0.4 million tonnes – corresponding to 8.4 million tonnes CO_2 equivalent.

[29] Residual municipal waste and waste of similar composition with biogenic/organic components

Pressure on the climate will be further reduced by the utilisation of energy from waste incineration. Due to substitution for primary fuels, the overall efficiency of 47 percent currently achieved in waste incineration (13% electricity, 34% heat) ultimately results in a CO_2 reduction of 4-4.5 million tonnes. Further optimisation of energy utilisation with an improvement in overall efficiency to 70 percent (20% electricity, 50% heat) could be expected to save an additional 2 million tonnes CO_2.

Further substitution for primary fuels and resulting CO_2 savings can be achieved by making greater use of substitute fuels from waste and waste wood and sewage sludge in power stations and industrial combustion installations.

The biogenic component of the waste is of particular importance here, as it counts as a renewable energy source and its combustion has a neutral impact on the climate.

III. Inventories of anthropogenic greenhouse gas emissions

As a party to the Framework Convention on Climate Change, Germany has since 1994 been under an obligation to prepare, publish and regularly update greenhouse gas emission inventories. This and especially the entry into force of the Kyoto Protocol in February 2005 gives rise to very extensive obligations with regard to the preparation, reporting and verification of emission inventories. As a result of the European implementation of the Kyoto Protocol upon the adoption of EU decision 280/2004, these requirements became legally binding on Germany as early as spring 2004. In addition to the emission inventories, for example, each party has to prepare an annual National Inventory Report (NIR) providing complete and detailed information on the entire process of compiling the greenhouse gas inventories. Germany presented the third update of this report at the same time as the inventory data for 2005. For further details and the determination and calculation of emission inventories, the reader is referred to this National Inventory Report (NIR).[30]

The following section summarises the information on the direct greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (laughing gas, N_2O), hydrofluorocarbons (HFC), perfluorocarbons (PFC) and sulphur hexafluoride (SF_6).

III.1. Presentation, determination and structure of emission data

The emission data on the relevant greenhouse gases in Germany for the years 1990 to 2004 are presented in tabular overviews and in substance-specific trend tables. To demonstrate the emission trends more clearly, these are also presented in graphic form.

In this connection it should be noted that detailed annual emission information can be found in the inventories published annually in the common reporting format (CRF). The data used in this report correspond to the emission information sent to the UNFCCC Secretariat on 13 April 2006.[31]

30 The National Inventory Report is available from: http://www.umweltbundesamt.de/luft/emissionen/bericht/aktuelle_daten/aktuelle_daten.htm

31 The NIR is also available from: http://www.umweltbundesamt.de/emissionen/veroeffentlichungen.htm

III.2. Accuracy of emission data

The IPCC Good Practice Guidance document characterises the determination of uncertainties as an essential element of a complete inventory. Ideally the emission inventories and uncertainty information would be derived from a large number of plant measurements and could therefore be taken as exact information on emissions. In practice, however, comprehensive measurement of emissions is not possible, which means that in many cases it is necessary to make representative statements on the basis of characteristic sources. This results in a bandwidth for the result that can be expressed as a best available value – combined with uncertainty information that describes this greater or lesser bandwidth. As a rule the "expert judgement" method is used for this process.

There are basically two methods used to determine uncertainties. The Tier 1 method simply combines the uncertainty of activity rate and emission factor for each source group and greenhouse gas, and aggregates this across all source groups and greenhouse gas components to arrive at the overall uncertainty of the inventory. In principle, the Tier 2 method of determining uncertainties proceeds in the same way, but it takes account of the distribution function of the uncertainty and performs the aggregation using a Monte Carlo simulation.

The results summarised below were determined using the Tier 1 method. In future it is planned to make further improvements to the database and to supplement the uncertainty information for the greenhouse gas inventory so that its uncertainty can be reported following the Tier 2 approach. The necessary work is currently in progress.

According to the Tier 1 analysis performed for 2003, the uncertainty of the greenhouse gas inventory as a whole is +/- 5.6 percent. For this analysis all emission data were standardised using the GWP values. At the same time this analysis found an uncertainty factor of +/- 4.3 percent for emission development since 1990 (trend).

III.3. Greenhouse gas emissions

Under the burden-sharing arrangements agreed within the EU, the Federal Republic of Germany has undertaken to reduce emissions of all six Kyoto gases by 21 percent compared with the base year (1990 or 1995[32]) by the end of the first commitment period 2008 to 2012. The development of greenhouse gas emissions in Germany since 1990 is set out for the individual greenhouse gases in Table III - 1 and shown graphically overall terms in Fig. III - 1 as total emissions of CO_2 equivalent.

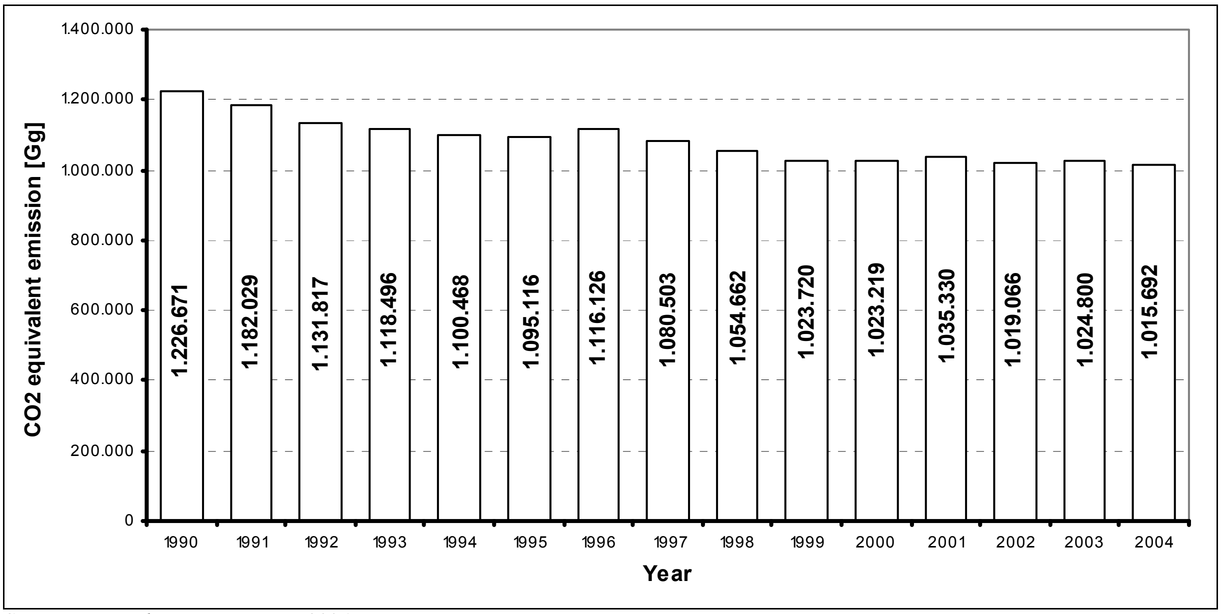
[32] For HFC, PFC and SF_6

Table III - 1 Development of greenhouse gas emissions in Germany since 1990 [in CO_2 equivalent]

Greenhouse gas emissions	Base year	1990	1995	2000	2001	2002	2003	2004
	CO_2 equivalent [Gg]							
Net CO_2 emissions / removals	1,001,615.6	1,001,615.6	888,618.2	851,904.0	864,173.3	851,131.3	856,674.9	849,601.8
CO_2 emissions (without LUCF)	1,030,231.3	1,030,231.3	920,154.9	886,258.2	899,301.0	886,480.3	892,545.2	885,854.2
CH_4	99,794.7	99,794.7	81,748.5	64,912.5	62,084.0	59,162.3	56,171.8	51,443.0
N_2O	84,783.6	84,783.6	77,683.2	59,627.2	60,352.2	59,779.9	62,433.8	64,281.5
HFC	6,555.5	4,368.8	6,555.5	6,556.1	7,971.1	8,647.0	8,486.9	8,802.0
PFC	1,749.6	2,707.6	1,749.6	785.7	723.2	794.7	857.3	830.5
SF_6	7,223.8	4,785.0	7,223.8	5,079.0	4,898.9	4,201.5	4,304.6	4,480.5
Total #	**1,201,722.8**	**1,198,055.3**	**1,063,578.8**	**988,864.5**	**1,000,202.7**	**983,716.7**	**988,929.3**	**979,439.4**
Total *	**1,230,338.5**	**1,226,671.0**	**1,095,115.6**	**1,023,218.8**	**1,035,330.4**	**1,019,065.7**	**1,024,799.5**	**1,015,691.8**

**) without CO_2 from LUCF*
#) without net CO_2 emissions / removals
Source: National Inventory Report 2006

Fig. III - 1 Overall development of greenhouse gases (excl. CO_2 from LUCF) in Germany [in CO_2 equivalent]



Source: National Inventory Report 2006

By 2004 Germany had already succeeded in meeting a large part of its obligations under the European burden-sharing agreement, with a reduction of 17.4 percent compared with the base year. The individual greenhouse gases made varying contributions to this development (see Table III - 2). This is not surprising in view of the different shares of total emissions for a year that are accounted for by the individual greenhouse gases.

Table III - 2 Greenhouse gas emissions in Germany – annual shares due to individual greenhouse gases [in CO_2 equivalent]

Greenhouse gas emissions [CO_2 equivalent]			1990		1995		2000		2004	
	[Gg]	[%]	[Gg]	[%]	[Gg.]	[%]	[Gg]	[%]	[Gg]	[%]
CO_2 emissions *	**1,030,231**	83.7	**1,030,231**	84.0	**920,155**	84.0	**886,258**	86.6	**885,854**	87.2
CH_4	**99,795**	8.1	**99,795**	8.1	**81,749**	7.5	**64,912**	6.3	**51,443**	5.1
N_2O	**84,784**	6.9	**84,784**	6.9	**77,683**	7.1	**59,627**	5.8	**64,281**	6.3
HFC	**6,555**	0.5	**4,369**	0.4	**6,555**	0.6	**6,556**	0.6	**8,802**	0.9
PFC	**1,750**	0.1	**2,708**	0.2	**1,750**	0.2	**786**	0.1	**831**	0.1
SF_6	**7,224**	0.6	**4,785**	0.4	**7,224**	0.7	**5,079**	0.5	**4,480**	0.4
Total *	**1,230,338**		**1,226,671**		**1,095,116**		**1,023,219**		**1,015,692**	

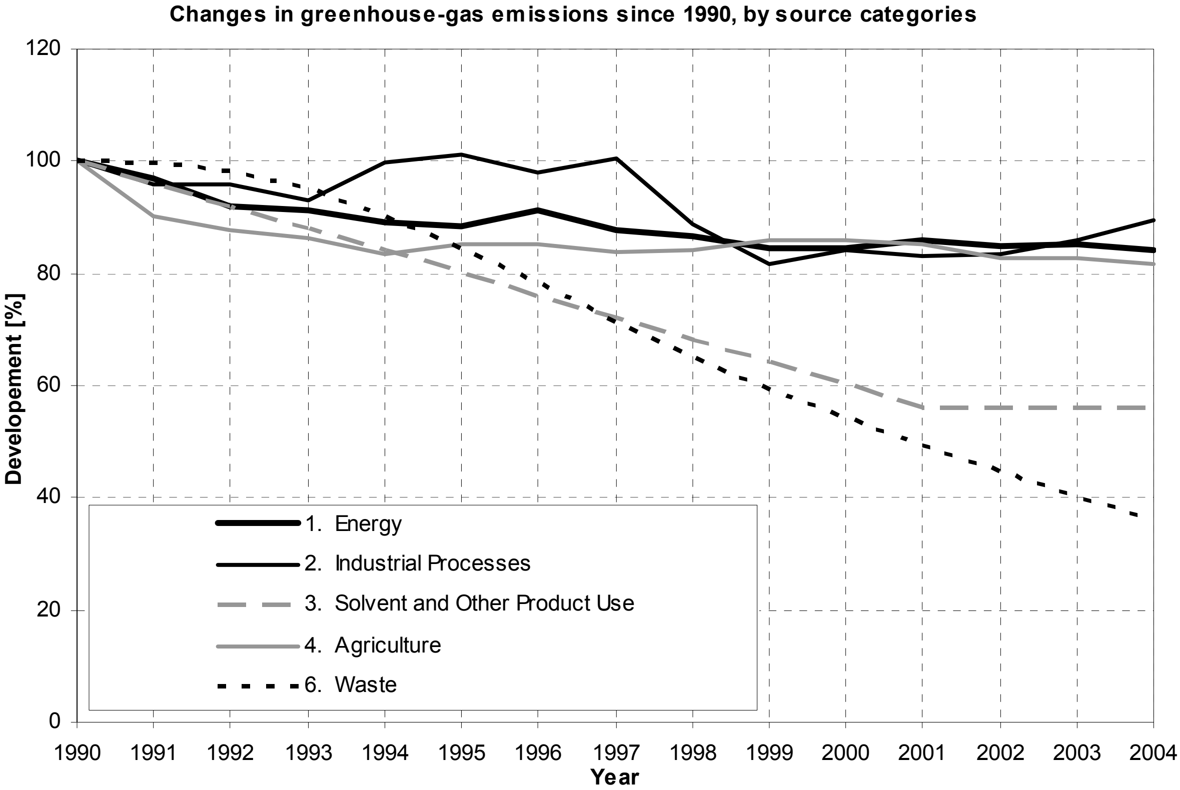
Source: National Inventory Report 2006

With a share of 87.2 percent in the release of carbon dioxide, stationary and mobile combustion processes are the principal causes of emissions. Particularly as a result of the above-average drop in the other greenhouse gases, the share of total emissions due to CO_2 emissions has risen by 3.5 percentage points since the base year. Methane emissions (CH_4) due to livestock farming, heating fuel distribution and landfill emissions account for a share of 5.1 percent. Emissions of laughing gas (N_2O) are largely causes by agriculture, industrial processes and traffic, and contribute 6.3 percent to releases of greenhouse gas. The other Kyoto gases (F gases) account for about 1.4 percent of total emissions. The distribution of Germany's greenhouse gas emissions is typical of a developed and highly industrialised country.

The emissions are calculated on a component-specific basis for the source groups or sinks specified by the IPCC. The greenhouse gas inventories do not take account of chemical changes that take place in the atmosphere to carbon compounds which are not emitted as CO_2 (e.g. NMVOC solvents).

The trends of these developments, based on 1990, are summarised in the following diagram. Substantial emission reductions were achieved in the period under review for the direct greenhouse gases of major importance in terms of volume.

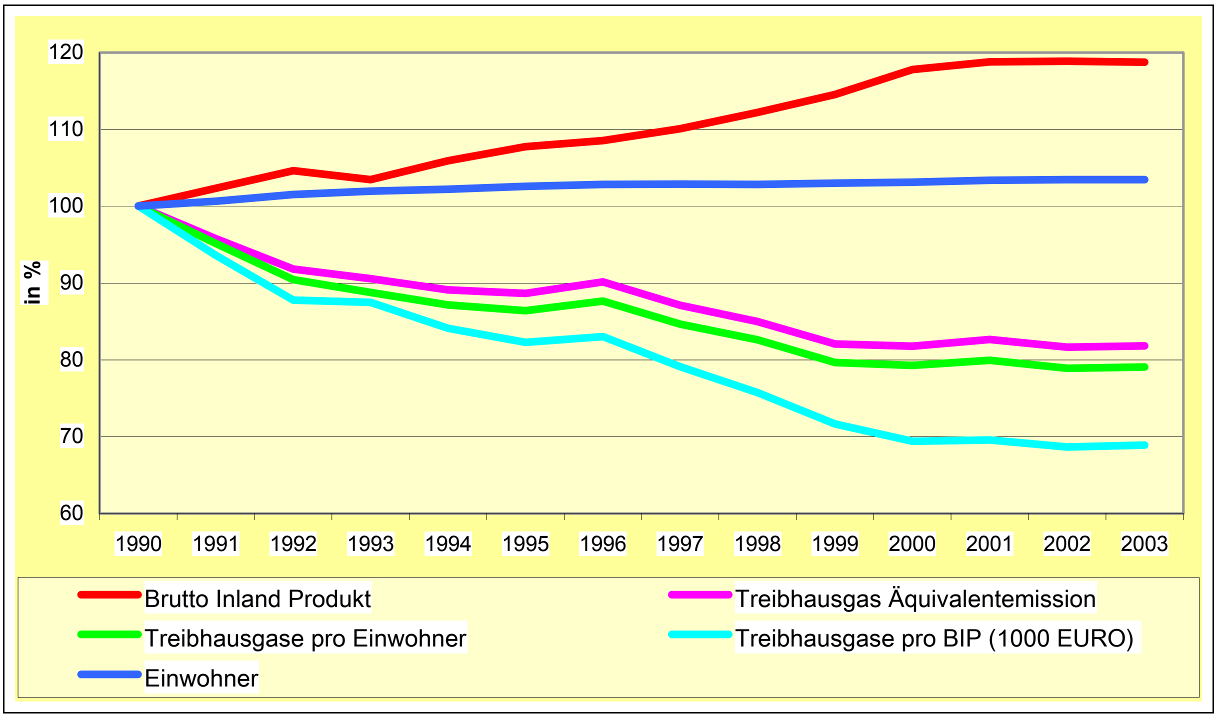
Fig. III - 2 *Relative development of emissions of selected source groups since 1990*



Source: National Inventory Report 2006

The following diagram illustrates the fact that during the period 1990 to 2003 there was a clear decoupling of economic growth (18.7%) and population development (+3.5%) from the trend in greenhouse gas emissions (–18.2%). These successes become even more apparent when one compares the development of "emissions per head" (–20.1%) with "greenhouse gases per GDP" (–31.1%).

Fig. III - 3 Relative development of emission indicators since 1990



Since the annual inventories and substance-specific emission trends are described in detail in the National Inventory Report, these are shown below for the individual greenhouse gases in graphic form as trends in "emissions per head".

Almost identical patterns are displayed by the trends in total greenhouse gases (stated as CO_2 equivalent emissions: –20.9%) and the release of CO_2 (–17.6%). The reason for this is the dominance in volume terms of carbon dioxide – in the period under review the share of total greenhouse gas emissions accounted for by CO_2 emissions rose from 81 percent to 85 percent.

During the period 1990 to 2003, emissions of methane were reduced by more than 2.7 million tonnes, reducing "emissions per head" from nearly 80 to 43 kg per head of the population. This reduction of over 40 percent was due to the reduction in livestock numbers, the increasing thermal treatment of much reduced quantities of waste for landfill, the collection and recovery of landfill gas, the decline in coal production and the use for energy purposes of methane recovered from coal mining operations. Other factors tending to reduce emissions were the refurbishing of gas distribution networks and the changeover to liquid and gaseous fuels for small combustion plants.

Emissions of nitrous oxide in 2003 were nearly 29 percent below the 1990 level. This resulted in "emissions per head" falling from 3.5 to 2.5 kg per head of the population. Here emission reductions in the agricultural sector (reduced livestock numbers) were offset by the increase in emissions in the traffic sector. From 1997 onwards, technical reduction measures in the production of adipic acid led to a sharp fall in total emissions.

III.4. Emissions of fluorinated greenhouse gases

Different trends can be seen in the development of emissions of the “F-gases” (PFC, HFC and SF_6) during the period 1990 to 2003. Total emissions of these gases in 2003 came to 10 million tonnes CO_2 equivalent. Owing to increased use as a substitute for CFCs, emissions of HFCs in this period showed a rise of about 130 percent to reach an “emissions per head” figure of about 100 kg. The increase since the base year 1995 was thus around 54 percent. Total emissions of HFCs in 2003 amounted to slightly over 6,000 t, corresponding to 8.2 million tonnes CO_2 equivalent. Unlike other emission sources, large quantities of HFCs are stored in refrigeration and air conditioning systems and certain rigid foams. Germany reports these stored quantities as potential emissions.

The development of SF_6 emissions between 1990 and 2003 shows an overall rise from 44 to 51 kg per head of the population, but reduction measures introduced since the base year 1995 have resulted in emissions falling by over 37 percent to 171 t, corresponding to 4.1 million tonnes CO_2 equivalent. As in the case of HFCs, there are a number of applications in the field of SF_6 where large quantities of SF_6 are stored, for example in electrical power transmission systems and sound-insulation window panes. Germany reports these stored quantities as potential emissions.

Emissions of PFC compounds have been substantially reduced since 1990, falling from 34 to 10 kg per head of the population. This represents a reduction of around 70 percent, and is largely due to the reduction in CF_4 emissions by the aluminium industry. The reduction since the base year 1995 was over 50 percent. In 2003 PFC emissions came to 111 t, corresponding to 0.8 million tonnes CO_2 equivalent.

Depending on the measures taken, an estimated 20, 16 or 13 million tonnes CO_2 equivalent will be emitted in 2010. In view of the different trends in the three substance groups, the individual substance groups/gases are examined separately below.

Fig. III - 4 *Population-adjusted development of HFCs, PFCs and SF_6 in Germany*

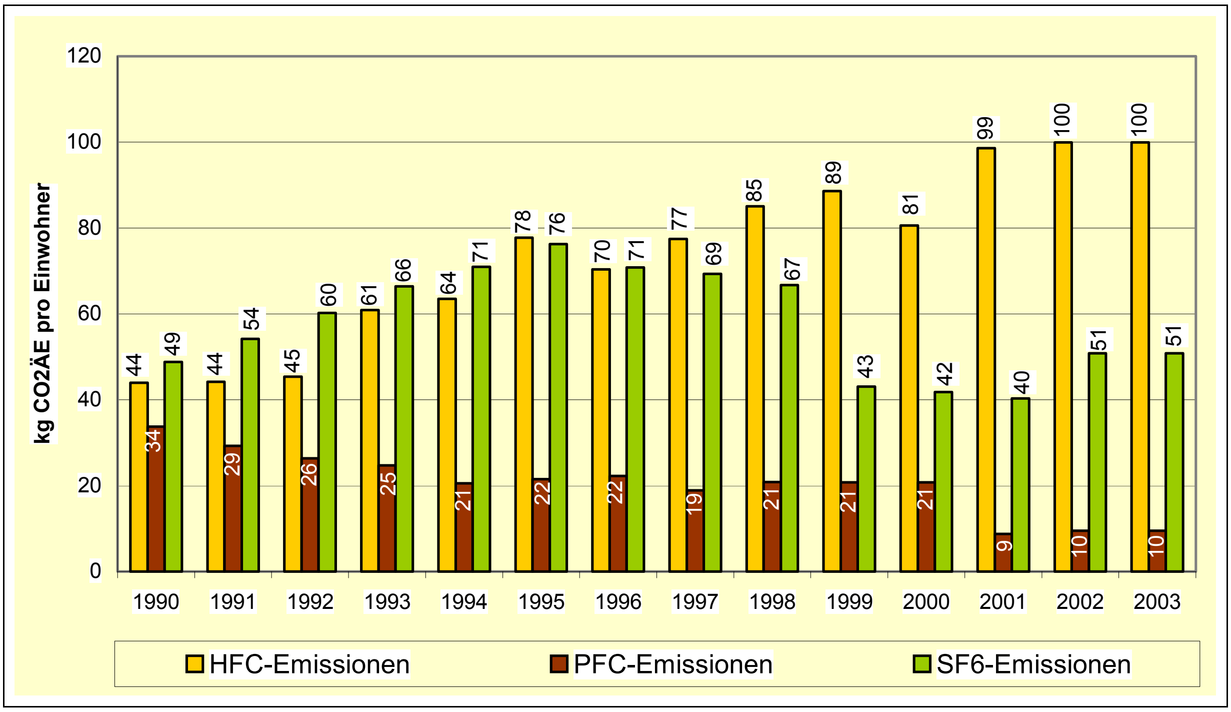
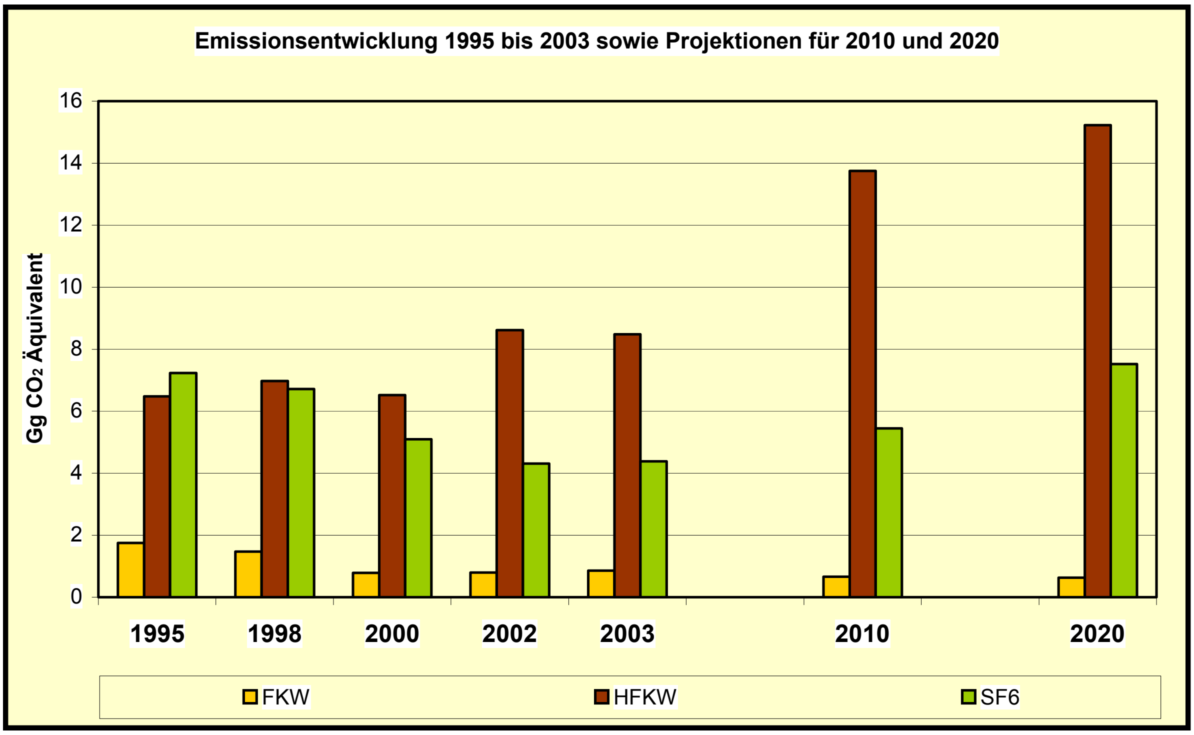


Fig. III - 5 *Estimated development of emissions of HFCs, PFCs and SF_6 between 1995 and 2020, taking account of all measures implemented up to 2003*



III.4.1. Emissions of perfluorocarbons (PFC)

Not all PFC emissions are the result of deliberate use of these substances in products and processes. In this respect the PFC group of substances differs considerably from HFCs and SF_6. A large proportion of PFC emissions originate from aluminium smelting, where CF_4 and C_2F_6 are formed as a side effect in the electrolysis of aluminium (anode effect). Other emission sources are the semiconductor industry (CF_4, C_2F_6, C_3F_8, C_4F_8) and circuit board manufacture (CF_4). PFC gases are used here for etching purposes. Until 1994 CF_4 was also emitted as a by-product in CFC production. PFC emissions from applications where they are used as a substitute for CFCs are comparatively low in Germany. This is due to the fact that most applications make use of other substitute substances. Only in refrigeration and air conditioning systems have PFCs been used in isolated cases since about 1995. For a time Nike used PFCs as a shock-absorbing gas in the soles of sports shoes.

In 1990 and 1995, aluminium smelting was already the biggest source of PFC emissions. Despite extensive measures and substantial emission reductions this is still the case today. However, between 1995 and 2003 the share of emissions due to aluminium smelting fell from 90 percent to less than 60 percent of total PFC emissions. In 2003 approximately 30 percent of PFC emissions were due to the semiconductor industry (1995: about 10%) and approximately 12 percent (1995: about 0.5%) to refrigeration and air conditioning systems.

Latest estimates indicate that PFC emissions in 2010 and 2020 will be around 0.6 million tonnes CO_2 equivalent. This presupposes continued rigorous implementation of measures already initiated and established.

III.4.2. Emissions of halogenated fluorocarbons (HFC)

Since the early 1990s, HFCs have been used as substitutes for fully or partially halogenated chlorofluorocarbons (CFCs or HCFCs), which damage the ozone layer and contribute to the greenhouse effect. Accordingly, their emissions largely originate from products and processes in which they are specifically used as refrigerants, expanding agents, propellant gases, etching gases or fire extinguishing agents. Moreover, HFC emissions (HFC-23) also occur as a by-product in the production of HCFC-22.

When assessing emission levels, the great variations in the greenhouse potential (GWP) of the individual HFCs make it necessary to distinguish between emissions in tonnes (first percentage in brackets) and in CO_2 equivalent (second percentage). In 2003 stationary (18%; 33%) and mobile (26%; 27%) refrigeration and air conditioning systems were the biggest source of HFC emissions. Other relevant emission sources were expanding polyurethane (PU) foam (12%; 6%), XPS and PU rigid foams (34%; 12%) and aerosols (8%; 7%). Some 2% (15%) consisted of emissions from the production of HCFC-22.

Whereas emissions from refrigeration and air conditioning systems have been increasing steadily since 1995, emissions from expanding PU foam have been substantially reduced. This latter effect is due to reduced use of HFC in the expanding agents, use of HFCs with a lower GWP, and the incipient use of halogen-free substances. In the rigid foam sector, emissions have remained virtually unchanged since HFCs started to be used as substitutes for (H)CFCs (PU since 1996, XPS since 2001). The decline in HFC 23 from HCFC-22 production has had a particularly striking impact on the trend in total emissions. Thanks to feeding the gases into a splitting unit and other measures, these emissions were reduced by 80%, to 100-200 t in 2003.

Latest estimates indicate that HFC emissions in 2010 and 2020 will be around 14 and 15 million tonnes CO_2 equivalent respectively. By implementing measures already planned, they could be reduced to around 11 and 9 million tonnes CO_2 equivalent respectively, and by implementing other measures to 9 and 6 million tonnes CO_2 equivalent respectively.

III.4.3. Emissions of sulphur hexafluoride (SF6)

SF_6 emissions result exclusively from targeted use of this substance. In 2004 emissions of SF_6 originated largely from non-ferrous metal foundries (30%), sound-insulating window panes (28%), electrical power transmission systems and other electrical systems (21%). There are also a large number of minor applications that add up to about 21 percent of the total emissions.

Whereas in 1995 car tyres were still the main source of SF_6 emissions, this application is now of minor importance. Emissions from sound-insulating window panes and electrical power transmission systems have also fallen steadily since 1995. By contrast, there has been a sharp rise in emissions from non-ferrous metal foundries, and here the increase since 1999 has been due in particular to aluminium foundries. Emissions from magnesium foundries have also increased.

Latest estimates indicate that SF_6 emissions in 2010 and 2020 will be around 5 and 8 million tonnes CO_2 equivalent respectively. By implementing measures already planned, they could be reduced to around 4 and 6 million tonnes CO_2 equivalent respectively, and by implementing other measures to 3 and 5 million tonnes CO_2 equivalent respectively.

IV. Policies and measures

IV.1. General and political background

Germany pursues an ongoing climate protection policy that is both ambitious and comprehensive. To this end the Federal Government in 1990 set up the interministerial working group (IMWG) “CO_2 Reduction”, which now has seven sub-committees. The working group is lead managed by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, whereas the individual sub-committees are each chaired by the responsible ministry. The interministerial working group on “CO_2 Reduction” provides a body where all climate protection issues can be discussed and agreed within the Federal Government. Activities at national level are coordinated with the regional level (*Laender*) through joint national/regional committees, like the conference of environment ministers, and with the local level (municipalities) via the central associations of the local authorities. Since it was set up, the IMWG “CO_2 Reduction” has submitted six reports to the Federal Cabinet, establishing the basis for the national climate protection policy. In view of the great importance of emissions trading as an innovative instrument of climate protection policy, the Federal Government decided on 18 October 2000 to set up the Working Group on Emissions Trading to Combat the Greenhouse Effect (AGE) under the lead management of the Federal Environment Ministry. In addition to representatives of the Federal Government and selected regional (*Land*) governments, this working group includes in particular participants from industrial associations and enterprises and from trade unions and environmental associations. The working group has met 51 times since December 2000. Today it effectively performs the function of a permanent hearing as far as integration of emissions trading into the range of climate protection policy instruments is concerned.

The Federal Government’s climate protection programme, which was recently updated and improved in the “National Climate Protection Programme 2005”, contains as absolute requirements specific reduction targets for CO_2 and the other Kyoto greenhouse gases CH_4, N_2O, H-CFC, CFC and SF_6. These greenhouse gas emission reduction targets were to be supported by, among other things, the implementation of various sub-goals geared to the sustainability approach. In this way Germany seeks to make a contribution to the worldwide efforts to limit global warming to a maximum of 2 degrees Celsius.

<u>Greenhouse gas reduction targets by 2008-2012</u>

The National Climate Protection Programme 2005 explicitly states the following climate policy objectives:

- Reduction of average annual emissions of the six greenhouse gases of the Kyoto Protocol over the period 2008-2012 by 21 percent compared with the base year;

Overall reduction targets for carbon dioxide, which have been allocated to the individual sectors on the basis of Section 4 of the Allocation Act 2007 in the course of implementing the European emissions trading scheme:

Table IV - 1 National CO_2 emission targets and their allocation to individual sectors

	Allocation period 2005-2007	**Allocation period 2008-2012**
Energy and industry	503 mill. t/year	495 mill. t/year
Transport and households	298 mill. t/year	291 mill. t/year
Trade, commerce and services	58 mill. t/year	58 mill. t/year
Total	**859 mill. t/year**	**844 mill. t/year**

Source: Allocation Act 2007 and National Allocation Plan for Germany, 2004

The targets for the second allocation period 2008-2012 will be reviewed in connection with the preparation of the Second National Allocation Plan in 2006, and this must take account of the latest findings about greenhouse gas accounts.

- Including the other Kyoto greenhouse gases (CH_4, N_2O, SF_6, H-CFC and CFC), the National Allocation Plan in 2004 set the climate protection targets at 982 million tonnes CO_2 equivalent per year for the period 2005-2007, and at 962 million tonnes CO_2 equivalent per year for the period 2008-2012. These targets are currently being reviewed, taking account of the latest findings about greenhouse gas accounts.

- In accordance with its voluntary undertaking, the Federal Government intends to make a 30-percent reduction in CO_2 emissions within its purview by 2008-2012 compared with the base year 1998.

It is agreed in the coalition agreement of 11 November 2005 that Germany will continue to play its leading role in the field of climate protection. The aim is to limit global warming to a climate-friendly level of 2°C compared with pre-industrial levels. The National Climate Protection Programme will undergo further development, and additional measures will be taken to ensure that Germany achieves its Kyoto target for 2008-2012. The following key points are laid down in the coalition agreement and the National Climate Protection Programme 2005:

- Double energy productivity by 2020 compared with 1990
- Speed up remediation of energy situation in existing buildings, among other things by increasing the annual volume of financial assistance for CO_2-oriented building remediation to at least EUR 1.4 billion
- Modernise power stations (e.g. by means of incentives to build efficient and climate-friendly power stations in the context of emissions trading)
- Promote expansion of decentralised power plants and high-efficiency CHP plants, and review the assistance system under the CHP Act on the basis of the monitoring report
- Support the European initiative to improve energy efficiency and to develop a European top-runner programme
- Continue and intensify the dena (German Energy Agency) initiatives for energy saving in the fields of buildings, electricity consumption (e.g. idle and stand-by) and transport
- Develop an international climate protection convention by 2009 for the period after 2012; this should build on the Kyoto Protocol and should integrate other industrialised countries and economically advanced threshold countries with commitments commensurate with their capabilities
- Further develop emissions trading with the aim of improving its environmental and economic efficiency and making the allocation system more transparent and less bureaucratic (prevent windfall profits, take special account of the international competitiveness of energy-intensive industry, reduce burden of costs for industry, integrate other industrialised countries and major threshold countries)
- Support the EU Commission in its investigation of the possibility of including air transport in emissions trading
- Make it easier to use the flexible mechanisms (Joint Implementation and Clean Development Mechanisms), to improve market prospects for German industry abroad

- Increase the share of electricity supplies accounted for by renewable energies to at least 12.5 percent by 2012 and at least 20 percent by 2020
- Increase the share of primary energy consumption accounted for by renewable energies to at least 4.2 percent by 2010, and 10 percent by 2020.
- In a CHP agreement supplementing the agreement on global warming prevention, the energy industry has given an undertaking to the Federal Government that it will achieve a total emission reduction of up to 45 million tonnes CO_2 per annum by 2010. The CO_2 reduction is to be achieved by means of CHP-specific measures as follows: reduction on a scale of 10 million tonnes a year by 2005 and a total of, if possible, 23 million tonnes p.a. or at least 20 million tonnes p.a. by 2010 compared with the base year 1998. Achievement of these targets will be supported by the CHP Act, which makes a contribution to energy saving, environmental protection and the climate protection objectives by giving limited-term protection to and modernising CHP plants, expanding electricity generation in small CHP plants and introducing the fuel cell on the market. Moreover, the agreement also provides for a CO_2 reduction of up to 25 million tonnes p.a. in 2010 by other means, which are specified in more detail in the individual declarations by the energy industry associations that give concrete shape to the voluntary undertaking. The Federal Government is currently examining in cooperation with industry whether these ambitious targets will be achieved.

- The share of total electricity supplies accounted for by renewable energies is to be stepped up to at least 12.5 percent by 2010 and 20 percent by 2020. According to the objectives of the sustainability strategy, renewable energies are to cover roughly half of total energy consumption by the middle of the century. Renewable energies as a share of total primary energy consumption are to be increased to at least 4.2 percent by 2010 and 10 percent by 2020, followed by a steady further increase in accordance with the national sustainability strategy.

- Double energy productivity and raw materials productivity by 2020 compared with 1990.

- Regarding the increasing use of biofuels and renewable raw materials in the period to 2020, the Federal Government is guided by the objectives laid down at EU level. The directive on the “promotion of the use of biofuels or other renewable fuels for transport” (Biofuel Directive) was passed in May 2003 . The Federal Government is seeking to further develop an automotive fuels strategy with the aim of stepping up the biofuel share of total fuel consumption to 5.75 percent by 2010. The exemption of biofuels from petroleum excise duty is to be replaced by an obligation to include a specified admixture. The introduction of synthetic biofuels (BTL) onto the market is to be promoted in cooperation with industry by constructing and operating industrial-scale facilities, and work will press ahead in conjunction with industry on researching and developing renewable raw materials and launching them on the market.

Medium to long-term objectives

If it is to be successful, a national and international climate protection policy must take a long-term approach. The Federal Government considers it absolutely essential to give all actors a long-term perspective and hence a dependable framework for investment decisions.

The Federal Government advocates the creation, by 2009, of an international climate protection convention for the period after 2012 that builds on the Kyoto Protocol. Other industrialised countries and economically advanced threshold and developing countries (e.g. China, India, South Korea, Mexico, Brazil, South Africa) must be effectively integrated in the new climate protection convention and enter into commitments commensurate with their capabilities. The Federal Government proposes that in the context of the international negotiations on climate protection the EU should undertake to make a total reduction of 30 percent in its greenhouse gas emissions by 2020 compared with 1990. If this is done, Germany will endeavour to achieve an even greater reduction in its own emissions. Against this background the Federal Government welcomes the decision taken by the community of Kyoto states in Montreal in December 2005 to continue the international climate protection regime without a break beyond 2012.

To achieve the EU goal of preventing global warming of more than 2 degrees Celsius compared with pre-industrial figures, and in view of the global emission reductions that are necessary for this purpose, the Federal Government reaffirms that joint global efforts – including increased emission reduction efforts – are necessary in the decades ahead in keeping with the joint but differing responsibilities and capabilities of all countries with relatively advanced economies. In this context, and without prejudice to any new approaches to differentiation between states in a future fair and flexible framework, the Federal Government considers it necessary that the commitments entered into by the industrial states in the Kyoto Protocol for the first commitment period 2008-2012 be substantially stepped up in the succeeding commitment periods. For the group of industrialised countries, consideration should be given to the possibility of reduction paths of the order of 15–30 percent by 2020 and 60–80 percent by 2050, compared with the starting figures envisaged in the Kyoto Protocol. Within this framework the Federal Government will also continue with its ambitious efforts to update its existing commitments.

IV.2. Climate protection measures and instruments since 1990

The National Climate Protection Programme of 13.7. 2005 contains policies and measures that address all sectors. These include not only regulatory requirements, but also economic incentives and “soft measures” such as information and guidance, and education and training. From a technical point of view the National Climate Protection Programme concentrates on improving energy efficiency at all levels of energy supply, and on energy-saving activities and replacing carbonaceous energy sources with less carbonaceous ones. Increased use of renewable energies is of special importance here. The objectives of the climate protection programme focus not only on reducing greenhouse gas emissions, but also on bringing about changes in the energy mix and improvements in energy efficiency.
At an energy summit in April this year the Federal Government held discussions with various interest groups in preparation for developing a long-term national energy strategy that will take equal account of the aims of affordable energy, security of supplies and environmental impact.

Since 1990 Germany has already made great strides along the road to more efficient use of energy. Not only was primary energy consumption in 2005 well below the level of the early 1990s. Energy productivity, in other words economic output per unit of energy input, was also some 27 percent better in 2005 than in 1990. Compared with 1998 this was a further increase of as much as 9 percent.

However, the decoupling of the relationship between energy consumption and economic development has slowed down appreciably in recent years. In the early 1990s the rate of growth of energy productivity was still averaging more than 2 percent a year. This was due above all to substantial investment in the "New *Laender*". Once these investment projects were largely completed, the figure fell to an average of nearly 1 percent between 2000 and 2005. The reason for this is the already high level of energy productivity in Germany

Against this background the Federal Government's aim of doubling energy productivity by 2020 is very ambitious and calls for rigorous action. After the relatively low efficiency improvements in the first few years of this century (0.9% p.a. since 2000), the productivity growth rate in the years ahead will have to show a sharp increase to an average of 2.9 percent p.a. if the aim of doubling energy productivity is to be achieved. Even today not all options for reducing CO_2 emissions have been exhausted. Moreover, continuing high prices for energy are likely to result in a further slice of the remaining technical potential becoming economic.

The following sections explain the measures that the Federal Government has taken or will be taking to achieve the greenhouse gas reduction targets and the additional sub-goals. The description is broken down into cross-sectional measures, which relate especially to the fields of "Energy" and "Flexible Mechanisms", and sector-specific measures in the fields of "Private Households", "Trade/Commerce/Services", "Transport", "Industry and Energy Industry", "Agriculture and Forestry" and "Waste Management". A description is also given of climate-related activities by the *Laender*, local authorities and other actors.

IV.3. Cross-sectional measures

The National Climate Protection Programme adopted in October 2000 contained a package of measures for all areas of relevance to climate policy. This package of measures included numerous cross-sectional measures that have an impact on more than one sector.

On the basis of the data and studies available up to that time, it was assumed that the sum of the measures already adopted and the measures decided in the Climate Protection Programme 2000 for the period up to 2010 (or the average of the period 2008 to 2012) would, after allowing for double counting, result in a reduction of at least 107 million tonnes CO_2 equivalent. (In this connection see Chapter V.2 Projections for the period 2008 to 2012)

Table IV - 2 Reduction contributions up to 2008-2012 in Climate Protection Programme of 18 October 2000

Measures and instruments	Reduction potential (in mill. t CO_2 equivalent)
Ecological tax reform	20
Renewable energy sources	20
Measures in household and buildings sector	18 to 25 (by 2005)
Measures in industry	15 to 20 (by 2005)
Measures in transport sector	15 to 20 (by 2005)
Measures in energy sector	20 (by 2005)
Contribution by waste sector	20
Measures in the agricultural and forestry sector	not quantified

Source: National Climate Protection Programme of 18 October 2000, page 36.

IV.3.1. Energy

Supplies of energy are an essential basis for prosperity and are thus a precondition for maintaining “quality of life” at a high level. Energy is needed everywhere – whether in production processes, in the transport sector or to provide heat.

Security of energy supplies is therefore a central concern of modern societies. Their ability to function, and the quality of life attained in Germany, presuppose adequate provision of energy services. The core objectives of a sustainable energy policy include not only environmental acceptability including resource conservation and a precautionary approach to climate, but also efficiency and cost-effectiveness, and security of supplies. At an energy summit in April 2006 the Federal Government held discussions with various interest groups from political, industrial and scientific circles in preparation for developing a longer-term energy strategy that is to take account of the aims of environmental acceptability, affordable energy and security of supplies as goals of equal importance.
In recent years some signals for future energy supply structures have already been set. This process includes the expansion of renewable energies, the development of new energy technologies by stepping up investment in research in this sector (e.g. fuel cells), and the expansion of sustainable energy systems such as combined heat-and-power generation.

One component of security of supplies is efficient and economical use of increasingly expensive energy. In addition, avoiding undue dependence on individual energy sources or producing countries makes a contribution to security of supplies. For this reason Germany’s energy policy will be based on a balanced energy mix of petroleum, natural gas, renewable energies and lignite and coal, in order to limit potential supply and price risks in relation to the mostly scarce resources.

In the competitively organised energy industry, the individual energy sources’ supply shares cannot and should not remain permanently fixed. On the other hand, the energy mix is influenced by political framework conditions, for example in the fields of climate protection, industry, the energy industry and fiscal policy. There are also external factors such as developments on the world energy markets and physical or politically induced shortages of resources.

IV.3.2. Cost-effectiveness and structure of energy supplies

In addition to security of energy supplies, cost-effectiveness also plays a central role. Thus ensuring energy supplies at minimum cost in times of constantly rising raw material prices is one of the goals of sustainable energy policy from both an economic and a social point of view. However, a long-term approach to cost-effective use of energy makes it necessary to take account of the burdens effectively arising from energy supply activities while also including any external costs. Only in this way is it possible to make efficient use of the available resources in the long term. At the same time the Federal Government is aware of the importance of energy prices as a competition factor, at least for energy-intensive enterprises exposed to international competition, and it actively includes such considerations as an equally important factor in energy policy decisions and agreements with industry.

Today, more than 93 percent of energy supplies in Germany come from fossil and nuclear fuels.

In the foreseeable future there will be shifts in the market shares of the individual energy sources. The importance of nuclear power will gradually diminish as a result of the phasing out of the use of nuclear energy that has been agreed with the energy industry and laid down by law. The winners will be renewable energies, and also natural gas, which increasingly has to be imported from outside the EU and transported over long distances.

Thanks to the further diversification of its energy mix, the German economy today is less sensitive to energy price fluctuations than twenty or thirty years ago. Improvements in energy efficiency also help to minimise dependence on imports and the associated risks.

IV.3.3. Energy efficiency

The Federal Government takes the view that both supply-oriented measures and demand-oriented activities are indispensable in a coordinated climate protection programme. Measures to improve energy efficiency are extremely important in this connection. Substantial progress in improving energy productivity has already been made in the past. Nevertheless, considerable potential still exists in this field. Further marked improvements are necessary to achieve the target laid down in the national sustainability strategy of doubling energy efficiency by 2020 compared with 1990.

IV.3.3.1. Energy efficiency in the buildings sector

The Federal Government is pursuing the following strategies for energy saving in the buildings sector:

- Optimising the regulatory framework, introducing energy certificates for existing buildings
- Providing financial assistance for energy-saving measures
- Influencing consumer habits by offering a wide range of information and guidance, for example financial assistance for on-site advice from engineers for existing buildings.

- Giving the building industry an additional boost with the "Research Initiative Building for the Future"

Regulatory Measures

The most important regulatory measure in the field of building efficiency is the Energy Saving Ordinance (EnEV), which entered into force on 1 February 2002 and is based on the Energy Saving Act; it was revised on 2 December 2004 to bring it into line with the latest technological rules. The underlying EU legislation is the "Buildings Directive" of 16.12.2002. The Energy Saving Ordinance combines the previous Heat Insulation and Heating Systems Ordinances. For the first time it pursues a primary energy approach. In limiting the energy requirements permitted for new buildings, it no longer considers only the annual heat requirements for heating purposes, but also takes into account the energy used for hot water heating and ventilation. In addition to non-renewable energy sources, such as heating oil and natural gas, it also assesses renewable energy sources (e.g. biomass heating, solar thermal energy) and combined heat-and-power generation. The assessment also includes all energy conversion and transport losses in the upstream chains.

Under a holistic planning system, new technical rules for test findings for new buildings have been introduced, as have a range of new European technical rules for building products. The entry into force of the ordinance was immediately followed by the entry into force on 1 March 2002 of the general administrative guideline pursuant to Section 13 EnEV, which regulates the content and structure of the energy and heat requirement certificates. The ordinance of December 2004 amending the EnEV makes reference to updated technical rules. The largely standardised energy and heat requirement certificates create greater transparency for energy consumers and the housing market, primarily in the case of new buildings. The majority of *Laender* have introduced such certificates on a compulsory basis under *Land* law as a building document required as evidence of compliance with energy saving requirements.

Providing financial assistance for energy-saving measures

In 2001, with the aim of ensuring faster and more comprehensive exploitation of the CO_2 reduction potential in existing buildings, the Federal Government originally made about EUR 1 billion worth of financial assistance available for a period up to 2005 in order to reduce CO_2 emissions. Since the Federal Government takes the view that this savings potential has not yet been adequately exploited, this financial assistance was expanded at the beginning of 2006 to form a building remediation project under which total annual assistance of EUR 1.4 billion is now provided for energy-saving remediation of buildings built before 1983. The aim is to refurbish 5 percent of the relevant buildings every year to take advantage of the substantial savings potential. Under the optimised CO_2 building remediation programme of the KfW-Förderbank (www.kfw-foerderbank.de), assistance is provided for the following measures in residential buildings built before 1983:

- Reduction of CO_2 emissions by at least 40 kilograms per year per square metre of useful floor space. Individual measures such as replacement of old heating systems, and measures that achieve CO_2 savings of less than 40 kg per m^2 per year, are also assisted on terms geared to the climate-friendliness of their impact. In most cases the increase in the maximum amount of assistance to EUR 50,000 per dwelling permits total financing of the remediation projects.

- Partial debt remission where old buildings are refurbished to the standard of a low-energy house.

In addition, assistance is given for the construction of particularly energy-saving buildings (energy-saving houses with a primary energy requirement of 40 or 60 kWh/m^2 per year, and passive houses) and installations for using renewable energies.

From February 2001 to March 2005 some 75,500 loans worth a total of EUR 4.2 billion were granted for the remediation of more than 223,000 homes. The programme is the biggest of its kind in Europe. According to a study by Forschungszentrum Jülich[33], the measures initiated under the programme since 2001 have reduced CO_2 emissions by around 1.2 million tonnes.

The main focus of building activities is increasingly concentrating on modernisation of existing buildings. To exploit the associated energy-saving potential the Federal Ministry of Economics and Technology, as part of its energy research activities, has considerably stepped up its assistance programme “Energy-saving improvement of building fabric (EnSan)” under the assistance concept “Energy-optimised building (ENOB)”. The objectives of “EnSan” include further developing the technical ways and means of reducing energy consumption in existing buildings and, in the longer term, combining them with an economic perspective: the savings in energy costs that result from addition energy-oriented remediation should, when totalled over appropriate payback periods, recover the necessary capital expenditure. In addition to basic research and development projects, research-intensive demonstration projects also will continue to be integrated in the financial assistance activity “EnSan”, for which some EUR 5 million p.a. is made available every year. The assistance is given specifically for testing of innovative methods and systems, newly developed constructional components and building services elements and materials, in conjunction with conventional remediation and modernisation measures that would have been carried out in any case.

Influencing consumer habits

Of the funds that the federal budget allocates to the CO_2 building remediation programme of the KfW-Förderbank for 2006, some EUR 12 million are to be used among other things for model energy-saving remediation projects, public relations work, stepping up trade and consumer information (including production of a brochure to accompany the introduction of energy certificates), and intensifying advice on energy saving.

In autumn 2000 the German Energy Agency (Deutsche Energie-Agentur – dena) was founded at the initiative of the Federal Government. As a centre of energy efficiency expertise, dena assists the Federal Government in its efforts to achieve further energy savings, primarily through targeted public relations work in the form of information campaigns. The budgets of the Federal Ministry of Economics and the Federal Ministry of Transport, building and Urban Affairs (BMVBS) each include up to EUR 2.5 million per annum for this purpose. Through these funds, the Federal Government assists a variety of dena projects, one aim being to step up public relations work for energy saving and climate protection. In this way it promotes the implementation of the Energy Saving Ordinance – and especially target group

[33] Forschungszentrum Jülich (Ed.) (2005): Evaluierung der CO2-Minderungsmaßnahmen im Gebäudebereich.

specific communication of its contents (to architects, planning experts and craft trades). A broad spectrum of media (press work, energy hotline, Internet portal, information brochures, specialist conferences and seminars) is used to publicise energy-efficient building to the general public – including the end consumer. In this connection the Internet portal developed by dena for informing planning experts and architects has proved to be a particularly suitable medium (www.dena.de). An advertising campaign has succeeded in bringing the new holistic approach of the Energy Saving Ordinance to the attention of architects and craft trades – the decisive target group for implementation of the Ordinance – through information in specialist journals, and in overcoming reservations. The information and guidance for citizens and planning experts through the energy hotline and the information brochures developed – especially for existing buildings – under the CO_2 building remediation programme are also well received by consumers and thereby help to increase public acceptance of the issue of climate protection, which is an indispensable basis for further successes in the reduction of CO_2 emissions.

Another factor which helps ensure that building is keyed more closely to the requirements of environmental protection is the dissemination of specialist information on low-cost, energy-saving building under the "Initiative for low-cost energy-saving building", which is run by the Federal Ministry of Transport, Building and Urban Affairs (BMVBS) in cooperation with the collective bargaining parties in the building trade, important associations in the building and housing industry, the professional organisations of architects and consulting engineers, the building finance companies and the consumer centres. Since autumn 2001 the centre of expertise for "low-cost energy-saving building" set up under the initiative of the same name has been informing private building clients about low-cost energy-saving homes through a broad spectrum of media (www.kompetenzzentrum-iemb.de).

The specialist discussions on quality under the "Architecture and Building Culture Initiative" are not confined to the individual building, but take in urban development aspects relating to sustainability and energy optimisation. Also involved in the joint initiative launched in autumn 2000 with the participation of the Federal Ministry of Transport, Building and Urban Affairs are the Federal Government's Culture and Media Officer, the nationwide chambers and associations of the planning professions, and other institutions. In the period under review the Federal Ministry of Transport, Building and Urban Affairs published the brochure "More Climate Protection Through Urban Development Competitions", which is designed as a handout for actors in the field of town planning. It gives concrete examples of how design options that benefit climate protection can be mobilised by means of intelligent planning concepts. Experience gained in model projects run under the ministry's research programme on experimental housing and urban development shows that this is a worthwhile approach and can lead to an appreciable reduction in CO_2 emissions in both existing buildings and new housing areas.

IV.3.4. The Federal Government's voluntary undertaking

The public sector, and especially the Federal Government, are at pains to live up to their role model function in connection with the climate protection programme as well, and to pay systematic attention to the aspect of climate relevance in their own economic activities. After all, five to six percent of total end-use energy consumption is accounted for by public institutions and facilities at federal, regional and local level.

At the same time substantial potential for energy saving and hence for reducing operating costs is known to exist in the field of heating energy and electricity consumption in public buildings and facilities. Activities necessary to implement the Federal Government's voluntary undertaking to bring about a 30-percent reduction in CO_2 emissions by 2008-2012 compared with the base year 1990 are concerned not only with the use of environmental management and controlling in public establishments, but also with taking account of environmental and climate aspects in public procurement and state investments.

Numerous buildings belonging to federal authorities have undergone energy-saving remediation in recent years. In addition to public-law requirements, there are also various special regulations for such projects, such as

- the planning specifications of AMEV (machinery and electrical engineering working group of the state and local authorities),
- the guide to “Sustainable Building for Federal Buildings” introduced in 2001.

Other aids are

- the information brochure on “Reducing CO_2 emissions within the sphere of responsibility of the Federal Government”
- the study on “Energy saving potential in existing federal buildings”.

As an integral part of its national sustainability strategy the Federal Government has approved the pilot project for “Energy efficiency contracting in federal properties”. The aim of the project is to have urgently needed energy-saving modernisation measures in federal properties carried out and financed by private-sector energy service providers. This enables the owners of the properties to optimise their energy management without having to make investments of their own. It permits cost-effective exploitation of existing energy-saving potential and reductions in CO_2 emissions. Lead management for the federal authorities' civil properties is in the hands of the Federal Ministry of Transport, Building and Urban Affairs, while for military properties it rests with the Federal Ministry of Defence (BMVg). Steering of the project is handled by the German Energy Agency (dena). To date 31 properties have been definitely recruited for the contracting project, which began in mid 2002, and this will result in annual CO_2 reductions of 12,000 tonnes. This saving corresponds, for example, to the total emissions for the entire sphere of responsibility of the Federal Environment Ministry.

The Federal Government appointed an energy officer for the building measures in Berlin in connection with the move from Bonn. Initial measurements during use of the buildings already indicate that the energy requirements have mostly been reduced to the ambitious level demanded by the energy officer. For example, heating energy requirements in the new buildings are 20-50 percent below the level required by the Heat Insulation Ordinance. Most of the buildings still to be completed can be expected to yield a reduction of 40 percent compared with the present situation. In the case of electrical energy too, the ambitious targets are mostly being achieved in practice. Special mention must be made of the results of the ecological energy supply efforts. The implementation of an innovative energy supply concept for the parliament and government buildings by the River Spree means that 80 percent of requirements are met from renewable energy sources. Other measures are: an “EMAS pilot group in federal authorities”, an Internet offering on “Environmental controlling/

environmental management in federal authorities", the publication of a "motivation brochure" for those responsible for procurement in public establishments, and the brochure "Environmental protection pays off for public authorities – strategies and examples of economic incentives"[34]. The Federal Environment Ministry also plans to publish a working aid on the procurement of green electricity. Starting in 2005, the introduction in the Federal Environment Ministry of the environmental management system in accordance with the EMAS Regulation will make an important contribution to reducing CO_2 emissions.

The task of coordinating the Federal Government's voluntary undertaking and preparing overall accounts is the province of the Federal Environment Ministry. Implementation of the measures within their own spheres is the responsibility of the individual ministries. As an aid to ministries, the Federal Environment Ministry and the Federal Ministry of Transport, Building and Urban Affairs have jointly produced the information brochure "Reducing CO_2 emissions within the sphere of responsibility of the Federal Government", which is essentially based on experience gained during implementation of the voluntary undertaking within their own spheres. By means of such measures the Federal Environment Ministry succeeded in reducing its CO_2 emissions by a calculated 800 tonnes p.a. by the end of 2003. Within the sphere of the Federal Ministry of Defence, a CO_2 reduction of exactly 144,975 tonnes p.a. was achieved in the heat supply sector from 2000 to 2004, mainly thanks to building remediation and installation of innovative heating systems and through changes in user habits ("Energy Saving Campaign 2004" throughout the federal armed forces). The brochure was presented at the meeting of the IMWG "CO_2 Reduction" on 18.03.2003 and subsequently sent to all ministries.

Furthermore, a federal energy officer is in future to be involved in all federal building projects with construction costs totalling more than EUR 50 million and other projects where energy is of great significance. Unutilised energy-saving and cost-saving potential is also to be exploited by optimising technical building service management, and especially operational monitoring.

For the period 2006 to 2009 the Federal Government intends to make up to EUR 0.5 billion available for energy-saving refurbishment of federal properties. The funds are to be used in particular to finance energy-saving measures that are economic in the longer term, such as replacement of windows or heat insulation improvements to external walls, which contractors do not normally include in their offer for economic reasons. The funds are also to be used to implement individual lighthouse projects that focus, for example, on innovative technologies for the use of renewable energies or on combined heat-and-power generation such as fuel cells.

<u>"atmosfair"</u>
In 2004 the Federal Environment Ministry started the "atmosfair" project. This gives every airline passenger the opportunity to compensate for the emissions caused by a flight by making an equivalent contribution to financing specific climate protection projects. The Federal Environment Ministry is currently looking into ways and means of neutralising the climate impact of official air travel within its sphere of responsibility and its subordinate authorities by financing suitable projects (see also Section IX.3.2).

[34] Federal Environment Ministry (BMU)/Federal Environmental Agency (UBA) (Ed.), December 2003.

IV.3.5. Expansion of renewable energies

Environmentally and economically meaningful expansion of renewable energies is a cornerstone of sustainable energy supplies and a systematic climate protection policy. In recent years the quantity of electricity delivered by renewable energy sources against payment has increased from around 39 TWh (including 10 TWh paid for under the Renewable Energies Act) in 2000 to about 62 (43) TWh in 2005. Approximately 43 percent was due to wind energy, 35 percent to hydro power and nearly 20 percent to biomass utilisation (including landfill gas and biogenic component of waste). Electricity generation from renewable energies made it possible to avoid some 58 million tonnes of climate-relevant carbon dioxide, including 38 million tonnes under the Renewable Energies Act. This makes the Renewable Energies Act one of Germany's most important climate protection instruments.[35]

Table IV - 3 Percentages of energy consumption due to renewable energies

	2000	2001	2002	2003	2004	2005
Primary energy consumption	2.6	2.7	3.0	3.5	4.0	4.6
Gross electricity generated	6.7	6.7	7.8	8.0	9.4	10.2
Heat supplied	3.9	3.8	4.0	5.1	5.2	5.4
Fuel consumption[36]	0.3	0.5	0.8	1.1	1.9	3.4

Source: BMU, AGEE Stat

IV.3.5.1. The Renewable Energies Act (EEG)

A decisive factor in the expansion of renewable energies is the Renewable Energies Act (EEG), which on 1 April 2000 superseded the Electricity Feed Act (StrEG). Under the Renewable Energies Act, plant operators are granted a fixed level of feed compensation differentiated by energy sources, usually for a period of 20 years. The compensation must normally by paid by the network operator for 20 years. This creates a large measure of planning certainty for the investor. The compensation is financed by a levy on all electricity consumers, which results in increased costs. The declining compensation rates create an incentive to reduce costs, but also an incentive to implement projects as early as possible. The revised Renewable Energies Act entered into force on 1 August 2004. In order to achieve the ambitious expansion targets for renewable energies, this improved the framework conditions for infeed, transmission and distribution of electricity from renewable energies and also improved and optimised the compensation rates for electricity from renewable energies compared with the Renewable Energies Act 2000 (reduction for electricity from wind power; marked increase for biomass in order to tap hitherto unexploited biomass potential). The compensation rates differentiated by energy type and plant size and the reference yield model for wind energy ensure rough alignment with the different production costs and hence a limitation of windfall profits or excessive assistance. A nationwide adjustment system ensures uniform geographical

[35] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Ed.): Erneuerbare Energie in Zahlen – Nationale und internationale Entwicklung, Berlin, February 2006

[36] Based on total fuel consumption in road traffic sector

distribution of the electricity quantities fed into the grid and the amounts of compensation, thereby avoiding undue burdens on individual network operators or electricity customers in specific regions.[37] The Act also extended the declining rate system.

By the end of 2007 the Federal Environment Ministry is required to submit to the Federal Government a report on experience, which is also to examine the economic efficiency of the individual compensation rates. On the basis of this experience, the compensation rates, decrement rates and assistance periods are, if necessary, to be adapted in line with the development progress of the individual renewable energies, and new focal points set where appropriate.

IV.3.5.2. The market incentives programme

The market incentives programme for promoting renewable energies (MAP) was introduced in connection with the ecological tax reform. The main focus here is on promoting solar collectors and biomass plants for heat generation. In 2003 the Federal Government raised the assistance rates for solar collectors, thereby ensuring that the number of applications approved more than doubled, from over 56,000 in 2002 to over 145,000 in 2003. The funds available under the guidelines amounted to EUR 190 million in each of 2002 and 2003, and EUR 200 million in 2004. The new guidelines for the MAP programme that entered into force on 1 January 2004 improved, for example, the assistance terms for modern wood combustion plants, enlarged the circle of eligible applicants, and laid down progressive environmental requirements regarding the eligibility of plants for assistance. New assistance guidelines for the market incentives programme came into force in July 2005. Significant innovations include increased assistance rates for solar collectors for combined hot-water heating and space heating support, and slightly reduced assistance rates for solar collectors exclusively for hot-water heating.

In addition to the grants for such installations, the KfW-Förderbank also offers low-interest loans for biogas systems, larger plants for burning solid biomass, plants for utilising deep geothermal heat and small hydro power plants; in some cases these are made even more attractive by debt remission under the programme. Some 1,951 loans with a total value of EUR 508 million were granted.

Since the start of the market incentives programme in 1999, assistance has been given for a total of more than 406,000 capital projects for utilisation of renewable energies.[38]

Impacts

The growth of renewable energies makes a substantial contribution to reducing greenhouse gas emissions. The Electricity Feed Act which entered into force in 1991, and in particular the Renewable Energies Act which has been in force since 1.4.2000 have led to the construction of additional plants for generating electricity from

[37] An overview of the latest compensation rates for renewable energy plants in the individual sectors can be found in: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Ed.): Erneuerbare Energie in Zahlen – Nationale und internationale Entwicklung, Berlin, June 2005, p. 22 f.

[38] Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Ed.): Erneuerbare Energie in Zahlen – Nationale und internationale Entwicklung, Berlin, June 2005, p. 24

renewable energies and have made possible the continued production of electricity by renewable energy systems that were already operating before 1991 (especially small hydro power plants). The total CO_2 saving as a result of these plants came to 38 million tonnes in 2005.

It is absolutely essential to make renewable energies competitive in the medium to long term. Only if renewable energies can survive on the market without financial assistance can they play a major role on the energy market in the long term.

In the course of the expansion of renewable energies, there has in recent years been a rise in the number of jobs at manufacturers of wind energy systems, photovoltaic systems, solar collectors, geothermal plants and hydro power plants and their components suppliers. In 2004 some 157,000 persons were employed in these areas. This is a simple view of the impact on the job situation. It does not take any account of the long-term economic impacts of the Renewable Energies Act on employment in other sectors of the economy.

CO_2 reduction potential in the building sector can be exploited not only by energy-saving refurbishment of existing buildings, but in particular through dynamic growth of renewable heating technologies (especially solar collectors and biomass heating systems). In 2005 an additional 18.5 million tonnes CO_2 was saved in the heat sector by using renewable energies. Funds from the market incentives programme made it possible to install an annual average of about 600,000 m² of collectors and build about 11,000 biomass systems for the production of heat. For buildings in the private household sector, local authorities have an important role to play because of their responsibility for physical development planning, especially where new buildings are concerned. The revision of the Federal Building Code in 2004 boosted the importance of physical development planning in sustainable urban development and stressed its function of ensuring an environment fit for people to live in and of protecting and developing the natural basis of life, also having regard to their responsibility for climate protection in general. To this end – as well as introducing a general requirement of environmental impact assessment for all physical development plans – it created in particular the possibility of specifying in the local development plan constructional requirements regarding the use of renewable energies, such as solar energy in particular, that are to be taken when erecting buildings. For urban development contracts it made it clear that agreements could also be made on the use of networks and CHP systems for heat and electricity supplies and on the use of solar energy systems.

To promote the use of renewable energies, the revision of the Federal Building Code in 2004 also facilitated the building of certain biomass systems in non-built-up areas in the context of agricultural, silvicultural, horticultural or livestock farming operations. To protect such non-built-up areas, however, this simplification was confined among other things to systems with an electrical output not exceeding 0.5 MW. In particular, the revised provisions made it possible under construction planning legislation for two or more farms to cooperate in the operation of a biomass plant.

IV.3.6. Agreement on global warming prevention and CHP agreement

In a CHP agreement supplementing the agreement on global warming prevention, the energy industry has given an undertaking to the Federal Government that it will achieve a total emission reduction of up to 45 million tonnes CO_2 per annum by 2010. The CO_2 reduction is to be achieved by means of CHP-specific measures as follows: reduction on a scale of 10 million tonnes a year by 2005 and a total of, if possible, 23 million tonnes p.a. or at least 20 million tonnes p.a. by 2010 compared with the base year 1998. Achievement of these targets will be supported by the CHP Act, which makes a contribution to energy saving, environmental protection and the climate protection objectives by giving limited-term protection to and modernising CHP plants, expanding electricity generation in small CHP plants and introducing the fuel cell on the market. Moreover, the agreement also provides for a CO_2 reduction of up to 25 million tonnes p.a. in 2010 by other means, which are specified in more detail in the individual declarations by the energy industry associations that give concrete shape to the voluntary undertaking. The Federal Government is currently examining in cooperation with industry whether these ambitious targets will be achieved.

The monitoring reports to date demonstrate German industry's ongoing efforts to improve energy utilisation efficiency and to reduce CO_2 emissions, and also its successes. Particularly in the industrial sector, there has been a very substantial reduction in CO_2 emissions in both specific and absolute terms. However, there has yet to be a definitive assessment of whether German industry has succeeded in implementing the targets stated in the agreement, especially in the field of combined heat-and-power generation.

IV.3.7. The ecological tax reform

The aim of the ecological tax reform which entered into force on 1 April 1999 is to

- make the factor "energy" more expensive by increasing taxes on heating and automotive fuels and electricity, and thereby create incentives to save energy, and
- make the factor "labour" less expensive by using the resulting additional tax revenue to reduce the rate of contributions to the statutory pension scheme, and thereby help to create a more favourable framework of conditions for the labour market.

The last stage of the ecological tax reform took effect in 2003. Essentially it increased the rates of excise duty on heating and automotive fuels, introduced the electricity tax and then successively increased it. Initially tax concessions in relation to petroleum excise duty and electricity tax were necessary for economic, environmental or social policy reasons, but these have already been reduced to some extent in the interests of better coordination of steering and distribution effects. This is an important step towards doing away with subsidies that are harmful to the environment.

The ecological tax reform has helped to save energy, reduce emissions of climate-relevant greenhouse gases, and improve the basic conditions for creating more jobs. It also creates incentives for investment in environmentally friendly technologies for the future and thereby increases the competitive strength of German industry. The ecological tax reform has proved its value as a national steering instrument. The overall balance is positive.

IV.3.8. Emissions trading, Joint Implementation/Clean Development Mechanism

Emissions trading was successfully introduced in 2005. The enterprises covered by the trading scheme basically have the option of implementing emission reduction measures of their own or buying emission allowances on the market. By providing this choice, the emissions trading scheme makes for cost-effective compliance with the emission targets for the energy and industry sectors that are laid down in the National Allocation Plan 2005-2007.

The EU Emissions Trading Directive of 13 October 2003 covers CO_2 emissions by all medium and large installations in the fields of energy conversion, refinery processes, coke ovens, and the steel, cement, glass, ceramic and cellulose and paper industries. In 2005-2007 the participating companies will be allocated annual emission allowances of 495 million tonnes CO_2 free of charge, and new installations will receive free allocations from the reserve for new installations. Compared with emissions in the emissions trading base period 2000-2002, the total quantity of allowances allocated for 2005-2007 has been reduced by a moderate 0.4 percent. However, as a result of redistribution effects between the installations participating in the emissions trading scheme, the individual cuts at installation level vary between 0 and 7.5 percent.

In the first half of 2006 the Federal Government will draw up the allocation plan for the second allocation period 2008-2012 and submit it to Brussels by 30.06.2006. The National Allocation Plan 2008-2012 further develops emissions trading as an important climate protection instrument with the aim of improving its environmental and economic efficiency and making the allocation system more transparent and less bureaucratic (prevent windfall profits, take special account of the international competitiveness of energy-intensive industry, reduce burden of costs for industry, integrate other industrialised countries and major threshold countries).

The Federal Government will also advocate the inclusion of other (non-EU) states in the emissions trading scheme. And it will support the EU Commission in its examination of appropriate means of including air transport in the emissions trading scheme.

The Kyoto Protocol gives the parties the opportunity to meet their obligations to reduce greenhouse gas emissions in ways that are as flexible and cost-effective as possible by using three “flexible mechanisms” in addition to the efforts made in their own countries. These are: projects implemented jointly by industrialised countries (“Joint Implementation – JI”; Article 6 Kyoto Protocol), the “Clean Development Mechanism - CDM”; Article 12 Kyoto Protocol) and international emissions trading (Article 17 Kyoto Protocol). JI projects are primarily climate protection projects implemented in the countries of Central and Eastern Europe. Allowances for JI projects may be issued for the first time in the first commitment period of the Kyoto Protocol. Under the CDM, climate protection projects are implemented in the threshold and developing countries without quantified emission limitation commitments (Non-Annex-B states). The CDM also pursues the objective of making a contribution to sustainable development in these countries by means of technology transfer and foreign investment. The organisational and procedural preparations for the CDM have been in progress at international level since 2001, which means that allowances arising from CDM projects be created between 2000 and 2008 and can then be used in the ensuing first commitment period of the Kyoto Protocol. Within the EU emissions trading scheme, companies can use these allowances even before 2008.

In February 2002, on the basis of the “Marrakesh Accords”, the Federal Environment Ministry presented a comprehensive guide for project developers and investors in CDM and JI projects that simplifies the development of CDM/JI projects by means of preliminary project examination at an early stage. The work on the CDM/JI database will be completed in 2006. The aim here is to create transparency and opportunities for public participation. The coordination unit (JIKO) at the Federal Environment Ministry has been the point of contact for investors and project developers since 1995. At the same time JIKO serves as a point of contact with the potential host countries.

With the Project Mechanisms Act (ProMechG), the Federal Government provided a legal basis for the use of CDM and JI with effect from 30.09.2005. At the same time the Federal Government also transposed the European supplementary directive on the use of emission allowances arising from the project-specific Kyoto mechanisms. On the basis of the Project Mechanisms Act the DEHSt was designated as the enforcing authority responsible for CDM and JI projects. However, the DEHSt is not only responsible for national approval of project applications, but can also support suitable CDM or JI project proposals by means of endorsing letters at the project planning stage. This creates the basis for German companies to meet their reduction targets more flexibly, at lower cost and without disadvantages in international competition.

IV.3.9. Research and development

In 2002 the Federal Ministry of Education and Research (BMBF) made an inventory of research into climate protection and compiled an overview of future research perspectives[39]. The basis for a responsible, action-oriented climate protection policy at both national and international level is an appropriate understanding of the climate system, the natural and anthropogenic causes of climate change, and the resulting impacts of such changes on nature and society. German climate research has made internationally acclaimed contributions to these goals in recent years. Particularly in the field of “Earth and environment”, important research findings have been made by the Helmholtz Association of German Research Centres (HGF) and at various establishments of the Max-Planck-Gesellschaft and the Leibniz Association. Institutional assistance for these establishments by the BMBF will continue to be maintained at a high level in the years ahead.

In the context of its framework programme for “Research for sustainability” presented in 2004, the Federal Ministry of Education and Research is currently implementing a new assistance activity concerned with the topic of “Research for climate protection and protection against climate change impacts”. The focus here is on technologies

[39] BMBF brochure “Forschung für den Klimaschutz – Stand und Perspektiven” (2002).

and processes for emission reduction, measures to adapt to climate trends and extreme weather situations in industry and society, and over-arching aspects of education and training.

In the field of energy research the Federal Government has in recent years given new emphasis to the fields of "energy efficiency" and "renewable energies" in particular. Under its programme of investment for the future, launched in 2001, the Federal Government made additional funds available to lend a new permanence to its assistance policy and to speed up new developments. With its new energy research programme, approved by the Federal Cabinet in June 2005, the Federal Government will continue its support for research and development of modern energy technologies and thereby make a concrete contribution to meeting the latest requirements in relation to energy and climate.

In the field of energy efficiency the focus is on developing efficient modern power plant technologies within the COORETEC concept of the Federal Economics Ministry (BMWi). In addition the Federal Economics Ministry sees key areas in the fields of fuel cells, hydrogen and energy reservoirs and in technologies and processes for energy-optimised building. Furthermore, the Federal Government has considerably stepped up the funds for research and development projects in the field of renewable energies. Key areas for assistance in the field of renewable energies are photovoltaic systems, wind energy and biomass. In addition, the Federal Environment Ministry provides assistance for research into high and low-temperature solar energy systems, geothermal heat and hydro power. Research projects on geothermal energy, thin-layer solar cells, fuel cell technology and high-temperature solar heat systems are also receiving support under the institutional assistance provided by the Federal Research Ministry to the Helmholtz Association of German Research Centres (HGF). The Federal Ministry of Education and Research also provides financial assistance for networks pursuing fundamental research in the fields of renewable energies and energy efficiency. The Federal Ministry for Food, Agriculture and Consumer Protection (BMELV) provides financial assistance for improved ways and means of using biomass in the production of heat, electricity and automotive fuels. The aim of the Federal Government's wide-ranging research activities in the fields of energy efficiency and renewable energies is to exploit the great potential for expansion, innovation and cost saving, and thereby make an important contribution to reducing energy-induced CO_2 emissions.

The financial assistance for research provided by the Federal Ministry of Education and Research supports the Federal Government's climate protection activities in the agriculture and forestry sectors as well. The aim of this assistance is to close gaps in our knowledge about greenhouse gas cycle processes, develop new action concepts for sustainable agriculture and forestry, and promote improvements in energy efficiency in the relevant added value chains by developing new technologies.

IV.3.10. Information and education measures by the Federal Government

Numerous surveys have shown that there are very substantial information deficits in the general public when it comes to ways of helping to protect the climate. Intensive and successful information and motivation work must therefore be a central element of climate protection policy. In the National Climate Protection Programme of 18 October 2000 the Federal Environment Ministry was requested to run a campaign on climate protection for households and small consumers. The campaign was to focus in particular on making a contribution to exploiting the considerable CO_2 reduction potential existing in the buildings sector.

In November 2003 the Federal Government also launched the information campaign "Home Quality Improvement". The campaign drew greater attention by landlords, tenants and owners to the possibility of refurbishing existing homes and provided information about the loan programmes of the KfW-Förderbank and other financial assistance facilities. Special emphasis was placed on energy-saving remediation in view of its impacts on the climate, its positive labour market effects and the spread of innovative components and technologies in the building remediation sector. The Home Quality Improvement campaign finished at the end of 2004.

Since 2002 the German Energy Agency (dena), in conjunction with cooperation partners from the energy industry and with Federal Government support as part of the *Energy Efficiency Initiative*, has been running broadly based motivation campaigns to raise consumer awareness of opportunities for energy saving in households. The initiative, with extensive information measures, is also devoted to improving energy efficiency in the Industry/Trade and Services sectors.

The German Energy Agency (dena) was also set up as a forum for specialist information on energy saving in the building sector. With its underlying communication strategy "Home future – Energy savings – Quality gains" it has created a uniform image for the campaigns in the buildings sector. It addresses all those involved in the building and housing sector and multipliers and decision makers in the building process, with the aim of harnessing investment in existing buildings for comprehensive energy-saving remediation measures and thereby contributing to reducing CO_2 emissions.

- Since 2002 the activity "Specialist information on the Energy Saving Ordinance (EnEV)" has been offering practical aids and background information on the ordinance and guidance on interpretation issues.
  The project "Low-energy options for existing houses" implements the recommendation by the Council for Sustainable Development to make greater use of opportunities for energy saving in existing buildings and make them known to the general public.
- The Federal Government is also implementing the recommendation of the Council for Sustainable Development by running the project "Energy efficiency contracting in federal properties". To this end, dena has produced the federal guidance document on energy saving contracting.
- The pilot project "Energy pass for buildings" serves to transpose the EU Buildings Directive on the overall energy efficiency of buildings into national law. Starting in 2006, the introduction of energy certificates or energy passes is required for existing buildings as well. Ahead of a statutory regulation, practical experience is being accumulated with building energy passes for existing buildings to create more market transparency in the existing buildings sector.

Another important element for influencing consumer behaviour through a wide range of information and guidance offerings is financial assistance for on-site engineering advice in relation to existing buildings, which is of great importance for exploiting the energy-saving potential in this sector. From 5,000 in 2001 the number of consultations rose to nearly 12,000 in 2005. This programme, financed by funds from the Federal Economics Ministry, is to continue until at least 2006. The Federal Economics Ministry also provides financial assistance for free advice on energy matters in the individual consumer advice centres, which is organised and run by the Federal Association of Consumer Centres (vzbv). Some 70,000 to 90,000 private consumers a year are given advice on energy-saving issues.

In order to achieve its goal more efficiently, the Federal Environment Ministry's climate protection campaign was completely revamped in 2004. One essential element of the concept is to address the relevant target persons directly, by using existing communication channels and making targeted use of the Internet, and then motivate them to take active climate protection measures, such as modernisation of heating systems, heat insulation improvements, more efficient lighting, use of energy-saving household appliances, use of public transport etc. The campaign also promotes education, training and public awareness about climate change and countermeasures. This also makes a contribution to complying with Article 6 of the Framework Convention on Climate Change. In line with the assignment under the climate protection programme, efforts are being made to involve as many relevant actors as possible in the campaign. The Federal Government will continue the realigned climate protection programme in the years ahead. A major partner for the climate protection programme has already been recruited in the shape of the German railways (Deutsche Bahn AG).

IV.3.11. Fluorinated greenhouse gases

In August 2003, as a result of the discussions under the European Climate Change Programme (ECCP) of March 2000, the EU Commission presented a proposal for a Regulation of the European Parliament and of the Council concerning certain fluorinated greenhouse gases (H-CFC, CFC and SF_6, known as "F-gases"). The aim is to limit and reduce emissions of the F-gases covered by the Kyoto Protocol by means of measures to prevent and minimise leaks in systems containing the substances in question, regulations on leakage testing and substance recovery and on expert knowledge, documentation and reporting obligations, restrictions on the marketing and use of certain substances, and gradual phasing out of the use of the refrigerant R 134a in air-conditioning systems in new vehicles. The Regulation of the European Parliament and of the Council on certain fluorinated greenhouse gases and the Directive of the European Parliament and of the Council relating to emissions from air conditioning systems in motor vehicles and amending Council Directive 70/156/EEC will enter into force in summer 2006.

On 20 June 2005 the Council adopted a common position. The spectrum of practicable measures for further reduction of fluorinated greenhouse gas emissions that was discussed in the National Climate Protection Programme of October 2000 ranged from regulatory requirements to voluntary agreements with industry. In this connection, SF_6 producers in Germany and manufacturers and operators of electrical equipment with an output exceeding > 1 kV presented a new voluntary undertaking in June 2005 which extended an existing voluntary undertaking dating from 1997. Key aspects of the new voluntary undertaking are constructional and process improvement measures in the entire chain from production to recycling or disposal of the substance, and the monitoring system that supplies all the necessary data for the SF_6 accounts every year, thereby permitting verification of the voluntary measures.

Furthermore, in their 2005 voluntary undertaking the semiconductor manufacturers with production facilities in Germany gave a commitment to reduce absolute aggregate emissions of certain F-gases by at least 8 percent by 2010 (calculated as CO_2 equivalent; base year 1995).

IV.4. Sector-specific measures

IV.4.1. Private households

Although the Federal Government has already taken measures to improve energy efficiency in the building sector, all experts are agreed that existing buildings in particular still offer great potential for energy savings, and climate protection is not the only reason why the Federal Government wishes to exploit this potential. In view of the difficult employment situation in Germany and the considerable multiplier effect of the building industry on incomes and employment, measures in this sector can also give a boost to employment, especially in local small and medium-sized businesses. This permits meaningful interlinking of energy efficiency, climate protection and employment aspects.

According to a study by Forschungszentrum Jülich, CO_2 emissions by households in the period 1990 to 2005 are expected to show a drop of 128 million tonnes to 125.3 million tonnes.

Roughly three quarters of household energy consumption is used for space heating. Exploitation of the energy-saving potential in this sector is therefore particularly urgent.

To provide an incentive to save energy and thereby reduce CO_2 emissions, homes eligible for assistance under the Owner-Occupied Home Allowances Act were able to receive “eco-allowances” for 8 years from 1996 onwards in addition to the basic allowance. This special arrangement was for a limited period and expired at the end of 2002. Although the investment allowances did provide economic incentives, these were not sufficient – especially in the case of existing buildings – to have a broad impact. Among purchasers of existing houses in 2001, for example, fewer than 1 percent of persons receiving an owner-occupied homes allowance also made use of the eco-allowance. In the case of new homes, by contrast, the figure was 36 percent. Of this figure, 9 percent was due to “energy-saving system technology” and about 27 percent to low-energy houses.

One important instrument of financial assistance for renovation of existing buildings in the New *Laender* was the investment allowance granted during the period 1999 to 2004 for maintenance and modernisation work on rented residential buildings. In connection with the upgrading programme for cities and towns in Eastern Germany, this introduced increased financial assistance for older buildings in inner city areas. Particularly in the case of the types of existing buildings in the New *Laender*, the continued use of which is highly desirable for housing and urban development reasons, designing the investment allowance in this way made it possible to carry out market-oriented repair and modernisation work, even if the cost was relatively high. This provided effective support for climate-relevant measures in older buildings, even in the face of a very difficult housing market situation.

With the new focus of public housing assistance on existing buildings, the city upgrading programmes for Eastern and Western Germany and the KfW's interest-reduction programmes, the Federal Government has already made substantial contributions to modernising existing buildings and hence to CO_2 savings in the private household sector.

In the course of the reform of housing legislation, public housebuilding was developed into a public housing assistance scheme. In particular, the relative importance of measures for existing buildings and for new housing was reassessed. Instead of the previous focus of the legislation on promoting new housing, the Housing Assistance Act (WoFG) that entered into force on 1 January 2002 will in future make better use of existing buildings to provide accommodation. Assistance can therefore be given not only for new buildings, but also to a greater extent for modernisation, establishing rights of occupation and purchasing existing housing. The greater emphasis on inclusion of existing buildings serves to improve the efficiency and accuracy of the financial resources used for the purpose of public housing assistance. In the 1990s, even before the entry into force of the new Housing Assistance Act, a considerable proportion of the assistance in the rented housing sector, especially in the New *Laender*, went into modernisation measures. On the whole, the public housing assistance scheme offers a broad spectrum of measures oriented to existing housing. These and other supporting measures (e.g. preparation of housing supply concepts, signing of cooperation agreements), put the *Laender* – which are responsible for detailed implementation of the public housing assistance scheme – in a position to take assistance measures appropriate to their respective housing situations.

In the New *Laender* the massive investment in the existing building sector since 1990 has brought about considerable reductions in climate-relevant emissions from buildings. The urgently needed and overdue repair and modernisation measures are effectively supported by means of various assistance programmes, some of which can be combined. In virtually all market segments (owner-occupied homes, older buildings, prefabricated apartment blocks) there has been a veritable modernisation thrust, with the result that the programmes as a whole are having a massive impact on a broad front. In the apartment building sector at least two thirds of existing buildings have been at least partially modernised, and some completely. Additional climate-relevant measures were also carried out in the course of these modernisation measures. Thus for the present a considerable proportion of the potential for climate-relevant measures in the building sector in the New *Laender* is exhausted. For the remaining third of existing apartment buildings, mainly unremediated prefabricated blocks and older buildings dating from before 1918, the large proportion of empty properties raises the question of their future market viability. Within the framework of the city remediation programme for Eastern Germany that has been running since 1.1.2002, assistance is provided under various individual programmes/programme units both for demolishing apartments to adjust and stabilise the local housing markets and for upgrading existing accommodation and the surrounding city precincts or immediate vicinity. At least 350,000 apartments are to be taken off the market during the period 2002 to 2009.

Through targeted design of the KfW programmes and their continued development to adapt to requirements, the federal authorities have given assistance for energy-saving modernisation of existing homes in particular by means of the following programmes:

- The KfW housing modernisation programme I for the New *Laender* which began in 1990, with loans totalling DM 79 billion (EUR 40.39 billion), helped to finance modernisation measures in some 3.6 million homes, in other words nearly half the homes in Eastern Germany. The funds were largely used for financing investment in rectifying damage to buildings and for converting heating systems from highly-polluting coal to gas or oil. The programme was closed at the end of January 2000.
- February 2000 saw the start of the much smaller follow-up programme, the KfW housing modernisation programme II. This programme concentrates on promoting particularly cost-intensive modernisation and repair measures to older buildings, high-rise blocks and listed residential buildings. A total loan volume of EUR 2.4 billion was pledged for this programme. Some 15 percent of the assisted investments were directly devoted to CO_2 or SO_2 reduction. The programme ended as scheduled on 31 December 2002.
- Under the CO_2 reduction programme, which after provision of the first billion DM (EUR 0.5 billion) from federal funds was continued from 1996 onwards with KfW resources, the following measures in existing residential buildings have received assistance: improving heat insulation of the external shell of the building, installing energy-saving heating systems, heat transfer stations for local or district heating systems, solar-based local heating systems and systems for the use of renewable energies. Furthermore, assistance was provided for the construction of KfW energy-saving houses models 40 and 60 (annual primary energy consumption not more than 40 or 60 kWh per m² of useful floor space) and passive houses. Under the KfW programme for CO_2 reduction a total of 56.8 million m² or 685,000 homes were refurbished during the nine-year period from 1996 to 2004.
- The KfW CO_2 building remediation programme forms part of the national climate protection strategy adopted by the Federal Cabinet in October 2000, and is designed for low-interest, long-term financing of particularly extensive investments in CO_2 reduction and energy saving in residential buildings built before 1979. This programme was updated on 1 February 2006 and, among other things, extended to include buildings erected before 1983. The increase in the maximum assistance to EUR 50,000 per dwelling in cases where the annual emission reductions are at least 40 kg CO_2 per square metre means that in most cases the remediation projects can be fully financed. In addition, partial debt remission is granted where older buildings are refurbished to low-energy standard.
- A new programme component in the CO_2 building remediation programme since 2003 provides assistance for achieving the status of "low-energy house standard in the existing buildings sector" (compliance with new building standard of the Energy Saving Ordinance), replacing gas, oil and coal-fired individual heating units and coal and night-storage heating systems, and installing gas and oil condensing boilers in combination with solar energy systems.
- From April 2003 to the end of 2004 the Federal Government, through the nationwide KfW housing modernisation programme 2003, gave assistance for investment projects by home owners, private landlords, housing companies and housing cooperatives. The focus was primarily on measures to modernise and repair existing residential buildings, both rented and owner-occupied. The Federal Government is providing funds totalling EUR 260 million to finance the reduced interest rates. The programme ended as scheduled on 31. December 2004.

In 2003 and 2004 the Federal Government supported the CO_2 building remediation and housing modernisation programmes of the KfW with its effective campaign “Federal government assistance for home quality improvement”. The nationwide campaign was intended to encourage home owners to modernise and refurbish their buildings. In this connection mention must also be made of the “Initiative for low-cost energy-saving building” referred to in Chapter IV.3.3.1.

On 1 January 2005 the KfW-Förderbank, with the support of the Federal Government, launched a new assistance programme; this was updated on 1 February 2006 with improved assistance terms and a considerably increased volume. The assistance for modernisation is being continued in a programme for Modernising housing”, but the KfW gives a rather lower interest-rate reduction for general repairs and modernisation of housing (standard interest rate). Climate-relevant measures such as heat insulation or the installation of heating systems using renewable energies qualify for a further interest-rate reduction from the KfW (“Eco Plus Variant”). Assistance for new buildings – KfW energy-saving houses 40 and passive houses (previously CO_2 building remediation programme) and KfW energy-saving houses 60 (previously CO_2 reduction programme) – is grouped in the programme “Ecological building”. There is also assistance for systems using renewable energies in new housing projects. Here reduced interest rates are made possible by the Federal Government for energy-saving houses 40 and passive houses, and by the KfW for energy-saving houses 60 and heating systems.

Electricity consumption in the household sector gives rise to CO_2 emissions in public power plants. The range of household appliances increasingly includes not only “white goods”, such as washing machines and refrigerators, but also information and communication technology equipment (e.g. computers, answering machines, fax machines, mobile phone) and entertainment systems (e.g. television, video systems, HiFi systems).

The infrastructure needed for information and communication technology is also playing a growing role in electricity consumption: for example, digital set-top boxes for TV infrastructure and the growth in broadband Internet access are becoming increasingly important factors in household electricity consumption. A study commissioned by the Federal Economics Ministry expects electricity requirements for information and communication systems in households (including their infrastructure) to rise from 22,517 GWh in 2001 to 30,891 GWh in 2010 – which represents an increase of nearly 37 percent.[40] The study also indicates that considerable amounts of energy are lost in households as a result of stand-by operation of equipment. For example, no-load operation actually accounts for more than two thirds of the total electricity requirement for household infrastructure (satellite receivers, antenna amplifiers, modems etc.). No-load loss (the bulk of which is due to stand-by losses) is the collective term for all energy consumption by a device that is not caused by the primary function of the device. At present not enough use is made of existing technical and behavioural opportunities for reducing electricity consumption in the operation of equipment. To improve this situation there is a need not only for

40 Centre for Energy Policy and Economics und Fraunhofer ISI (Ed.) (2003): Der Einfluss moderner Gerätegenerationen der Informations- und Kommunikationstechnik auf den Energieverbrauch in Deutschland bis zum Jahr 2010 - Möglichkeiten zur Erhöhung der Energieeffizienz und zur Energieeinsparung in diesen Bereichen. Zurich, Karlsruhe.

technical facilities in the devices themselves, but also for changes in habits by the people using the equipment. This is the aim of the campaign run by the German Energy Agency (dena) for "Efficient use of energy in households".

IV.4.2. Trade, Commerce, Services

Between 1990 and 2003, CO_2 emissions in the trade, commerce and services sector fell by around 13 million tonnes. This development was caused by the restructuring in the trade sector in the New *Laender* and the very high level of demolition and replacement compared with the residential buildings sector.

In the course of transposing Directive 2002/91/EC into national law, the Federal Government is making available a checking method based on an overall accounting system for non-residential buildings that will make it possible, starting in 2006, to specify requirements relating to the energy consumption of lighting and air conditioning systems. Moreover, air-conditioning systems are to be inspected regularly from 2006 onwards. These inspections and the associated energy consultations can be expected[41] to have a positive impact on the remediation of air-conditioning systems and the optimisation of their operation. An expert opinion estimates that this measure alone can be expected to result in CO_2 savings of nearly 0.4 million tonnes.

IV.4.3. Transport

In the field of tensions and constraints between the settlement, industry and transport structures that have grown up over the years and their environmental consequences, transport policy will continue to face increasing challenges in the future. There is a need to set signals for the future which ensure that the transport system remains efficient and continues to be a locational and production factor for the German economy. And people's demand for mobility must not be neglected. At the same time it is necessary to take account of environmental needs and to achieve further reductions in the environmental pollution due to transport.

In the traffic sector it is encouraging to note that a clear reversal of the upward trend in CO_2 emissions can be seen for the first time since 1999. In 2003 CO_2 emissions in the transport sector were down by 15 million tonnes compared with 1999. This development was probably largely due to reductions in specific fuel consumption figures, a marked shift of new registrations in favour of diesel vehicles, effects due to the ecological tax, a tendency to refuel abroad, and a general sharp increase in fuel prices. Looking at the accounts for transport-induced greenhouse gas emissions, it is striking to note the difference in trends between the goods transport and private motoring sectors. In recent years emissions in the personal transport sector have shown a much more favourable trend than in the goods sector.

In the interests of reshaping the transport sector in an environmentally friendly and resource-conserving manner, the Federal Government is pursuing a wide-ranging package of measures. With a large measure of market orientation it is seeking to promote environmentally friendly integrated solutions.

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[41] Schiller (2004) in: Forschungszentrum Jülich (Ed.) (2005): Evaluierung der CO2-Minderungsmaßnahmen im Gebäudebereich.

On the whole, the Federal Government has moved a step closer to its objective of using economic incentives to reduce transport intensity, redirect traffic streams to more environmentally acceptable means of transport, and conserve the environment. The differentiation of the HGV toll and vehicle road tax to take account of emissions is an example of effective approaches that also have the effect of avoiding external costs.

The successful introduction of the HGV toll system on 1 January 2005 ensures appropriate charging of highway costs to both the German and foreign heavy goods vehicles that cause them. In line with the Federal Government's environmental policy objectives, the HGV toll system also creates economic incentives to use heavy goods vehicles that comply with the latest emission standards and to maximise logistical efficiency.

Among other things, transport habits and the resulting emissions are influenced by urban and regional planning. In the field of infrastructure planning the Federal Government has set new standards on both the local and broader levels. The Federal Transport Routes Plan 2003 was prepared using a comprehensive, modernised assessment method for future infrastructure measures. Transport planning with a more environmentally friendly approach that also takes account of climate change aspects can make an important contribution to avoiding greenhouse gases.

The revision of the Federal Building Code in 2004 boosted the importance of physical development planning in sustainable urban development and stressed its function of ensuring an environment fit for people to live in and of protecting and developing the natural basis of life, also having regard to their responsibility for climate protection in general. It also placed special emphasis on the fact that one of the transport issues to be taken into account in planning is the mobility of the general public including local public transport and non-motorised transport, having special regard to an urban development approach geared to avoiding and minimising traffic. The revised version of the Federal Building Code also stressed the special importance of spaces for parking bicycles. In overall terms this strengthened the importance of environmentally friendly means of transport in physical development planning.

The Climate Protection Programme 2000 stated that better conditions would be created for rail transport. In this connection the revisions of relevant legislation that are currently in progress will make an important contribution to better framework conditions for the railways. For example, the revision of the General Railways Act, which among other things reorganises the allocation of rail tracks and decisions on track charges and establishes a track agency, is a further step on the way to non-discriminatory competition in the railway sector. Problems still exist with regard to smooth interlinking of railways across national boundaries. There are great obstacles to overcome here in the form of differences in technical specifications, such as electricity, brake and safety systems. Common technical standards are therefore being created for the future, and suitable interfaces for existing systems are being provided at the borders. The European Union has introduced initial regulations in the form of two directives and the relevant "Technical Specifications" (TSI). These regulations are currently being implemented in Germany.

In July 2002 both the German Automobile Association (VDA) and the Motor Vehicle Importers Association (VDIK) gave the Federal Ministry of Transport, Building and Urban Affairs a commitment to further fuel-saving measures such as increased use of low-friction tyres, low-friction oils and fuel consumption indicators. This will make it possible to exploit reduction potentials, which in the case of low-friction tyres and low-friction oils are each put at 2.5 percent of standard consumption.

The automobile industry's commitment provides for the following:

The automobile industry will step up its activities regarding the use of low-friction tyres. In the case of new vehicles from German production the figure is already over 90 percent, and for imported vehicles around 80 percent. In operating instructions and customer service information the manufacturers will draw owners' attention to the benefits of low-friction tyres, to encourage them to use such tyres when buying replacements.

Manufacturers have been making increasing use of low-friction oils for a good while now. Today they are used in well over 90 percent of new cars. Intensive efforts are being made to step up their use in the remaining niches. Even once the vehicle has been handed over to the owner, manufacturers will step up their information about the use of low-friction oils and encourage motorists to use them for oil changes. Guarantees will only be valid if owners comply with the oil-change intervals and use the oils approved by the manufacturer. In addition, more cars are to be equipped with fuel consumption indicators and/or gear-change indicators. This will encourage drivers to change up earlier and thereby adopt fuel-saving driving habits.

An important innovative key area for the future is seen in measures to support alternative fuels and innovative drive systems. As part of the National Sustainability Strategy 2004 the Federal Government reached agreement, in conjunction with all major actors and against the background of international development, on a strategic overall concept for the period to 2020 ("Federal Government's automotive fuel strategy"), which supports the market introduction in Germany of alternative and renewable fuels and innovative drive systems that appear at present to be environmentally and economically sensible in the long term.

Efficiency improvements in both petrol and diesel engines are of central importance here. Efficient drive systems offer – even in the short term – considerable potential for cutting pollution and reducing dependence on imports. Innovative technologies like hybrid drive and fuel cells in conjunction with optimised materials can offer further improvements in efficiency in the medium or long term. Alternative fuels also play an important role in the Federal Government's strategy. Here it is necessary – partly in view of the time scale – to pursue several different options. At present conventional biofuels such as biodiesel and bioethanol as admixtures to petrol and diesel fuels are making an important contribution, as are natural gas and liquefied gas. In the long term, however, synthetic biofuels and hydrogen will provide the basis for mobility. Synthetic biofuels will probably not play a major quantitative role until the next decade. Experts put their market share at up to 4 percent. All in all, therefore, present projections indicate that renewable fuels could reach a market share of between 10 and -20 percent by 2020[42].

[42] Kraftstoffstrategie der Bundesregierung, Fortschrittsbericht zur Nationalen Nachhaltigkeitsstrategie 2004.

The purpose of the Federal Government's fuel strategy is essentially to focus resources on the alternatives that currently look promising, and to make rapid progress with their development.

In terms of energy content, around 1.8 percent of fuel consumed in 2004 was of biogenic origin. This means a saving of about 2.7 million tonnes CO_2 compared with combustion of fossil fuels. In 2004 the Federal Government supported this by means of tax concessions totalling EUR 610 million.

The Federal Government also promotes the use of the climate-friendly fuels natural gas and liquefied gas by means of favourable tax rates. The reduced tax rate for natural gas is fixed until 2018. This gives industry and consumers a long period of certainty about their investments. The rate for liquefied gas is fixed until 2009. Support for natural gas as an automotive fuel has also been provided under a campaign for systematic development of the market for vehicles powered by natural gas, in which the German gas industry, automobile manufacturers and companies in the petroleum industry are taking part.

A further boost to reductions in CO_2 emissions by road traffic is provided by the automobile industry's voluntary undertaking. In July 2002 both the German Automobile Association (VDA) and the Motor Vehicle Importers Association (VDIK) gave the Federal Ministry of Transport, Building and Urban Affairs a commitment to further fuel-saving measures such as increased use of low-friction tyres, low-friction oils and fuel consumption indicators. This will make it possible to exploit reduction potentials, which in the case of low-friction tyres and low-friction oils are each put at 2.5 percent of standard consumption.
Previously, in 1995, the German Automobile Industry Association had promised make a 25 percent reduction in the average fuel consumption of newly registered cars by 2005 – compared with the figure for 1990. The European Automobile Industry Association also undertook (like the Japanese and Korean automobile industries) to reduce average CO_2 emissions by newly registered cars to 140 g/km by 2008. The industry is making good progress towards achieving its self-imposed reduction targets.

Under the Budget Accompanying Act of 2004, the distance-based tax allowance for commuters was reduced from EUR 0.36 to EUR 0.30 per km between home and work from 1 January 2004 onwards as part of extensive cuts in tax subsidies. The distance-based allowance reduces the financial burden of moving out from the cities into the surrounding country, and this results in longer distances to work. The cut in the allowance therefore makes an indirect contribution to emission reductions. In 2006 the owner-occupied homes allowance was also abolished, as was the commuter tax allowance for distances of less than 20 km between home and work.

Considerable CO_2 reductions can be achieved by energy-conscious and environmentally responsible behaviour on the part of road users, especially motorists. In view of this the Federal Government has started a campaign "Modern driving" in conjunction with other actors (e.g. automobile industry, the German motoring club ADAC and the German postal service Post AG). With a modern vehicle it is possible to drive economically by observing a few simple rules and adjusting one's driving style accordingly. It is possible to make fuel savings of up to 25 percent without having to give up comfort, enjoyment and getting quickly from A to B. In-depth learning of these new driving habits is possible in special training courses offered by a large number of providers.

In the long term the realistic potential for reducing individual consumption and CO_2 figures through fuel-saving driving habits averages about 12 percent for town driving.

The Federal Government sees considerable additional potential for reducing short car trips and hence avoiding pollution by encouraging people to use bicycles. With a share of 12 percent of the number of all trips, cycle traffic plays a relatively important role in Germany. The Federal Government promotes cycle traffic, in particular through the Federal Cycle Paths Programme. A total of 15,000 km of cycle paths are currently available beside federal highways. In April 2002 the Federal Ministry of Transport presented a “National Cycle Traffic Plan 2002 to 2012”. The plan contains extensive recommendations for action to promote cycle traffic, and has given rise to a broad public dialogue. There has been a massive increase in the resources allocated to cycle traffic in the federal budget.

The energy consumption labelling obligations for cars, requiring the provision of consumer information on fuel consumption and CO_2 emissions when marketing new cars, entered into force in 2004. In practice this means that a clearly visible notice showing the fuel consumption and the relevant CO_2 emission figures is to be displayed at the point of sale on each new model or in its immediate vicinity. This obligation is also supplemented by further requirements on the car trade, leasing companies etc. to provide information (annual guide to fuel consumption, notices in showrooms, statement of fuel consumption and CO_2 emissions in all advertising material including newspaper advertisements and posters). The consumer can thus expect to receive really comprehensive information about car fuel consumption and CO_2 emission figures.

It was not possible to implement all of the measures in the climate protection programme of 18 October 2000 on schedule. There was a delay in the introduction of the distance-related motorway toll for heavy goods vehicles, which had been planned for 2003. In the meantime, however, this measure is a cornerstone of climate protection policy in the transport sector.

A sustainable reduction in CO_2 emissions in the traffic sector can only be achieved if measures designed to maintain a steady flow of traffic by eliminating bottlenecks and avoiding jams (integrated traffic planning, anti-jam programmes or traffic control systems) are combined with any new traffic streams, a needs-oriented traffic mix and climate-friendly behaviour on the part of road users in a way that has a positive impact on the CO_2 accounts. The Federal Government intends to develop a “Goods Traffic Master Plan” with the aim of achieving, among other things, efficiency improvements in the goods transport sector.

IV.4.4. Industry and energy industry

The transposition of the Emissions Trading Directive and the introduction of the European emissions trading scheme in Germany on 1.1.2005 mean that 95 percent of CO_2 emissions by industry and the energy industry are covered. The process has been observed by the Federal Government from the point of view of ecological effectiveness, economic efficiency and competitive neutrality. The experience gained in the first trading period from 2005 to 2007 will now be incorporated in the second National Allocation Plan.

Industry

The Federal Government welcomes the fact that there has been a considerable reduction in greenhouse gas emissions in the industrial sector since 1990. From 1991 to 2001 the specific energy consumption of industry – as an efficiency indicator – fell by an average of 2.3 percent per annum, which was considerable faster than the fall in overall energy intensity with a reduction rate only 1.5 percent per annum. In both cases, however, the increasing energy efficiency succeeded in compensating more and more for the consumption-boosting effects of growing industrial and overall production.[43] The decline in specific CO_2 emissions in industry actually gained momentum in the second period. In other words the decline in absolute CO_2 emissions has eased off since 1995: between 1990 and 1994, CO_2 emissions in the industrial sector fell by an annual average of around 10.5 million tonnes, and between 1995 and 2003 the reduction was only about 2.8 million tonnes per annum. However, a considerable part of this effect is due to the fact that industrially operated power plants were transferred to the public electricity supply sector.

Energy industry

The electricity industry in Germany today is faced with great challenges. In accordance with the agreement of 14 June 2000 between the Federal Government and the electricity supply companies, nuclear power is to be phased out gradually over the next 20 years. A start has already been made with the closure of the nuclear power plants at Stade and Obrigheim. At the same time a considerable number of coal, gas and oil fired power stations need to be replaced because of their age. This will bring major changes in the energy mix in the electricity supply sector. In parallel with the phasing out of nuclear energy, the share due to renewable energies is to be increased to at least 20 percent by 2020. The fossil fuels lignite, coal and natural gas will then account for some 80 percent of electricity production (currently around 60%).

At the same time the expansion of combined heat-and-power generation will be of special importance. The deregulation of the electricity market brought a sudden deterioration in the conditions for this technology. In order to prevent an imminent decline in the share of electricity produced using combined heat-and-power generation, the Act Protecting CHP Electricity Generation was passed as an initial measure. It was replaced on 1 April 2002 by the Act on the maintenance, modernisation and expansion of combined heat-and-power generation (CHP Act).

The complete exemption of CHP plants from petroleum excise duty on the introduction of the ecological tax reform in April 1999 cushioned the adverse effects felt in this sector as a result of deregulation. The question of whether and to what extent the targets set were in fact achieved with the measures to promote combined heat-and-power generation (CHP Act and CHP Agreement), is currently being examined by the Federal Environment Ministry and the Federal Economics Ministry on the basis of an analysis of a study commissioned in accordance with the statutory agreement.

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43 DIW Wochenbericht No. 50/2002.

IV.4.5. Agriculture and forestry

Emissions of the greenhouse gases CO_2, CH_4 and N_2O in the agricultural sector all originate – with the exception of the energy-induced emissions arising from the production or use of operating equipment – from natural processes that can only be influenced to a limited extent. Thus in view of a continuing rapid increase in the world population and a corresponding growth in food requirements, further emission reductions can only be achieved by adopting agricultural production methods that are better adapted to climate protection needs. Technical possibilities exist, for example, in the use of biogas plants in the storage and application of organic manure or in needs-oriented feeding. Although a reduction in agricultural production in Germany could reduce greenhouse gas emissions in Germany, it must be remembered that, especially if the demand for food (especially meat) remained constant, this would as a rule be accompanied by local shifts into other countries, resulting in increased greenhouse gas emissions elsewhere. Furthermore, one cannot ignore the fact that in places where the biggest population increases are taking place around the world, stable and growing agricultural production is mostly impossible because of soil degradation and climatic conditions.

On the other hand it is important for climate protection that agriculture and forestry make an ongoing and growing contribution by fixing carbon in the soils and biomass of forests and grassland or in renewable raw materials. Agricultural policy, which is largely determined by the EU, is increasingly integrating environmental interests.

IV.4.5.1. Common Agricultural Policy

The cutbacks in the classic instruments of the Common Agricultural Policy, the decoupling of direct payments, and the introduction of obligatory modulation favour extensive forms of land management. This can be expected to bring reductions in both fertiliser use and cattle stocks.

IV.4.5.2. Organic farming

The federal programme for organic farming started by the Federal Ministry of Food, Agriculture and Consumer Protection in 2002 is intended to improve the framework conditions for organic farming und support the efforts being made by the economic players to achieve larger market shares for eco products.
As organic farming expands, the use of mineral fertilisers decreases, and as a result there is a reduction not only in emissions from the manufacture of N-fertilisers, but also in N-inputs and hence N_2O emissions from the soil. In livestock farming the area-linking system in particular leads to extensification and to a reduction in livestock numbers. In 2004 some 0.7 million ha of farmland in Germany was organically farmed by around 16,600 establishments.

IV.4.5.3. Soil conservation

To conserve the carbon stocks of soils used for agricultural purposes, farmers are required to comply with the principles of good professional practice as set out in the Federal Soil Conservation Act, and the provisions of the Federal Nature Conservation Act banning the ploughing of grassland in certain locations.

IV.4.5.4. Agro-environmental measures

As part of the "Joint Task of Improving Agricultural Structures and Coastal Protection" (GAK), the Federal Government in conjunction with the *Laender* promotes a number of measures which also result in reduced greenhouse gas emissions from the agricultural sector or the use of substitutes for fossil energy. Measures that have a positive impact on climate protection include in particular the promotion of extensive production methods in the field of arable farming and permanent crops, extensive use of grassland including conversion of arable land into grassland for extensive use, ecological growing methods and multi-year set-asides. In 2003 federal and regional authorities provided assistance for agro-environmental measures on some 4.3 million ha.

IV.4.5.5. Agricultural investment assistance

Under the Agricultural Investment Assistance Programme (AFP) assistance can be given for investments that result in reductions in greenhouse gas emissions from natural processes (e.g. biogas systems, storage and application of organic manure) and in energy-induced greenhouse gas emissions (e.g. heat and cold insulation, conversion of heating system etc.).

IV.4.5.6. Renewable energies in agriculture

The revision of the Renewable Energies Act on 1 August 2004 makes the generation of electricity from biomass in small plants even more attractive by introducing a new payment level with a higher basic payment of 11.5 cents/kWh for plants starting to operate in 2004 and also introducing a bonus of 2.5 to 6 cents/kWh for generation of electricity using biomass from the agricultural and forestry sectors.

In addition, the Market Incentives Programme Renewable Energies (MAP) continues to provide facilities for investment grants, low-interest loans or partial debt remission. Of 1435 applications assisted by the Kreditanstalt für Wiederaufbau (KfW), as many as 1216 were for biomass plants. At EU level it was decided that energy crops (e.g. maize, fodder beet) can be grown as renewable raw materials on set-aside land and used in farm-specific biomass plants. Biomass systems use substitutes for fossil fuels and also make it possible to reduce CH_4 emissions from organic manure if they are run on liquid manure from cattle and pigs or on poultry droppings. In recent years biogas development in particular has seen a veritable boom. The number of systems rose from 600 in 1998 to around 2,700 by the end of 2005. The guaranteed prices for electricity, the MAP programme and the promotion of biogas systems through the AFP will lead to a further increase in bio-energy systems run on raw materials from agriculture and forestry.

IV.4.5.7. Biofuels

In Germany the exemption of biogenic fuels from petroleum excise duty makes a contribution to reducing CO_2 emissions. In the last five years, production of biodiesel has risen from 250,000 t to 1.7 million tonnes in 2005. Some 0.2 million tonnes of bioethanol were used in the fuel sector for the first time in 2005, and the figure for vegetable oil is 0.15 million tonnes. Further systems with an annual capacity of about 500,000 t/a are under construction.

IV.4.5.8. Forestry policy

Conservation of carbon stocks in forests is pursued in Germany using a whole range of measures, which seek on the one hand to maintain and increase the area under forest and on the other hand to ensure the health and sustainable management of forests. General regional (*Land*) planning requirements, the forestry legislation at federal and *Land* level, and the Environmental Impact Assessment Act with its supplementary provisions at *Land* level lay down extensive official approval requirements for the conversion of forest into other forms of land use. This procedure means that deforestation practically never occurs without comparable afforestation. Moreover, the federal and *Land* authorities have been financial initial afforestation since 1975, co-financed from EU funds since 1992. Numerous measures help to protect existing forests from damage, and these are detailed in the Forest Status Report issued by the Federal Ministry of Food, Agriculture and Consumer Protection. With the "Wood Charter" the Federal Government is supporting a 20-percent increase in wood consumption in the next 10 years. Wood can store carbon in the form of wood products (wooden buildings, furniture, paper etc.). Of the approx 51 million m³ of wood harvested annually, about 60 percent is processed into durable products which keep the carbon immobilised for several decades. Wood can also be used as a substitute for other raw materials (concrete, steel, plastics etc.) that are produced using fossil energy, or can as a fuel be used directly instead of fossil fuels.

IV.4.6. Waste management

The waste management sector made a substantial contribution to reducing emissions of climate-relevant gases in Germany, both in the years leading up to 2000 and in the years after. The main focus was on avoiding methane emissions from landfill sites by reducing the use of untreated biodegradable waste as landfill. During the period 1990 to 1999, methane emissions from landfill sites were reduced by about 0.82 million tonnes – corresponding to 17.2 million tonnes CO_2 equivalent. Between 2000 and 2003 methane emissions fell by a further 2.8 million tonnes CO_2 equivalent. This represents a reduction of about two thirds compared with 1990. This meant the target in the National Climate Protection Plan 2000 was already met.

To ensure the complete cessation of landfill deposition of untreated waste by 1.6.2005, the requirements of the Technical Instructions for Municipal Waste (TA Siedlungsabfall), which already laid down this date, were incorporated in the – legally more stringent – Waste Deposition Ordinance (which entered into force on 1 March 2001), thereby implementing the relevant decision from the National Climate Protection Programme 2000. The Waste Wood Ordinance had already banned landfill of waste wood since 1 March 2003. Landfill of untreated waste is generally to be discontinued not later than 1 June 2005.

The waste management sector has also brought about further substantial CO_2 savings, for example by using waste for energy in waste incineration operations, mostly CHP systems, and by co-incinerating high-calorific waste, since about 50 percent of such waste is of biogenic origin. The recovery and recycling of ferrous and non-ferrous metals and the separate collection and recycling of glass, plastics and other packaging materials have also led to considerable CO_2 savings by the waste management sector, though these cannot be quantified accurately, partly because they are accounted for in the relevant branches of industry and not in the waste management sector. Considerable CO_2 savings are also due to the increased use of waste wood for energy as promoted from 2000 onwards by the Renewable Energies Act in conjunction with the Biomass Ordinance. These contributions too do not appear in the waste management accounts, but in the energy sector.

IV.5. Climate policy activities by the *Laender*, local authorities and other actors

Climate protection with a lasting impact calls for contributions at all levels. There is a need for integration of climate protection interests not only at international, European, federal, regional and local level, but also in industry and among all socially relevant groups (environmental and consumer associations, trade unions, churches etc.). In the past these groups and bodies have taken up the issue of global warming prevention in different ways. There is now a need for systematic expansion of these approaches. Today nearly all the *Laender* have their own climate protection programmes, and numerous cities and local authorities are also turning their attention to the implementation of climate-relevant measures.

Munich, the capital of Bavaria, is one of the pioneer local authorities when it comes to climate protection. As a member of the European countries' climate alliance "Klima Bündnis / Alianza del Clima" it has, along with over 1,000 other local authorities in Europe, committed itself to reducing its emissions of the main greenhouse gas carbon dioxide (CO_2) to half the 1987 figure by 2010. Thanks to numerous activities by the city, the municipal enterprises and establishments and the citizens, a moderate emission reduction has been achieved despite a growing population and economic output. CO_2 emissions per head of the population fell by 12 percent to 7.6 tonnes a year between 1987 and 2000.

In order to achieve the target of halving CO_2 emissions, the Federal Environment Ministry and the City of Munich have commissioned a study on "Local authority strategies for reducing CO_2 emissions by 50 percent: the example of Munich". In this study, Öko-Institut has taken Munich as an example and described inexpensive measures that promote economic development and are suitable for other local authorities as well.

It is important to involve other actors, not only with regard to their active initiative, but also – and especially – in view of their participation in the implementation of numerous measures adopted at federal level. In this connection great importance must be attached to systematic enforcement of the energy-saving regulations, programmes and measures by the *Laender*.

IV.5.1. Federal Laender

The climate protection policy activities of the *Laender* cover a wide range:

- implementing assistance programmes and regulations of Germany and the EU,
- organising projects and measures of their own, using financial assistance from the Federal Government or the EU, where appropriate
- pursuing their own assistance programmes and regulations.

Since these fields of action are complementary, the following table based on information from the *Laender* gives a summary of examples of focus activities.

Table IV - 4 Climate protection programmes and focal issues in the Laender

Federal "*Land*"	Programme / Concept	Selected key areas
Baden-Württemberg	• Climate protection concept Baden-Württemberg (1994), updated version for period to 2010 is currently in preparation and identifies a CO_2 reduction potential of 2-4 mill. t p.a. • Environmental plan Baden-Württemberg (2000)	• Assistance and guidance programmes on building remediation, energy concepts, energy efficiency, renewable energies • Expansion of rail transport • Doubling of renewable energy share by 2010 (electricity generation and primary energy consumption) • Research projects on efficient energy generation and conversion (renewable energies, renewable raw materials, fuel cell technology, efficiency improvements in the use of fossil fuels) • Public relations and education work
Bavaria	• Climate protection concept of Bavarian government (2000, first update 2003) – Goal: Reduce CO2 emissions to 80 million t p.a. by 2010 • Overall concept: renewable raw materials in Bavaria, 28.04.2003 • Overall concept for Bavaria on energy policy, 20.04.2004 • In preparation: Overall concept for Bavaria on a sustainable climate protection policy	• Research into impacts of global climate change on the region of Bavaria (e.g. BayFORKLIM, BayFORUV), into adaptation strategies (e.g. KLIWA) and into CO_2 reduction technologies (e.g. FORTVER) • Assistance for renewable energies (especially biomass) • Assistance for innovative R&D and demonstration projects in the field of renewable energies and energy efficiency and new energy technologies (e.g. photovoltaic, hydrogen) • Key area: Energy saving in existing buildings: model character of own properties and assistance programmes for local authorities • Forestry monitoring and assessment of the consequences of global climate change on Bavaria's forests, including on the basis of 22 forest climate stations • Key area: Forest conversion programme: climate change in state forest (WUKS) as strategy for adaptation to regional climate change • Information and guidance on renewable energies (e.g. geothermal energy), building and energy (e.g. energy-saving remediation of existing buildings) and general tips on energy saving • Public relations work and awareness raising in the Bavarian climate alliance: alliances with industry (climate dialogue since 2001), with Bund Naturschutz (since 2004). (other alliances in preparation)
Berlin	• Energy concept (1994) - goal: CO_2 reduction of 25% per head by 2010 compared with 1990 • Energy report 1997-2000 • *Land* energy programme 2000-2003 (2000) • planned: update of *Land* energy programme • planned: Climate protection management	• Pilot projects for introduction of energy passes • Photovoltaic systems on public roofs • Energy-saving building remediation (campaigns for economic solar remediation and for expansion of energy services, establishment of a broad initial energy advisory service) • Public relations work, international partner cities • Continuation of ImpulsE programme • Energy transparency in rent overview • Energy-aware physical development planning • Contracting offers for energy services including solar energy and building remediation for public facilities, institutions and corporations, and in tertiary sector • Ecological electricity purchasing
Brandenburg	• *Land* energy concept Brandenburg (1996) • Energy strategy 2010 (2002)	• Increase in renewable energy share to 5% of primary energy consumption by 2010 • Support/assistance for (energy) use of renewable raw materials and wind energy • Assistance for energy research, especially on efficiency improvements in generation of power from lignite • Assistance for communication, information and cooperation through networks, working groups, advisory campaigns etc.
Bremen	• Second update of *Land* energy programme (2001) - Goal: Reduction of CO_2 emissions by 11.6% compared with 1993	• Assistance for low-emission or zero-emission electricity generation technologies (especially wind energy, solar energy, geothermal energy) • Assistance programmes for building remediation, non-investing energy saving

		• Integrated traffic concept • Public relations and education work
Hamburg	• Programme “Hamburg’s contribution to avoiding climate risks” (1990, latest update of concept 2002)	• “Initiative Labour and climate protection”: assistance for energy-saving building remediation, use of solar technology and passive house construction methods • Advisory and assistance programme on entrepreneurial resource conservation • Measures to make local public transport more attractive • *Land* initiative on hydrogen • Energy-aware physical development planning
Hesse	• Integrated climate protection programme Hesse 2012 (InKlim 2012) • Hesse’s greenhouse gas accounts	• Pilot projects on Kyoto mechanisms (emissions trading, funding models etc.) • Assistance for measures for low-emission energy generation and efficient use of energy (especially use of biomass) • Assistance for church and municipal solar energy systems and photovoltaic systems • Pilot and demonstration projects on efficient use of energy and sustainable energy-saving modernisation of existing buildings • Public relations work: extensive offerings of information and guidance on efficient energy management for businesses, local authorities and households
Mecklenburg-W. Pomerania	• Climate protection concept Mecklenburg-W. Pomerania (1997) – currently being updated to a “Climate Action Plan” • Energy report 2002 (accounts period 2000)	• Assistance for measures to reduce carbon dioxide emissions • Urban development remediation programmes • Advisory and PR work, e.g. support for information events about use of renewable energies / alternative fuels and drive systems • Database for determining CO_2 emissions • *Land* atlas of renewable energies Mecklenburg-W. Pomerania 2002 • Climate protection congress on climate consequences research in 2006 • Construction and expansion of Solar Centre Mecklenburg-W. Pomerania • Solar conference, annually in Solar Centre • Study: “Photovoltaic systems for farmers” • Support for local authority activities to save energy / European Energy Award
Lower Saxony	• Lower Saxony initiative on fuel cells • Lower Saxony initiative on energy saving • Lower Saxony bio energy offensive • Lower Saxony CO_2 accounts (two-year reporting period)	• R&D projects for efficient energy generation and conversion (renewable raw materials, fuel cell technology, fuels for the future from biomass, improving efficiency in the use of fossil fuels) • Advisory and PR work on energy saving, especially with regard to improving efficiency in buildings sector (energy-saving building remediation, contracting) • Cooperation projects on climate protection and business, especially in the context of the Lower Saxony government’s commission on “Environmental policy in European competition” (5th government commission) • Assistance programme Local Agenda 21 for local authority concepts/projects
North-Rhine/ Westphalia	• Climate protection concept (2001) • Implementation report 2005	• Assistance for market launch of renewable energies (solar, biomass, hydro power, geothermal energy) and of technologies for improving energy efficiency (CHP, use of mine gas etc.) through various promotion programmes and campaigns, including • Assistance programme “Efficient energy utilisation and use of inexhaustible energy sources” (REN broad-impact and demonstration assistance); to date over 600 million EUR assistance funds (since 1988) have initiated investments totalling over 3 billion EUR and promoted around 50,000 projects (www.energieland.nrw.de) • Assistance for energy-producing use of untreated wood (since 1998) under the Wood Sales Promotion Guideline (HAFÖ); expenditure to date 30 million EUR (www.munlv.nrw.de) • Wood pellets campaign (information campaign for heating with domestic renewable fuels); (www.aktion-holzpellets.de) • *Land* initiative on energies for the future; to coordinate the activities of the *Land* government in the renewable energies sector and energy efficiency between ministries and with industry and

		research (www.energieland.de) • Power station renewal programme • Expertise network power plant technology (since 2005) (www.mvel.nrw.de) • Expertise network hydrogen and fuel cells (since 2000) (www.brennstoffzelle-nrw.de) • Assistance, certification, award and action programme for local authority energy (saving) concepts; including European Energy Award • Comprehensive energy consulting offering for small and medium companies, local authorities and consumers (pilot project "Energy Pass", building energy check, energy efficiency initiative); (www.ea-nrw.de; www.vz-nrw.de) • "Climate protection alliance" (since 2001) with the 4 largest companies in the building and housing industry in NRW and the *Land* construction and property management agency • Assistance for local public transport • Expertise network "Fuels of the future" (since 2005) • Information initiative "Rhine-Ruhr steps on the gas" for broader use of natural gas in the road traffic sector • Fleet project for converting local authority vehicle fleets to biogenic fuels (www.munlv.nrw.de) • Energy-saving measures in sewage works; manual "Energy in sewage works"
Rhineland-Palatinate		• Efficient use of energy in buildings and industrial installations (including informative, user-friendly Internet presentation of both projects)
Saarland	• Expert report on climate protection (1998)	• Annual "Future energy programme" Assistance for various systems for improving energy efficiency and use of renewable energies and energy-saving building remediation • Support for education and research work
Saxony	• Saxony climate protection programme (2001) • Saxony energy programme (2004)	• Improving energy efficiency in companies • Support for local authority energy efficiency measures • Energy saving in existing buildings (Saxony energy pass introduced throughout the *Land*, model and demonstration project), innovation and practical network for passive houses in Saxony • Assistance for biomass and solar energy • Coordination of and assistance for energy research
Saxony-Anhalt	• Climate protection programme (1998) - Goal: Stabilize energy-induced CO_2 emissions at 1994 level. Reduce emissions by 1.5 million t compared with forecast 2010, 7% renewable energy share of electricity generation by 2010 and 0.8 TWh electricity from wind energy in 2010. • Energy concept (2003), targets for 2010: 24% renewable energy share of electricity generation, 6-fold increase in energy from renewables compared with 2000 for electricity generation and 14-fold increase for heat generation.	• Energy-saving building remediation • Assistance for and coordination of use of renewable energies (wind potential study, biomass potential study, identification of geothermal heat potential, coordination unit for renewable raw materials) • Support for local authority energy management (software, experience sharing) • Project assistance for regional and local authorities through Stiftung Klimaschutz (Climate Protection Foundation) • Emissions trading working group of Saxony-Anhalt environmental alliance • Assistance for natural gas vehicles and natural gas filling stations • Investment assistance for industry (biomass power plant, biofuel production, manufacture of PV modules)
Schleswig-Holstein	• Energy report 2004 • Agenda 21 and climate protection report Schleswig-Holstein 2004 – targets by 2010: 15% reduction in CO_2	• Expansion of use of renewable raw materials for materials and energy (investment assistance and soft measures) • Wind energy – repowering and offshore • Solar energy: Solar campaign 2004/05, assistance for photovoltaic systems from agricultural investment assistance programme

	emissions by 2010 compared with 1990, renewable energy share of electricity consumption 50% • CO_2 reduction and climate protection programme Schleswig-Holstein (1995)	• Various projects for sustainable building and housing (support for energy-saving building remediation, passive houses, soft measures, scenarios and dialogue processes) • Climate protection in companies (information and advice on emissions trading, environmental management, assistance for eco technology/eco business) • Support for local authority climate protection, *Land* joins climate alliance
Thuringia	• Thuringian climate protection concept (2000) – Scenario: CO_2 reduction of 6% by 2010 Update 2005 • Erfurt declaration on climate protection (2002) • *Land* development programme 2004 • 2003/2004 Three parallel studies on climate situation in Thuringia: 1. Emission register Thuringia 2. Regional climate diagnosis 3. Regional change • Annual energy reports as part of annual economic report • Annual energy accounts incl. CO_2 accounts	• Initiation of communication processes: 1./2. Thuringian Climate Forum (2002/2004) and Status Conference (2003) • Increase in renewable energy share to up to 10% of primary energy consumption in 2010 • Promotion of renewable raw materials • Payments for electricity from renewable energy under Renewable Energies Act • Public relations and education work, especially advice on energy saving • 2004: Broadening of cross-sectoral cooperation to form a climate network • Seminars on climate protection and climate change consequences and sustainable development for employees of the *Land* government and subordinate areas • 2004: Excursion guide "Sustainable development in Thuringia" – 65 excursions to learning locations relating to renewable energy • In 2005 some of the seminars and workshops on climate topics are offered by the climate network on a cross-sectoral and cross-target-group basis • Model project "CO_2 monitoring system for companies in Thuringia" in preparation for emissions trading • Assistance for biomass and solar energy

IV.5.2. Local authorities

Local authorities continue to be an action level with considerable potential for reducing CO_2 and other greenhouse gases.

The greatest potential arises from the various tasks and functions of local authorities:
- as the administrative level that implements federal and *Land* legislation,
- as the authority that sets standards for the local community,
- as an entrepreneur in cases where energy supply is ensured by a local authority energy supply entity,
- as an owner in the case of local authority properties such as administrative buildings, schools, kindergartens, swimming baths, or
- as an owner in cases of local authority assistance programmes for CO_2 reduction, especially for energy saving and the use of renewable energies.

In addition, local authorities offer a suitable setting for carrying out pilot projects.

Table IV - 5 Important fields of action for local authority climate protection

Sector	**Measures**
Ecological urban development and regional planning	• Implementing climate-friendly, energy-saving physical development and building planning and construction permit • Bringing about less CO_2-intensive spatial structures (functional mix, city of short distances etc.)
Information, guidance and public relations work	• Establishing a local and regional energy advisory service • Communicating climate-relevant information in an environmental guidance context
Energy saving in the consuming sector	• Improving energy efficiency in local authority buildings through physical heat insulation improvements, efficiency-boosting measures in heating, instrumentation and control technology, establishing a local authority energy management system and further energy-saving measures in the fields of heating and electricity • Providing financial assistance for efficient use of heat and electricity in the other consuming sectors: households, small consumers (trade, craft trades, services), manufacturing industry and other public/local authority institutions (through information, planning or similar supporting measures)
Environmentally acceptable energy supply structures	• Expanding network-based energy supplies (including the space heating sector: gas, local/district heating networks) • Converting to different fuels (e.g. coal to gas) • Modifying supply infrastructure to increase use of CHP generation / micro CHP plants • Use of renewable and local energy sources (wind energy, hydro power, solar energy, biomass, waste heat etc.)
Environmentally acceptable traffic development	• Avoiding motorised personal transport in favour of a shift to local public transport and environmentally friendly, low-emission means of transport • Improving the performance of public transport infrastructure, especially local public transport and other, less traffic-intensive means of transport (cycle paths, pedestrian zones etc.) • Environmentally acceptable design of goods transport (intensifying supply relationships between town and periphery etc.)
Local authority waste and wastewater treatment	• Avoiding waste, separate collection of waste, recovery of waste as material • Waste treatment (as a consequence of a systematic avoidance and recovery policy): recovering waste and landfill gas as thermal energy; recovering waste biomass in biogas systems; composting systems • Wastewater treatment: utilisation of sewage gas, process energy savings

IV.5.3. Other actors

The Federal Government expressly welcomes the many activities by other socially relevant groups, e.g. the churches, media, scientific circles, the environmental and consumer associations, the trade unions, networks like the genanet – “focal point gender, environment, sustainability”, and the German railways (Deutsche Bahn AG). Social groups help to raise the necessary awareness among citizens, and make a contribution to reducing the considerable information deficits that still exist. The Federal Government welcomes the dedication and commitment of many development and environment policy initiatives in Germany. It is particularly concerned to help improve the national and international framework conditions for such honorary activities. The Federal Government will maintain and intensify the constructive debate with these actors and groups.

By way of example, some of the actors are described briefly below:

IV.5.3.1. Deutsche Bundesstiftung Umwelt (DBU)

Deutsche Bundesstiftung Umwelt (DBU) in Osnabrück is one of the biggest environmental foundations in Europe. It was founded with the proceeds of EUR 1.2 billion from the sale of the federally owned company Salzgitter AG, which serves as the foundation's capital. The DBU was set up under the Establishment Act announced on 18 July 1990 and established as a civil-law foundation with legal capacity.

Its principal objective is to provide financial assistance for innovative model projects in the fields of environmental technology, environmental research, nature conservation and environmental communication. In keeping with the act establishing the foundation, special attention is to be given to small and medium enterprises. Network projects between small or medium enterprises and research establishments are explicitly regarded as desirable. Support is also possible for projects by institutions, associations and interest groups, which in their capacity as multipliers are important communicators for putting the results of research and technology into practice.

Every year the DBU awards an environmental prize worth EUR 500,000 for achievements that have made a decisive and exemplary contribution to protecting and maintaining the environment or will lead to a marked reduction in environmental burdens in the future.

In the past 15 years the foundation has provided financial assistance totalling around EUR 1.2 billion for more than 6,200 projects.

IV.5.3.2. Deutsche Energie-Agentur (dena)

On 29 September 2000 the German Energy Agency (Deutsche Energie-Agentur – dena) was established at the initiative of the Federal Government as a nationwide institution for promoting efficient and environment-friendly energy generation and use, including renewable energies. dena is not a subordinate authority of the ministries, but a limited liability company (GmbH). The partners in dena are the Kreditanstalt für Wiederaufbau (KfW) and the Federal Republic of Germany, each holding 50 percent. The latter is represented by the Federal Ministry of Economics and Technology, the Federal Ministry of Transport, Building and Urban Affairs, and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety.

With flexible projects, dena supports certain activities of the Federal Government in the fields of efficient use of energy, renewable energy sources and climate protection. It is intended to be a communicator of information to local and regional energy agencies, and also consumer advice centres. The aim is also to supply the necessary information to interested persons in households, businesses, associations and authorities. Another important activity of the agency is to establish a presence at the international level through experience sharing and joint implementation of projects with partners from other countries, and at the same time to advise the Federal Government.

IV.5.3.3. Deutsche Bahn (DB AG)

The German railway system (Deutsche Bahn), having regard to national and international developments in the environmental sphere, its business interests and possibilities and the expectations of society, has laid down the following strategic objectives:

- 25 percent reduction in specific primary energy consumption for traction purposes by 2005 compared with 1990,
- further reduction in absolute primary energy consumption for stationary processes, and
- reduction of at least 15 percent in specific CO_2 emissions compared with 2002, and halving of rail noise

V. Emission scenarios and projections, and assessment of the impact of measures

V.1. The information value of forecasts, scenarios, projections

Forecasts and scenarios are indispensable aids to getting an idea of future possibilities for a climate protection strategy and assessing the impacts of possible measures. In political discussions, however, people often lose sight of the fact that it is not possible to have any certain knowledge of the future, and that scenarios are quite clearly “What if?” statements. Every forecast is closely linked to future-oriented trends that have been ascertained and are judged to be probable. Thus the information value of every scenario depends on the premises that underlie it.

This means: Depending on the assumptions about the future development of the economic, demographic and political limiting conditions and depending on the assessment of the cause-and-effect relationships of relevance to energy consumption, there are always several consistent and non-contradictory descriptions of the future that are possible at the same time. Target-oriented forecasts are known as projections. The extent to which the results of such projections can be achieved requires further investigation.

From a methodological point of view the preparation of emission projections is characterised by impact analyses and an integrated view of the combined effects of various measures and policies. The longer the projection periods, the more it becomes necessary to fall back on numerical models, which can naturally provide no more than a limited picture of reality. This is because the growing lack of precision as one moves along the time axis means that impact analyses for individual measures no longer produce reliable information.

The projections presented are based on the study “Policy scenarios III – Climate protection in Germany to 2030”. The data on which this study is based date from 2003. It must be expressly pointed out here that the projections from the study “Policy scenarios III – Climate protection in Germany to 2030” which are used in this report do not yet take any account of the developments in prices on the world energy markets caused by the massive increases in crude oil prices since 2005. This report is therefore not in a position to include the resulting economic developments that have been and will be induced by the new, modified energy price scenario. Climate policy measures recently introduced by the Federal Government and the much more dynamic expansion of renewable energies than was assumed in the study are not included in the report either. For this reason the Federal Government is currently having the existing scenarios and forecasts updated. Moreover, it does not endorse the results of scenarios and forecasts that have been commissioned by itself or presented by other parties – though it does take account of such results in its deliberations.

In March 2005 the Energy Institute of the University of Cologne and Prognos AG, Basel, submitted their latest reference forecast for the energy industry ("Energy Report IV – The Development of the Energy Markets to 2030"). This links long-term development trends in industry and society with assumptions about the continued application of energy and climate policy. However, the energy report is not available in the formats required for the projection report.

In 2005 Forschungszentrum Jülich presented the study "Evaluation of CO_2 reduction measures in the buildings sector". This provided the scientific basis for the emission scenarios of the "National Climate Protection Programme 2005", thereby permitting an up-to-date estimate and plausible quantification of the savings measures implemented.

The scenarios described below for the building sector, especially the estimates of future CO_2 emission scenarios up to 2012 and 2020, are not in line with the Federal Government's latest information.

As regards the scenarios for the expansion of renewable energies in the electricity sector, a study on "Expansion of renewable energies in the electricity sector up to 2020" prepared for the Federal Environment Ministry by the DLR, ZSW, and Wuppertal-Institut was published in December 2005 .

V.2. Projections for the period 2008 to 2012

Between 1996 and 1999 various analyses concerned with reduction of greenhouse gases in the German energy system, industrial processes and other emission sources were commissioned by the Federal Environmental Agency and carried out under the title of "Policy scenarios for climate protection" by the partners Deutsches Institut für Wirtschaftsforschung (DIW Berlin), Forschungszentrum Jülich, Fraunhofer-Institut für Systemtechnik und Innovationsforschung (FhG-ISI) and Institut für angewandte Ökologie (Öko-Institut). In particular, these made use of the IKARUS range of instruments. To be able to take account of more recent developments – national and international – and resulting changes in the questions to be asked, and also of recent climate policy decisions by the Federal Government, there was a need to update the information and extend the timeline considered. The resulting study – "Climate protection in Germany up to 2030 – Policy scenarios III" [44] – provides the data on which this chapter is based.

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[44] The Federal Government does not endorse the results of the study in question.

Background information on methodology

On the basis of the reference scenario of the Commission of Inquiry of the 14th Bundestag, entitled “Sustainable energy supplies under the conditions of globalisation and deregulation”[45], the study, in the light of current assessments and political decisions, developed a with-measures scenario which serves as a reference scenario in the study used here. It includes a quantitative analysis of the emission-reducing impact both of measures contained in Germany’s National Climate Protection Plan of 18 October 2000 and of more recent measures. The quantification of the impacts is based on expert estimates for the individual sectors. This reference scenario is contrasted with a (fictitious) without-measures scenario that differs from the former by not including the measures taken or approved between 1998 and 2002.

The difference between these two scenarios reflects the contribution that the measures implemented since are expected to make to reducing greenhouse gas emissions. In the presentation of the scenario results, the year 2010 is used to represent the period 2008 to 2012.

Since the measures taken by the Federal Government between 1990 and 1998 are already covered in both scenarios, their impacts are also taken into account accordingly in the final overall accounts for greenhouse gas emissions in relation to the base year 1990.

The impact assessments in Sections V.2.1 and V.2.2 are based on the methodological principles explained above.

Where possible for the sake of simplicity and to avoid double counting, the impacts of a measure – even if it is basically of cross-sectional design – are allocated to the different sectors involved. Whereas the contributions made by the various CO_2 reduction measures are considered across all sectors, the other Kyoto greenhouse gases are examined on a sector-specific basis.

In isolated cases, impacts that mainly affect one sector are allocated to that sector completely, and the minor sector is only mentioned in passing. The final greenhouse gas emission accounts in relation to the base year 1990 can be found in Chapter V.2.2.9.

V.2.1. Cross-sectoral measures

Measures to improve energy efficiency, measures to promote renewable energies, the ecological tax reform and the emissions trading scheme are central cross-sectoral measures and policies of Germany’s endeavours to protect the climate. For definition reasons, the Federal Government’s voluntary declaration, which also has to

[45] Enquete (2002), Enquete-Kommission “Nachhaltige Energieversorgung unter den Bedingungen der Globalisierung und Liberalisierung”: Endbericht. Deutscher Bundestag. Bundestags-Drucksache 14/9400. Berlin 2002.

be basically classified as a cross-sectional measure, is assigned to the sector “Trade, Commerce, Services” and dealt with conclusively here.

V.2.1.1. Measures to improve energy efficiency

As already described in Chapter IV.2, measures to improve energy efficiency are implemented in many areas and sectors. In the building sector, for example, the Energy Saving Ordinance (EnEV) and the Federal Government’s energy-saving building remediation programme apply. They are to be implemented in the sectors: Private Households; Trade, Commerce, Services; and Industry. German industry’s voluntary undertaking to reduce CO_2 emissions and the CHP Agreement relate to the sectors: Industry and Energy Industry. Attempts to classify the impacts of “soft” instruments such as the measures initiated by the Federal Government to improve information and education run into problems when it comes to quantifying them. In the sections that follow, the measures to improve energy efficiency are assigned directly to the various sectors and their impacts quantified.

V.2.1.2. Promotion of renewable energies

Environmentally acceptable and nature-friendly expansion of renewable energies is one of the cornerstones of sustainable energy supplies and a systematic climate protection policy. It was therefore incorporated in the national sustainability strategy with the medium-term expansion target of at least 4.2 percent of primary energy consumption by 2010 and a long-term target of roughly half of total primary energy consumption in 2050. In recent years Germany has already achieved a substantial increase in the share of energy consumption accounted for by renewable energies. In 2005 biomass, water, wind, sun and geothermal energy had a combined share of about 4.6 percent of primary energy consumption and about 10.2 percent of electricity consumption. (Cf. Chapter IV.2)

Comparing the with-measures scenario and the without-measures scenario reveals a marked difference in the future share of primary energy consumption due to renewable energies. The following description dispenses with subdivision and impact allocation of the many and various individual measures set out in Chapter IV.2, since their overall effect is often only achieved in combination. Attention must however be drawn to the great importance of the Renewable Energies Act for the electricity generation sector, and of the market incentives programme for the heat supply sector. The use of automotive fuels profits above all from the present total tax exemption.

V.2.1.2.1. Electricity generation

Overall, the with-measures scenario indicates that in 2010 some 67 TWh of electricity will be generated from renewable energies, and if one includes energy production using biogenic waste the figure is as high as 69 TWh. In 2005 it had already reached 62 TWh. On the basis of gross electricity consumption to date, this results in renewable energy shares of 11.5 percent and 12 percent respectively for 2010. The following table shows a breakdown by different primary energy sources:

Table V - 1 Electricity generation from renewable energies (in TWh) in 2010 with and without post-1998 measures

	Ist	Normaljahr	Mit Maßn.	Ohne Maßn.	Differenz
	1998		2010		
Erzeugung in TWh					
Wasserkraft	19,2	20,0	21,6	20,0	1,6
Windkraft	4,5	4,2	38,0	9,8	28,2
Biomasse	1,1	1,1	6,0	2,3	3,7
Photovoltaik	0,0	0,0	0,9	0,1	0,8
Geothermie	0,0	0,0	0,5	0,0	0,5
Summe	24,8	25,3	67,0	32,2	34,8
Anteil am BSV in %	4,5	4,5	11,5	5,5	6,0
Vermiedene CO2-Emission in Mt	19,8	20,2	53,6	25,7	27,9

Quellen: Schätzungen des DIW.

All in all, policy scenario III without measures would result in about 32 TWh of electricity generation from renewable energies in 2010. This would be about 35 TWh less than under the forecast with measures. Accordingly, the measures considered here would reduce CO_2 emissions in 2010 by an additional 28 million tonnes. To this must be added a saving of around 26 million tonnes of CO_2 in 2010 due to measures implemented between 1990 and 1998 to promote renewable energies. Thus electricity generation from renewable energies (including biogenic waste) in 2010 results in a total CO_2 saving of about 55 million tonnes compared with 1990.

V.2.1.2.2. Heat and fuel production

Under the scenario with measures, heat and fuel production from renewable energies makes a renewable energy contribution of around 375 PJ in 2010, which corresponds to a difference of over 200 PJ compared with 1998. The growth during the period under consideration results mainly from the increased use of biomass.

The following table shows the development of heat and fuel production for renewable energies with and without measures.

Table V - 2 Heat and fuel production (in PJ) from renewable energies in 2010 with and without post-1998 measures

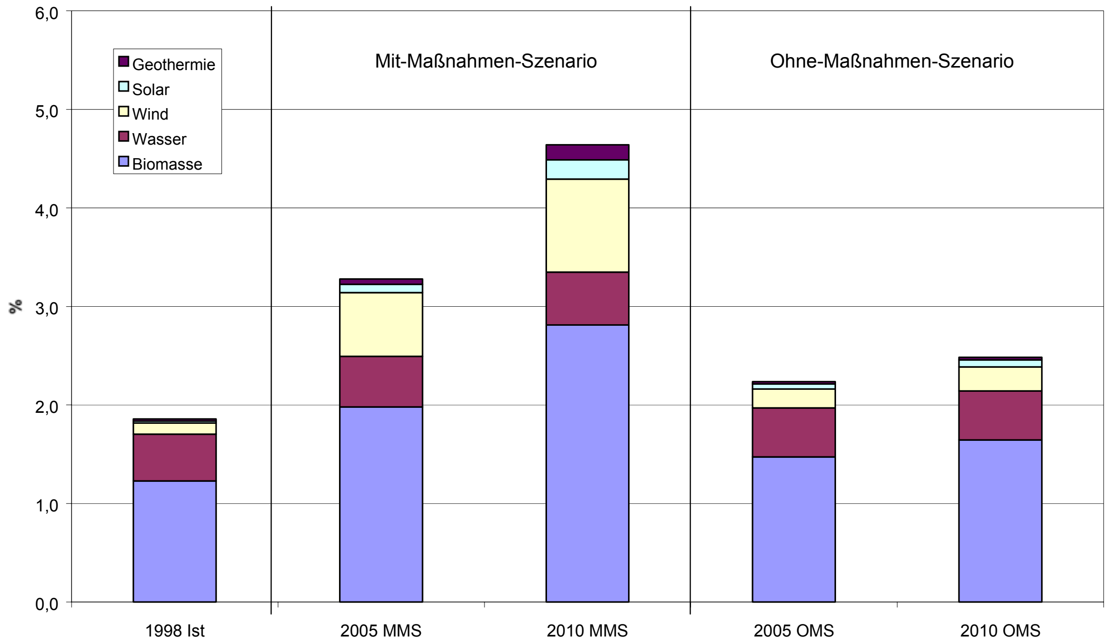
	Ist	Mit Maßn.	Ohne Maßn.	Differenz
	1998	2010		
Energie in PJ				
Biomasse, -gas	162,0	290,0	200,0	90,0
Biodiesel	3,7	56,0	15,0	41,0
Solarthermie	3,1	25,0	10,0	15,0
Geothermie	3,0	4,5	4,0	0,5
Summe	171,8	375,5	229,0	146,5
CO_2-Emission in Mt	11,3	24,7	15,0	9,7

Ohne Abfall.
Quellen: Schätzungen des DIW.

Without measures, the systems considered here would result in production of around 230 PJ of heat or fuel in 2010, corresponding to a difference of 147 PJ from the scenario with measures. The CO_2 saving for 2010 is about 15 million tonnes without measures, or about 25 million tonnes with measures. Accordingly, the measures considered here would reduce CO_2 emissions in 2010 by an additional 10 million tonnes compared with 1998.

V.2.1.2.3. Overall picture

Fig. V - 1 Renewable energies as a percentage of primary energy consumption in Germany up to 2010 (without waste and ambient heat)



Quellen: Istdaten nach BMU (2002), Schätzungen des DIW.

In the scenario with measures there is a marked rise in biomass and wind energy in particular, whereas the contribution of hydro power shows little increase. Solar energy and geothermal energy achieve only small shares by 2010. In this scenario, renewable energies achieve a 4.6-percent share of primary energy consumption in 2010 (without waste and ambient heat).

By contrast, in the scenario without measures this share would only be around 2.5 percent in 2010. Nearly 90 percent of the difference between the scenarios with and without measures is due to the different trend in biomass and wind energy.

Similar ratios are found in the case of CO_2 emission reductions. In the scenario with measures, a total 78 million tonnes of CO_2 is avoided in 2010 thanks to renewable energies (see the following table). This is 38 million tonnes CO_2 more than in the (fictitious) scenario without measures, or 47 million tonnes more than in 1998.

Table V - 3 *CO_2 reduction due to renewable energies, with and without measures*

	Ist	Mit Maßn.	Ohne Maßn.	Differenz
	1998	2010	2010	2010
	Mio. t CO2			
Strom	19,8	53,6	25,7	27,9
Wärme	11,0	20,9	14,0	6,9
Kraftstoff	0,3	3,8	1,0	2,8
Summe	31,1	78,3	40,8	37,5

Ohne Abfall.
Quelle: Schätzungen des DIW.

The CO_2 emission reductions of the cross-sectoral measures for promoting renewable energies are allocated to the different individual sectors as follows:

- electricity generation to the energy sector (Section V.2.2.1)
- heat production to the private households sector(Section V.2.2.5), and
- fuel production to the transport sector (Section V.2.2.3).

V.2.1.3. The ecological tax reform

With the introduction and continuation of the ecological tax reform in 1999 and 2000, the petroleum excise duty on heating and automotive fuels was raised and the electricity tax was introduced and successively raised in five stages through to 2003 (cf. following table).

Table V - 4 Rates of increase under the ecological tax reform[46]

Energy sources		Stage 1 (April 1999)	Stage 2 (Jan. 2000)	Stage 3 (Jan. 2001)	Stage 4 (Jan. 2002)	Stage 5 (Jan. 2003)
Automotive fuels[47]	cents / litre	3.07	3.07	3.07	3.07	3.07
Light heating oil	cents / litre	2.05	-	-	-	-
Heavy fuel oil[48]	cents / kg	-	0.26	-	-	0.71
Natural gas	cents / kWh	0.164	-	-	-	0.202
Electricity	cents / kWh	1.02	0.26	0.26	0.26	0.26

Initially tax concessions in relation to petroleum excise duty and electricity tax were necessary for economic, environmental or social policy reasons, but these have already been reduced to some extent in the interests of better coordination of steering and distribution effects.

The ecological tax reform has helped to save energy and reduce emissions of climate-relevant greenhouse gases. The impacts of the ecological tax reform are described in detail for the individual sectors in Sections V.2.2.2 to V.2.2.5.

All in all, the Federal Government expects that in the medium term the ecological tax reform will bring about a reduction in CO_2 emissions by at least 12.2 million tonnes.

Table V - 5 Estimate of sector-specific CO_2 emission reductions by 2008/2012 as a result of the ecological tax reform, in the scenario with measures

Sector	**Expected effect by 2010**
Transport	- 5.0
Industry	- 2.2 (direct emissions)
Trade/Commerce/Services	- 5.0 (direct emissions)
Private households	not quantifiable
Total	**-12.2**

Source: Politikszenarien III

V.2.1.4. Emissions trading

Since 1 January 2005, a new environmental policy instrument of central importance for climate protection has been in use in the EU, in the form of emissions trading. The emissions trading scheme creates economic incentives for participants to save energy, improve energy efficiency and change to less carbonaceous fuels with the aim of reducing CO_2 emissions. (see also Chapter IV.3.8)

Since January 2005, the CO_2 emissions from certain installations are bound by limited emission allowances. These are allocated to the installation operators free of

[46] Figures rounded
[47] From 01.11.2001 for low-sulphur, from 01.01.2003 for zero-sulphur automotive fuels
[48] With effect from 1 January 2000 the different rates of petroleum excise duty on heavy fuel oil for heating and for electricity generation were brought together in a single petroleum excise duty rate

charge for the first two trading periods 2005-2007 and 2008-2012, and can be freely traded throughout the EU. If the actual emissions from an installation exceed the allocated quantity of emission allowances, the operator must reduce the installation's emissions or purchase additional emission allowances. If the emissions are lower, he can sell allowances.

Those taking part in the emissions trading scheme in Germany are currently the operators of large energy installations (with a firing rate of > 20 MW) and energy-intensive industrial installations in the fields of refinery processes, coke ovens and the steel, cement, glass, ceramics, and cellulose and paper industries.[49] At present some 1,849 installations are taking part in the emissions trading scheme. Most of these are installations for the conversion of energy. Two thirds of all installations (and nearly 80 percent of all emission allowances) are accounted for by power stations. Most of the remaining installations in production sectors subject to compulsory emissions trading are in the ceramics production (206 installations) and paper industries (122 installations).

The emissions trading scheme covers about 58 percent of German CO_2 emissions.

Table V - 6 National CO_2 emission targets and their allocation to individual sectors

	Allocation period 2005-2007	**Allocation period 2008-2012**
Energy and industry	503 mill. t/year	495 mill. t/year
Transport and households	298 mill. t/year	291 mill. t/year
Trade, commerce and services	58 mill. t/year	58 mill. t/year
Total	**859 mill. t/year**	**844 mill. t/year**

Sources: Allocation Act 2007 and National Allocation Plan for Germany, Berlin 2004

Projections of the impacts of emissions trading on CO_2 emissions are currently in preparation.

V.2.1.5. The Federal Government's voluntary undertaking

The Federal Government's voluntary undertaking to make a 30-percent reduction in its own greenhouse gas emissions by 2005 compared with the base year 1990 raises problems of quantification and allocation. Although the sectors involved are mainly Transport and Trade/Commerce/Services, clear allocation is difficult. Moreover, many impacts of the Federal Government's voluntary undertaking are already contained in other measures specifically designed to meet the relevant target (e.g. the Energy Saving Ordinance (EnEV) in the energy sector). The voluntary undertaking is, as intended by the Federal Government, to be seen above all as a clear signal to the public.

[49] The installation types are listed in Annex 1 to the Greenhouse Gas Emissions Trading Act (TEHG).

V.2.2. Sector-specific measures

The following section presents and compares the results of the scenarios with and without measures for the sectors: energy; private households; industry; trade, commerce, services (TCS); transport; agriculture, land use and forestry; and waste management, recycling, material efficiency. This involves not only sector-specific measures, but also cross-sectional measures allocated to various sectors.

V.2.2.1. The energy sector (energy conversion)

The energy sector as defined here on the basis of the German energy accounts comprises the fields: coke ovens, coal and lignite briquette factories, public heating plants (excluding CHP plants), industrial heating plants, nuclear power plants, hydroelectric power plants, wind and photovoltaic systems, public CHP plants, district heating plants, blast furnaces, refineries and other energy generation systems. Apart from refineries, in which energy conversion is primarily concerned with conversion of substances, the electricity generating fields within this very heterogeneous sector are by far the most important in terms of energy input – their share of CO_2 emissions is correspondingly large. The other greenhouse gases produced in the energy sector originate from coal mining and the production and transportation of natural gas.

The measures to promote renewable energies, and also their impacts, have already been described in Chapter IV.2 and Section V.2.1.2.

V.2.2.1.1. Carbon dioxide (CO_2)

The conversion sector plays a particularly important role in CO_2 emissions. According to the National Inventory Report 2005 and the associated emission data supplied in the common reporting format (CRF), some 38 percent of all energy-induced CO_2 emissions in 2003 were due to the sector “public electricity and heat generation”. The allocation of CO_2 emissions by the industrial energy industry to the industrial sector, which is used in the National Inventory Report for 1990 to 1993 produced by the Federal Environmental Agency in accordance with the common reporting format (CRF), differs from the system used in the German energy accounts, which allocates these emissions to the conversion sector – and hence the energy sector. The calculations from the German energy accounts are used here for calculating the scenarios.

Table V - 7 Development of carbon dioxide emissions in the energy sector

	1990	1995	1996	1997	1998	1999	2000*	2001*	2002*	2003*
	(a) CO_2-Emissionen in der Gliederung des Nationalen Emissionsinventars (Stand: Januar 2005) in Mio. t									
Energiesektor	413,9	355,2	360,7	342,8	345,0	330,9	343,9	349,2	356,6	362,6
Öffentl. Strom- und Wärmeerzeugung	334,6	299,9	312,2	297,7	303,4	293,2	303,8	309,4	316,9	322,6
Mineralölraffinerien	19,4	19,9	20,9	20,1	20,9	19,7	19,9	19,9	19,7	19,4
Übriger Energiesektor	59,9	35,4	27,7	25,0	20,8	18,0	20,2	19,9	20,1	20,6
Summe energiebedingte CO_2-Emissionen	988,9	876,1	900,0	868,1	859,6	831,6	834,6	850,4	841,1	841,7
	Anteile an den gesamten energiebedingten CO_2-Emissionen in %									
Energiesektor	41,9	40,5	40,1	39,5	40,1	39,8	41,2	41,1	42,4	43,1
Öffentl. Strom- und Wärmeerzeugung	33,8	34,2	34,7	34,3	35,3	35,3	36,4	36,4	37,7	38,3
Mineralölraffinerien	2,0	2,3	2,3	2,3	2,4	2,4	2,4	2,3	2,3	2,3
Übriger Energiesektor	6,1	4,0	3,1	2,9	2,4	2,2	2,4	2,3	2,4	2,4
	(b) CO_2-Emissionen in der Gliederung der deutschen Energiebilanzen in Mio. t (Stand: April 2003)									
Energiesektor	439,2	377,7	380,3	361,6	365,1	350,6	361,1	369,1	373,0	noch keine Angaben verfügbar
Kraftwerke	353,8	319,7	321,3	309,3	313,1	303,1	309,5	316,9	332,0	
Heizkraft-/Heizwerke	43,0	29,3	30,3	25,8	25,6	23,6	27,1	28,5	27,6	
Übrige Umwandlung	42,4	28,7	28,7	26,5	26,4	23,9	24,5	23,7	23,4	
Summe energiebedingte CO_2-Emissionen	986,8	872,4	896,4	864,5	855,7	828,7	830,7	849,1	833,6	
	Anteile an den gesamten energiebedingten CO_2-Emissionen in %									
Energiesektor	44,5	43,3	42,4	41,8	42,7	42,3	43,5	43,5	44,7	noch keine Angaben verfügb.
Kraftwerke	35,9	36,6	35,8	35,8	36,6	36,6	37,3	37,3	38,6	
Heizkraft-/Heizwerke	4,4	3,4	3,4	3,0	3,0	2,9	3,3	3,4	3,3	
Übrige Umwandlung	4,3	3,3	3,2	3,1	3,1	2,9	3,0	2,8	2,8	

*) Vorläufige Angaben.

Quellen: Umweltbundesamt; AG Energiebilanzen; Berechnungen des DIW Berlin.

The measures in the energy sector since 1998 are described briefly below and their impacts are quantified:

Use of renewable energies for electricity generation (Renewable Energies Act, MAP)
The Federal Government expects the use of renewable energy sources for electricity generation to have substantial emission-reducing impacts. As described in detail elsewhere (cf. Section V.2.1.2), the reduction effect up to 2010 totals nearly 28 million tonnes.

Legislation and measures to promote combined heat-and-power generation
The expansion of combined heat-and-power generation will also be of special importance. Since the deregulation of the German electricity market in 1998 had resulted in a deterioration in the conditions for this technology, measures were taken to avert an imminent decline in the share of electricity produced by co-generation and to promote the expansion of this efficient technology:

- Act protecting CHP electricity generation (CHP Act) of 12 May 2000 (Federal Law Gazette I 2000, 2992).
- Act on the maintenance, modernisation and expansion of combined heat-and-power generation (CHP Act) of 19 March 2002 (Federal Law Gazette I 2002, 1092).
- Exemption of CHP plants from petroleum excise duty on the introduction of the ecological tax reform in April 1999
- Financial assistance for CHP under the Renewable Energies Act in cases where electricity is generated from biomass, by granting a bonus of 2 cents/KWh above the basic payment.
- Agreement between the Federal Government and German industry on the reduction of CO_2 emissions and on promoting CHP generation, as a supplement to the Climate Agreement of 9 November 2000 (for details see Chapter IV.2)

The CHP Act dating from 2000 merely had the function of preserving the status quo. The same is true of the total tax exemption under the ecological tax reform. Above all, both measures prevented a decline in CHP electricity generation as a result of fierce competition in response to the deregulation of the electricity market.

The situation changed with the entry into force of the new CHP Act on 1 April 2002, which pursues the following objectives:

- Support for the operation of (old and new) existing plants
- Modernisation of existing plants; commissioning of the modernised plants to take place not later than 31 December 2005 and a number of other ancillary requirements to be complied with
- Additional construction of small CHP plants (up to 50 kW or 50 kW to 2 MW) and of fuel cells, the bonus payments for plants in the 50 kW to 2 MW being on a declining basis and also ending on 31 December 2010; for small CHP plants up to 50 kW and fuel cells, by contrast, the bonus payments are made for a total of 10 years from the start of continuous operation of the plant.

The agreement between the Federal Government and various industry associations lays down for CHP generation a total reduction target of 20-23 million tonnes CO_2 by 2010 (10 million tonnes by 2005). The CHP Act is intended to make its contribution to achieving this target mainly by maintaining and modernising existing installations and building additional small CHP plants, whereas other aspects of expansion under the CHP agreement are largely left to market forces.

The results of the interim examination of the extent to which the targets laid down for German industry in the CHP Act have been achieved are currently being evaluated. It is not yet clear when reliable results will be available. In the event that these results show that the targets and objectives are not met, the agreement provides that the Federal Government is to propose suitable measures.

An important framework condition for the future development of CHP generation within the public district heating sector was established during the German implementation of the EU emissions trading scheme (National Allocation Plan). Since heat from public CHP plants is generally in competition with heating plants that are not subject to the emissions trading scheme, there was reason to expect distortions of competition. To counteract this, the Allocation Act 2007 provides for the additional allocation – on application – of allowances totalling 27 t CO_2/GWh for electricity generated in CHP plants.

V.2.2.1.2. Methane (CH_4)

Increased use of mine gas under the undertaking by the German Coalmining Industry Association

The German Coalmining Industry Association is a party to the agreement between German industry and the Federal Government. In addition to reductions in CO_2 emissions from production-related energy consumption, it promised to reduce methane emissions into the atmosphere from active and abandoned mines. In total, the German coalmining industry expects an additional emission reduction for methane alone of 3.8 million tonnes p.a. CO_2 equivalent between 2000 and 2010, which corresponds to a reduction of around 180,000 tonnes of CH_4. Of this figure, the Federal Government attributes an emission reduction of 1.9 million tonnes p.a. CO_2 equivalent to the measures since 1998.

Production and transportation of natural gas: reduction in methane losses

The optimisation of technical processes in the production and transportation of natural gas (better seals and faster leak identification) contributes to ongoing emission reductions. The Federal Government attributes an effect of 0.2 million tonnes p.a. CO_2 equivalent to the measures since 1998.

V.2.2.1.3. Nitrous oxide (N_2O)

The reduction in N_2O emissions from stationary combustion installations (especially fluidised-bed firing), part of which is due to the energy sector, is discussed in Section V.2.2.2.3 together with the installations in the industrial sector.

V.2.2.1.4. Summary

The following overview summarises the various measures in the energy sector.

Table V - 8 Policies and measures in the energy sector

Description of Policy / Measure	Objectives / Impact	Green house gas	Status	Expected effect 2008/ 2012 (mill. t CO_2 equiv.)	Outlook 2020
Renewable Energies Act (EEG), Biomass Ordinance, R&D, demonstrations	Promote the use of renewable energies in electricity and heat generation and for production of fuels Goal: Substitution for fossil fuels, here: impact sector Electricity Generation -> impact sector Heat Production shown under "Households", see Section V.2.2.5 -> impact sector Fuel Production shown under "Transport", see Section V.2.2.3 -> Avoidance of methane emissions shown under "Waste, Recycling, Material Efficiency", see Section V.2.2.8	CO_2	in force (Renewable Energies Act 2000, Biomass Ordinance 2001, Market Incentives Programme 1999, ongoing R&D)	-27.9	rising
Act promoting combined heat and power generation 2000	Safeguard the economic basis for existing CHP plants	CO_2	1.1.2002	only marginal effect	no impact
Act on the maintenance, modernisation and expansion of CHP 2002	Modernise and promote (limited) expansion of CHP	CO_2	1.4.2002	- 4.0	depends on follow-up act
Increased use of mine gas under the undertaking by the German Coalmining Industry Association	Use of extracted mine gas for energy purposes, especially in NRW. Influenced to a large extent by impact of Renewable Energies Act; a) non-energy emission reduction through avoidance of methane emissions	CH_4	since 1993 + voluntary undertaking 2002	reference	still rising slowly
Reduction of methane losses in the extraction and transportation of natural gas	Optimisation of technical processes in the extraction and transportation of natural gas Reduction of methane losses thanks to better seals and faster leak identification	CH_4	ongoing	- 0.2	long-term reduction potential is small
Total of direct impacts on non-CO_2 greenhouse gas emissions (total "increased use of mine gas" and "reduced methane losses in natural gas production and transportation") Accounting in relation to base year in Section V.2.2.9		**CH_4**		**-2.1**	no sector-specific time series available

(Calculation method for CO_2 emissions based on classification in German energy accounts)

The scenario assessments for CO_2 emissions in the energy sector up to 2010 yield the following results:

Table V - 9 *CO_2 savings due to measures in the energy sector, scenario with and without measures*

	Actual 1998	With measures[50] 2010	Without measures 2010	Difference 2010
	mill. t CO_2			
Energy sector	**367.5**	**352.8**	**370.5**	**17.7**

Source: DIW estimates

V.2.2.2. Industry

In the industrial sector there has been a sizeable reduction in greenhouse gas emissions since 1990. From 1991 to 2001 the specific energy consumption of industry – as an efficiency indicator – fell by an average of 2.3 percent per annum, which was still considerable faster than the fall in overall energy intensity with a reduction rate only 1.5 percent per annum. In both cases, however, the increase in energy efficiency offset the consumption-boosting effects of the growth in industrial and national production, with the result that the link between economic growth and emission development in Germany can be regarded as broken.[51] The decline in specific CO_2 emissions in industry actually gained momentum in the second period. In other words the decline in absolute CO_2 emissions has eased off since 1995: between 1990 and 1994, CO_2 emissions in the industrial sector fell by an annual average of around 10.5 million tonnes, and between 1995 and 2003 the reduction was only about 2.8 million tonnes per annum. However, a considerable part of this effect is due to the fact that industrially operated power plants were transferred to the public electricity supply sector.

V.2.2.2.1. Carbon dioxide (CO_2)

The catalogue of measures for industry consists to a large extent of cross-sectional measures. For example, the measures for reducing CO_2 emissions in the buildings sector show a great deal of overlap with those in the sector trade, commerce, services (TCS) and, in the field covered by the Energy Saving Ordinance, with measures for private households. The ecological tax reform applies to all sectors. In this section the emission reduction potentials attributable to industrial CHP and the indirect CO_2 emissions due to electricity and district heating are merely mentioned for information purposes, as in the accounts they are attributed to the energy sector.

Energy Saving Ordinance (EnEV)

The estimate of the impacts of the Energy Saving Ordinance in the industrial sector is based on the following assumptions:

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50 In the “with-measures” scenario for the energy sector, the Commission of Inquiry data originally taken as the basis for the scenario were modified to take account of the latest estimates, e.g. with regard to growth rates for renewable energies or shutdown periods for nuclear power plants. As a result the figure for 2010 assumed here is some 15 million tonnes CO_2 higher than the figure of 337.6 million tonnes CO_2 calculated by the Commission of Inquiry.

51 DIW Wochenbericht No. 50/2002.

- Space heating as share of industry's heating fuel requirements: approx. 15%;
- For newly erected buildings: 2% building turnover per annum; estimate of impact of measure over 8 years (2002 to 2010); degree of compliance with ordinance: 85%; saving achieved compared with Heat Insulation Ordinance of 1994: 30 %;
- For existing buildings (heating only): saving 10%; impact of measure over 4 years (2006 to 2010; end of transitional period for old boiler systems); 15% of existing buildings affected.

On the basis of these assumptions, a reduction of around 2 million tonnes in direct CO_2 emissions in the industrial sector which is attributable to the Energy Saving Ordinance will take place by 2010. Even if the present requirements of the Energy Saving Ordinance are merely maintained (i.e. not made any tighter), the CO_2 reduction effect can be expected to continue rising until 2020: given the assumptions described, only about one sixth of the buildings existing at the time will have been covered by the Energy Saving Ordinance by 2010 in view of the long turnover time for buildings. The impact on existing buildings will therefore continue after 2010.

<u>The ecological tax reform</u>
In the industrial sector only the emissions directly induced by the ecological tax reform are taken into account. Indirect emission reductions such as those due to electricity savings in response to rising prices are attributed to the energy sector.

In the industrial sector the first stages of the ecological tax reform resulted in direct CO_2 emission reductions of 1.13 percent for basic materials/chemicals, 1.54 percent for capital goods, and 1.05 percent for consumer goods[52]. In total these reductions, weighted to take account of the consumption sectors' relative shares of total industrial energy consumption, would result in direct CO_2 emission reductions of around 1.4 million tonnes by 2010 that are attributable to the ecological tax reform.

However, for the period 2003-2010 it is also necessary to take account of the impacts of the Act on the continued development of the ecological tax reform which entered into force on 1 January 2003, and the overall view therefore results in larger CO_2 reductions. In the course of the continued development of the ecological tax reform, the reduced tax rates for the industrial sector were trebled from 20 to 60 percent and changes made to the peak smoothing system. On the whole, the redesigned ecological tax reform is expected to bring a marked increase in the impact of incentives to reduce demand for energy and hence CO_2 emissions in the industrial sector. However, since the impact of the changes varies from one company to another, the effect estimated for the existing regulation is not expected to treble, but at most to double. Taking into account the shorter impact period, there is thus an additional CO_2 reduction of about 0.8 million tonnes by 2010.

This leads to a total CO_2 emission reduction in the industrial sector of around 2.2 million tonnes by 2010 as a result of the ecological tax reform. The further impacts of the ecological tax reform beyond the year 2010 – and possibly even for the second half of this decade – depend on the further development of tax rates as a whole, the tax structure and the reduced tax rates for industry. If there is no further

[52] "Klimaschutz in Deutschland bis 2030" – Endbericht zum Forschungsvorhaben Politikszenarien für den Klimaschutz – Langfristszenarien und Handlungsempfehlungen ab 2012 (Politikszenarien III), Umweltforschungsplan 2001, Forschungskennzahl 201 41 142, Ed.: Umweltbundesamt, Reihe Climate Change 1/2005, Berlin 2005.

tightening of the conditions, the impact can be expected to remain more or less constant.

Declaration by German industry on global warming prevention II
In an agreement on global warming prevention signed between the German Federal Government and German industry on 9 November 2000, various industry associations declared their willingness to “make a total reduction of 35 percent in their specific emissions of all six greenhouse gases listed in the Kyoto Protocol (CO_2, CH_4, N_2O, SF_6, H-CFC and CFC) by 2012 compared with 1990”, and to make additional efforts to achieve a 28-percent reduction in specific CO_2 emissions by 2005 compared with 1990. [53]

A large number of the associations thereupon promised reductions of their own, some of which actually went further. Some associations, which regarded the reduction pledges for the industry in question as impossible to fulfil, reduced their (specific) pledges.

On the whole, the impacts of the voluntary undertaking given by German industry in 2000 (with its 2001 supplement) and the precursor declaration of 1996 are difficult to evaluate because the declarations contain numerous points that are unclear and/or overlap. It is also difficult to distinguish between CO_2 emission reductions due to the voluntary undertaking and those due to other measures.

On the basis of a constant level of activity, a total emission reduction of 4.6 million tonnes of energy-induced CO_2 was calculated. Deductions must be made from this figure to avoid any double counting of the impacts of emission reductions due to other measures taking effect in the industrial sector or attributable to other voluntary declarations.[54] A conservative estimate which includes such deductions to avoid double counting indicates a reduction of 2.5 - 3 million tonnes in direct CO_2 emissions by 2010.

Only a few industries have given voluntary undertakings for non-CO_2 greenhouse gases and non-energy-induced CO_2 emissions, although some of the industries giving voluntary undertakings (coalmining, chemical industry, cement industry) intend to make significant contributions to emission reduction. In the field of non-energy-induced CO_2 emissions, the reduction pledge given by the cement industry is calculated to yield a reduction of 6 percent by 2005 and 2012, which corresponds to approx. 0.9 million tonnes CO_2.

Voluntary undertaking by industry, assistance for industrial CHP plants (incl. CHP Act)
On 9 November 2000 the Federal Government approved the climate agreement with German industry. This was supplemented by the CHP agreement of 25 June 2001. The aim is to reduce CO_2 emissions by maintaining, modernising and expanding CHP generation. German industry declared that it intended to continue implementing the climate protection agreements with the Federal Government in the future. The Federal Government therefore reached agreement with German industry on a rigorous and transparent monitoring system. This was carried out in 2005 in the form

[53] This is based on the agreements of 10 March 1995 and 27 March 1996 between the Federal Republic of Germany and German industry.
[54] For details see the study “Klimaschutz in Deutschland bis 2030”, page 55 ff.

of an interim examination by the Federal Ministry of Economics and Technology in conjunction with the Federal Environment Ministry in cooperation with the central associations of German industry. The results are currently being evaluated. The CHP Act lays down that if the interim examination finds that the targets and objectives are not met the Federal Government is to propose suitable measures to achieve the targets.

The monitoring reports to date demonstrate German industry's ongoing efforts to improve energy utilisation efficiency and to reduce CO_2 emissions. Particularly in the industrial sector, there has been a reduction in specific CO_2 emissions. The statutory regulations underlying assistance for CHP have already been dealt with in the discussion of the measures in the energy sector (cf. Section V.2.2.1).

<u>Improvements to KfW/DtA loan programmes</u>
The most important fiscal instrument for reducing CO_2 emissions is the improvements to the assistance programmes of the Kreditanstalt für Wiederaufbau (KfW) and the Deutsche Ausgleichsbank (DtA). At the end of 2002, KfW and DtA were amalgamated in a new bank for small and medium enterprises. Until 2002 all assistance programmes were run separately and are therefore shown separately here.

As far as KfW assistance is concerned, the main programme of relevance to the promotion of efficient use of energy in the industrial sector is the *KfW Environment Programme*. Under this programme, which has hitherto been funded entirely from the KfW's own resources, both industrial companies and enterprises in the sector trade, commerce, services (TCS) can be granted financial assistance[55]. Assistance is given to projects that bring about a substantial improvement in the environmental situation. In particular, the programme addresses businesses in trade and industry, self-employed persons, operator models in the waste management industry, and companies in which the public sector, churches or charitable organisations hold a stake. Since 1998 there has been a marked rise in the volume of loans granted compared with the period 1990-1997:

Table V - 10 Annual loan volume granted by the KfW environment programme 1990-2002 (industry and TCS together): figures in EUR million

	1990-1997	1998	1999	2000	2001	2002
Total KfW environment programme	488	814	833	681	919	866
of which: efficient use of energy						419
Share due to industrial sector						approx. 57%

Source: Studie Klimaschutz in Deutschland bis 2030.

Loans granted by the Deutsche Ausgleichsbank (DtA) fell considerably over the same period (see following table).

55 The other KfW programmes in the environmental sector relate especially to residential housing, with special emphasis on renewable energies and infrastructure investments.

Table V - 11 Loans granted by DtA in the environmental sector to promote efficient use of energy in industry and TCS) – Loan volume in EUR 1000

	1990-1999	1998	1999	2000	2001	2002
Combined heat and power	1,184,880	123,300	48,680	24,216	3,350	28,328
Energy-saving production processes	2,317,820	257,597	272,374	207,495	229,663	88,725
Instrumentation and control facilities	21,620	1,174	654	46	171	2,380
Refrigeration systems	12,260	2,234	1,024	583	156	35
Waste heat recovery	37,570	17,229	no data	205	215	50
Other energy savings	1,098,720	115,360	172,850	75,222	93,960	34,683
Total for efficient use of energy	**4,672,870 (519,208/a)**	**516,894**	**495,582**	**307,767**	**327,515**	**154,201**

Source: Klimaschutz in Deutschland bis 2030, under: DtA assistance reports

If one looks at the total volume of assistance for efficient use of energy under the KfW environment programme or the DtA environment sector, there is no evidence of any appreciable overall improvements or extensions to the programmes since 1998. For this reason no additional CO_2-reducing impact is attributed to this measure in the “with-measures” forecast.

Summary of direct CO_2 emission reductions in the industrial sector

A comparison of the two scenarios indicates that a reduction of around 7 million tonnes in CO_2 emissions in 2010 is due to the climate policy measures implemented in the industrial sector.

Table V - 12 Direct CO2 emission savings due to measures in the industrial sector, scenario with and without measures

	Actual 1990	With measures 2010	Without measures 2010	Difference 2010
	mill. t CO_2			
Industrial sector	**169.3**	**110.5**	**117.4**	**- 6.9**

Source: estimates by Fraunhofer ISI.

V.2.2.2.2. Nitrous oxide (N_2O)

The development of N_2O emissions involves energy conversion and process-induced emissions which can be assigned largely to the industrial sector, but also partly to the energy and transport sectors. In view of the difficulty of further differentiation, an overall estimate will be made here.

N_2O emissions are determined by two different developments. On the one hand the increased use of three-way catalytic converters in motor vehicles and a general increase in the volume of traffic have led to an increase in N_2O emissions, while on the other hand N_2O emissions from stationary combustion installations have shown a parallel development to the trend in CO_2 emissions. Particularly as a result of the introduction of optimised catalytic converters, traffic-induced N_2O emissions have been declining since 2000. This trend is supported by Directive 98/70/EC on the phased introduction of reduced-sulphur fuels, which entered into force on 01.01.2000. Such fuels enable the catalytic converter to come into action earlier after the starting phase. All in all, the measures taken since 1998 are expected to result in an N_2O emission reduction of 2 million tonnes CO_2 equivalent by 2010.

Mention must also be made of the following measures which were taken before 1998 and are therefore not shown separately (i.e. they are included in both the "without-measures" and the "with-measures" scenario):

- technical measures in adipic acid production (voluntary agreement), in effect since 1996, marked reduction in process-induced N_2O emissions from these sources as early as 1994 onwards;
- nitric acid production,
- Fertiliser Ordinance (agricultural sector), in force since 1996 (N_2O). The decrease in fertiliser production also contributes to a decline in emissions.

These measures have a reduction effect of rather more than 28 million tonnes CO_2 equivalent.

V.2.2.2.3. Halogenated hydrocarbons (HFC, PFC) and SF_6

In August 2003 the EU Commission put forward a proposal for a regulation to limit and reduce emissions of certain fluorinated greenhouse gases (HFC, FC and SF_6, known as F-gases). In particular, it provides for measures to prevent and minimise leaks in systems containing the substances in question, regulations on leakage testing and substance recovery and on expert knowledge, documentation and reporting obligations, restrictions on the marketing and use of certain substances, and gradual phasing out of the use of the refrigerant R 134a in air-conditioning systems in new vehicles. In the meantime the phasing-out of R 134a in car air-conditioning systems has been transferred to a separate directive.

<u>XPS rigid foam and PU foam</u>

Until 2000 some use was still being made of H-CFC (CH_2FCF_3 and $C_2H_4F_2$) to replace CFC as an expanding agent for XPS insulating materials. To phase out these substances with their damaging effect on the ozone layer, some manufacturers have since been using HFCs, whereas others are dispensing with halogenated expanding agents altogether and replacing them with CO_2, for example.

For a long time CFCs and H-CFCs were also used in the manufacture of expanded PU foam, but these have now largely been replaced by halogen-free expanding agents. Under the future EU Directive, the HFCs still used in expanding PU foam are to be replaced except in certain safety-relevant applications. The reduction effect of the proposed regulatory measures is estimated at 1.4 - 2.8 million tonnes CO_2 equivalent by 2010. Thanks to voluntary measures already implemented by industry, a reduction effect of 1.3 million tonnes CO_2 equivalent has already been achieved.

<u>Semiconductor production</u>

Approximately 30 percent of FC emissions are due to the use of this gas as an etching gas in semiconductor manufacture. Although this has only been replaced to a small extent by NF_3 in German production facilities, FC emissions in 2001 nevertheless for the first time showed a renewed drop from the previous year's figure, partly due to the use of improved technologies. The emission level was maintained in 2002.

As long ago as 1999 the World Semiconductor Council (WSC) undertook to achieve a 10-percent reduction in emissions of fluorinated gases by 2010 compared with 1995. In the meantime the European association has presented a similar undertaking to the EU Commission, and the manufacturers producing in Germany have given a national voluntary undertaking pledging an emission reduction of at least 8 percent despite growing production.

The measures are currently expected to have a reduction impact of 0.6 million tonnes CO_2 equivalent in 2010. Since the industry is characterised by rapid development of a variety of production technologies and predictions of strong growth, forecasts are subject to great uncertainties.

Modernisation and optimisation processes in aluminium production

As a result of extensive modernisation measures in German aluminium foundries and the closure of production capacity, FC emissions by this sector fell by 71 percent (1.1 million tonnes CO_2 equivalent) between 1995 and 2002. Further FC reductions due to ongoing modernisation can be expected to amount to about 0.1 million tonnes CO_2 equivalent. Complete conversion to the latest point-feeder technology would bring a further reduction of 0.1 million tonnes CO_2 equivalent.

Replacement of sulphur hexafluoride as a shielding gas in magnesium production

SF_6 is used as a shielding gas in the processing of magnesium. In addition to SO_2, possible substitutes include HFC and a fluoroketone. Whereas SO_2 has been used for some years in a number of magnesium foundries, commercial marketing and use of other substitutes has only started recently. Owing to the toxic properties of SO_2, its use calls for safety-relevant modifications which are not economic for smaller magnesium foundries. Complete conversion to alternatives that guarantee an optimised overall solution for every foundry introducing process changes will not be possible before 2009, despite potential cost benefits. A regulation proposed by the European Commission provides for a ban on use that is initially restricted to large foundries. The effect achieved in 2010 depends on the details of this or other measures and is put at around 0.5 million tonnes. A reduction effect has already been achieved as a result of modernisation measures.

Electrical equipment – precautions in manufacture, operation and disposal

The voluntary declaration by manufacturers and operators of electrical equipment (> 1 kV) was updated and improved, and in June 2005 it was presented in a modified and extended form. For example, alternatives are to be tested and used for special applications, and leakage rates are to be reduced still further. The impact is estimated to be in excess of 0.3 million tonnes CO_2 equivalent.

V.2.2.2.4. Summary

The following overview summarises the measures in the industrial sector.

Table V - 13 Measures in the industrial sector

Description of Policy / Measure	**Objectives / Impact**	**Green-house gas**	**Status**	**Implemen-ting institution**	**Expected effect 2008/ 2012** (mill. t CO_2 equiv.)	**Outlook 2015**
Energy Saving Ordinance (EnEV)	Merges and tightens up existing requirements of the Heat Insulation Ordinance (WSchV) and the Heating Installations Ordinance (HeizAnlV) with the aim of reducing heating requirements in new buildings by an average of 30% and exploiting energy-saving potential in existing buildings	CO_2	ongoing since 01.02.2002	Federal Government	–2.0	building renewal frequency continuing to rise
Act on the Ecological Tax Reform	Phased introduction or raising of tax rates on individual energy sources (electricity, gas, automotive fuels, heating oil) with simultaneous relief for the factor labour; reduced tax rates for manufacturing industry	CO_2	ongoing since 01.04.1999	Federal Government	–2.2	constant to rising, depending on develop-ment of tax rates
Improvements to KfW/DtA energy programmes	Between 1998 and 2002 slight increase in loans granted under KfW environment programme, but decrease in DtA programme; i.e. no appreciable improvement visible to date	CO_2	uncertain	Examination Federal Government	0	depends on further develop-ment of assistance programmes
Declaration by German industry on global warming prevention II	Update of 1996 voluntary undertaking by German industry on emission reduction: CO2 reduction by 2005 of 28% (previously 25%); reduction in Kyoto gases by 2012 of 35% (previously 21% by 2008/2012) compared with 1990. (Overlaps with CHP measures and electricity industry measures. Contradictions in overall declaration between absolute CO_2 savings stated and specific targets)	CO_2	ongoing since 9.11.2000	Federal Government and industry	direct emissions –2.5 to –3.0	constant
Declaration by German industry on global warming prevention II	as above, in this case: N_2O and fluorinated greenhouse gases	N_2O, greenhouse gases containing fluorine			-2	Further reductions possible, on small scale in case of F-gases
Declaration by German industry on global warming prevention II**	Here: Update of voluntary undertaking by cement industry (-28% by 2012 for specific non-energy-induced emissions and –16% by 2012 for total specific CO_2 emissions, in each case compared with 1990)	CO_2 (process-induced)	ongoing since 9.11.2000	Federal Government and industry	0.9**	further reductions possible
Incentives for expansion of industrial CHP generation: CHP Act, Ecological Tax Reform, Renewable Energies Act	The measures cited promote CHP indirectly, because they result in higher electricity prices for externally purchased electricity and thereby make industrial CHP plants more economic	CO_2	ongoing	Federal Government	*for info:* emissions –1 to –2	rising

Description of Policy / Measure	Objectives / Impact	Green-house gas	Status	Implemen-ting institution	Expected effect 2008/ 2012 (mill. t CO_2 equiv.)	Outlook 2015
Voluntary undertaking by industry to promote CHP	Voluntary undertaking by sections of German industry / energy industry to increase use of CHP	CO_2	ongoing since 4.7.2001	Industry	for info: emissions 0 to –1	constant
XPS rigid foam and PU foam	In certain applications replacement of HFC by e.g. CO_2 from 2000 onwards and no introduction/ use of HFC for PU foam products / expanding PU foams; goal: use of gases with lower ODP when replacing gases which deplete the ozone layer	HFC	uncertain	Industry	< -2	Further reduction potential
Semiconductor production	Modernisation measures; to some extent replacement of FC etching gases, e.g. by NF_3. Note: rapidly growing industry	FC	since 1999	Industry	-06	hardly any potential left in excess of voluntary undertaking
Modernisation of aluminium production	Reduction of FC emissions through modernisation and optimisation processes in the aluminium industry	FC	in effect since 1996, extended since 2000	Industry	-1.1	
Modernisation of aluminium production	Reduction of FC emissions through additional modernisation and optimisation processes in the aluminium industry	FC	in effect since 2000	Industry	-0.1	further savings on same scale possible
Replacement of SF_6 as a shielding gas in magnesium production	Gradual replacement of SF_6 by SO_2 and other alternative gases as shielding gas in magnesium processing	SF_6	ongoing on voluntary basis, regu-lations expected 2005	Industry	-0.5	Cost-effective-ness oriented
Electrical equipment	Global warming prevention, recovery, environmentally friendly disposal	SF_6	ongoing since 1996, extended 2005	Industry	-0.3	Further savings only possible through substitution
Total impacts on direct CO_2 emissions		**CO_2**	Figures mentioned for information purposes not included in total due to impact overlap		**-7.0**	
Direct CO_2 emissions with measures		**CO_2**			**110.5**	
Direct CO_2 emissions without measures		**CO_2**			**117.4**	
CO_2 emissions in base year 1990		**CO_2**			**169.3**	
Sum of direct impacts on non-CO_2 greenhouse gas emissions For accounting in relation to base year see Section V.2.2.9		**N_2O, FC, HFC, SF_6**	(stated in CO_2 equivalent)		**-6.6**	no sector-specific time series available
Total impacts of non-energy-induced CO_2 emissions (identified by **, cf. accounting in Section V.2.2.9)		**CO_2**			**-0.9**	

(Calculation method for CO_2 emissions based on classification in German energy accounts)

V2.2.3. Transport sector

In the interests of sustainable climate protection in the transport sector the Federal Government uses a broad spectrum of measures consisting of pricing-policy, technical, regulatory and education and information measures. This package of measures is substantially united in the Federal Transport Routes Plan (BVWP). Accordingly the Federal Government's transport policy addresses the following key action areas:

- incentives to reduce transport intensity and increase energy efficiency in the transport sector,
- reduction of distortions of competition, and inclusion of external costs in mobility prices,
- technical optimisation of means of transport and fuels, plus promotion of alternative fuels and innovative drive systems and targeted information for the public on resource-conserving transport/driving habits.

V.2.2.3.1. Carbon dioxide (CO_2)

Following a steady increase in fuel consumption and hence also in traffic-induced CO_2 emissions until 1999, a reversal of the trend can be observed since then. By 2003 the CO_2 emissions in the transport sector fell by approx. 15 million tonnes compared with 1999 – which represents an emission reduction of 8.5 percent. In total, however, traffic-induced CO_2 emissions rose 5 percent by 2003 compared with 1990.

The positive trend since 1999 is probably largely due to the reduction in specific fuel consumption, a marked shift in favour of diesel cars, the subdued economic situation and the marked increase in "tank tourism". For example, consumption of petrol between 1999 and 2003 showed a much larger decrease (-14.7%) than diesel consumption (-2.2%). Unlike the consumption of petrol and diesel fuel, however, consumption of jet fuel (kerosene) continued to increase until 2003.

Looking at the accounts for transport-induced greenhouse gas emissions, it is striking to note also the difference in trends between the goods transport and private motoring sectors. In recent years emissions in the personal transport sector have shown a much more favourable trend than in the goods sector.

Measures such as

- the ecological tax reform
- a distance-based motorway toll for HGVs
- an emission-related vehicle road tax
- the introduction of zero-sulphur fuel
- the voluntary undertaking by the automobile industry to reduce average fuel consumption by 25 percent
- a CO_2 labelling requirement
- the abolition of the owner-occupier homes allowance and the cuts in the commuter tax allowance
- the national cycle traffic programme

are in progress and will continue to have an impact into the period 2008 - 2012.

The ecological tax reform

The measures under the various stages of the ecological tax reform have already been explained in detail in Chapter IV.2 and Section V.2.1.3. Within the ecological tax reform, the raising of petroleum excise duty on automotive fuels plays a particularly important role. Here the tax rates per litre were raised successively by EUR 0.18 (incl. value-added tax) between 1999 and 2003.

Since there are no plans at present for a continuation of the ecological tax reform, the CO_2 reduction effects can be expected to grow smaller as time goes on. Assuming a normal growth curve for incomes and GDP and falling crude oil prices, the “with-measures” scenario indicates a reduction effect of 5 million tonnes CO2 due to the ecological tax reform.[56] Most of the reduction potential is likely to be achieved in the passenger traffic sector, which displays much higher price/demand elasticity than goods transport.

The Federal Government’s voluntary undertaking

The Federal Government’s voluntary undertaking to make a 30-percent reduction in the CO_2 emissions within its own sphere of responsibility by 2010 compared with 1990, which has already been described in detail above, has not been given concrete shape for the transport sector in the form of special reduction pledges (cf. Chapter IV.2). The reductions are included in the estimates for other measures. The traffic increases that can be expected within the government’s sphere of responsibility as well are likely to counteract the effects of the other savings efforts.

Promoting the use of zero-sulphur fuels

November 2001 saw the early implementation in Germany of the EU Fuels Directive for 2005, which introduced split rates of petroleum excise duty for petrol and diesel fuel depending on their sulphur content. Accordingly, the tax rate for fuels with a high sulphur content (in excess of 50 mg/kg, or since 2003: in excess of 10 mg/kg) is 1.53 cents/litre higher than for low-sulphur fuels.

Zero-sulphur fuels permit engine technologies that offer fuel savings of up to 15 percent compared with conventional technologies. Moreover, zero-sulphur fuels help – even in older engines – to reduce pollutant emissions (oxides of nitrogen, carbon monoxide and hydrocarbons) and particulate formation.

In the with-measures scenario, promotion of low-sulphur or zero-sulphur fuels is estimated to have a reduction potential of 2 million tonnes CO_2 by 2010.

Motorway toll for heavy goods vehicles (HGVs)

On 1.1.2005 a distance-based electronic toll system was introduced for heavy goods vehicles (=12 t permitted total weight). The mileage-dependent motorway toll for HGVs, with its differentiation by axle count and pollution category, helps to make the use of lower-emission HGVs even more attractive and thereby supports the achievement of transport and environmental policy objectives. Depending on axle count and pollution category the motorway toll is currently between 9 and 14 cents/km, and the average rate is 12.4 cents/km. The HGV toll can also provide

[56] As already mentioned in the introduction to this chapter, the Federal Government is currently updating the scenarios to take account of the latest oil price trends and new climate policy measures.

an incentive to step up the transfer of a proportion of goods traffic from the road sector to other, more environmentally friendly means of transport such as rail or inland waterway/short sea shipping.

The findings of the Federal Government's current investigations ("Report on the switching of HGV traffic to the non-motorway road network in response to the introduction of the HGV toll") indicate that since the toll is levied only on heavy goods vehicles of at least 12t permitted total weight and only on the federal motorway network, traffic on sections of non-motorway highways has increased as a result of attempts to by-pass the system. Under changes to the Road Traffic Ordinance which have already been approved, the *Laender* now have the opportunity to take measures to counteract such evasion traffic and to ban HGVs from using federal highways with particularly heavy traffic loads. Moreover, the final adoption of the revised EU Road Charging (Eurovignette) Directive opens up the possibility of charging a toll not only for motorways, but also for (sections of) non-motorway highways, which could also help to counteract evasion traffic.

There is also reason to fear the emergence of incentives to spread the goods to be transported among trucks just below the present toll limit of 12t total permitted weight (downsizing).

The compensation already promised to German road transport companies for the additional burdens, in combination with the restriction of the toll to motorways and large trucks, is likely to ensure that only minor effects can be expected as regards traffic avoidance, traffic switching and CO_2 reductions.

The introduction of the HGV motorway toll is therefore expected to result in CO_2 emission reductions not exceeding 1 million tonnes in 2010, as revealed by the comparison of the scenarios with and without measures. Assuming unchanged toll rates, the impact potential can also be expected to diminish from 2010 onwards.

Emission-related road tax for passenger cars

The amendment to the Motor Vehicle Road Tax Act, which entered into force on 1 July 1997, seeks to reduce environmental pollution due to road traffic by granting tax concessions for passenger cars with low consumption and low emission levels. The declared aim of the staggered road tax rates is to increase the incentives for motorists and car manufacturers to reduce exhaust gas emissions. The marked increase in the tax rates for cars with high pollutant emissions is intended to accelerate the renewal of the population of cars on the road and create further incentives to retrofit exhaust gas purification systems to existing vehicles.

A positive aspect is the broader spread of tax rates based on the impact of the vehicle's exhaust gases on air quality. The resulting additional burden for existing vehicles is often such as to make retrofitting economic.

The reduction in the tax rates for new vehicles was considerably larger for diesel cars than for petrol-engined cars, which made diesel cars more attractive than petrol cars. In view of the emissions of carcinogenic particles, a deficit on the emissions side that detracts from the fuel consumption benefits of diesel cars, this improvement in the costs situation for diesel cars is questionable from an environmental policy point of view.

From 1997 to 2001 the number of high-emission cars was reduced by two thirds. A quarter of all new cars registered in 2001 already satisfied the Euro 4 emissions standard that applies from 2005/2006. It is however questionable whether the emission-related vehicle road tax contributed to this.

The impacts of the existing regulations with regard to possible CO_2 reductions are negligible. Under the "with-measures" scenario, reductions of about 1 million tonnes CO_2 can be expected for 2010.

Campaign on climate protection in the transport sector
"Aktion Klimaschutz" is the name of a nationwide campaign aimed primarily at private consumers. In the next few years they, and small consumers in the trade, commerce and services sector, are to be informed about the contribution they can make to climate protection. The campaign sets out to achieve a number of objectives in the transport sector: economical driving habits, increased use of transport chains (bicycle, car, local public transport, rail and air), and increased use of low-friction oils and tyres.

Assuming that the present design of the climate protection campaign with its focus on information remains unchanged, a reduction of 2 million tonnes CO_2 by 2010 is forecast for the "with-measures" scenario. The impacts after 2010 are hardly likely to be any greater.

Promotion of cycling
The Federal Government promotes cycle traffic, in particular through the Federal Cycle Paths Programme[57].

Half the car trips made in Germany involve a distance of less than 5 km. The Federal Government therefore believes that the expansion of measures to promote cycling offers considerable further potential for reducing local car trips, even if it is not possible to use the bicycle for all local trips (such as shopping trips, trips in hilly country, trips in bad weather and on poor roads).

The CO_2 reduction effects are put at 1 million tonnes in the "with-measures" scenario, and are hardly likely to increase after the period in view.

V.2.2.3.2. Other greenhouse gas emissions

The problems of N_2O emissions from catalytic converters have been discussed in the industrial sector (cf. Section V.2.2.2). The filling of car tyres with SF_6 and the use of HFC in air-conditioning systems is examined in the following section on the trade, commerce, services (TCS) sector (cf. Chapter V.2.2.4).

[57] Federal Ministry for Transport, Building and Urban Affairs: Nationaler Radverkehrsplan 2002-2012 – FahrRad! Maßnahmen zur Förderung des Radverkehrs in Deutschland. Berlin 2002.

V.2.2.3.3. Summary

To achieve sustainable climate protection in the transport sector, it is necessary to design traffic in a way that makes the most sparing use possible of resources.

The Federal Government expects that with traffic levels on the increase, there could well be a renewed rise in CO_2 emissions in the transport sector if no further measures are taken. The impacts on CO_2 emissions forecast under the "with-measures" scenario are summarised in the following table.

Table V - 14 Climate policy measures for the "with-measures scenario" in the transport sector

Measure/ Implementation / Institution	**Description/ Objectives**	**Implementation status (start of impact)**	**Expected effect 2008/2012** million t CO_2 equiv.	**Outlook 2020 (qualitative)**
Ecological tax reform in force, several stages up to 2003 Federal Government	Mileage reductions in motorised personal traffic and road goods traffic; create incentives to use other means of transport, to use vehicles that are more energy efficient, and where possible to avoid traffic	In force since 1. 4. 1999 and completely implemented in 5 stages up to 2003	-5.0	decreasing
Federal Government's voluntary undertaking Decision Federal Government	Reduction in CO_2 emissions of 25% by 2005 and 30% by 2010; Goal: Improvements in energy efficiency	in force	Included in impacts of other measures	Included in impacts of other measures
Promoting the use of zero-sulphur fuels in force Federal Government	Promotion of low-sulphur or zero-sulphur fuels as basis for low-consumption and low-emission engine technologies by raising petroleum excise duty on fuels that do not comply with the sulphur limit of 50 ppm from 1.11.2001 or 10 ppm from 1.1.2003; Goal: Reduction in fuel consumption	from 1.11.2001 and 1.1.2003	-2.0	rising
Promotion of cycling in force Federal Government	National Cycle Traffic Plan 2002-2012 – FahrRad. Berlin 2002	in force	-1.0	rising
Emission-based road tax for cars Decision Federal Government	Promotion of use of low-consumption cars Goal: Improving efficiency in motorised personal traffic	from 1.7.1997	-1.0	decreasing
Campaign on climate protection in the transport sector Decision Industry/ Federal Government	Multiple goals: economical driving habits, low-friction oils and tyres, combination of means of transport (bicycle, local public transport, car, rail, air), "3-litre car" (car consuming not more than 3 litres per 100 km); Goal: Improvements in energy efficiency	in force	-2.0	constant

Measure/ Implementation / Institution	Description/ Objectives	Implementation status (start of impact)	Expected effect 2008/2012 million t CO_2 equiv.	Outlook 2020 (qualitative)
Reduction in average fuel consumption of new cars Voluntary undertaking Industry	Update of voluntary undertaking by German automobile industry on further reduction in average fuel consumption of new cars; target with effect from 2005 raised from 25% to 30%; Goal: Improvements in energy efficiency in personal traffic	in force	no	no
Distance allowance independent of mode of transport Decision Federal Government	Tax allowance for trips between home and workplace; designed to create equality of tax positions for competing means of transport for trips to work; Goal: improve attractiveness of bicycle and local public transport, and thereby reduce energy consumption in the transport sector	1. 1. 2001	counter-productive	counter-productive
Motorway toll for heavy goods vehicles Decision Federal Government	Distance-related and emission-related motorway toll for HGVs exceeding >12 t permitted total weight, Goal: shift goods traffic from road to rail	since 1.1.2005	-1.0	decreasing
Emission-related landing charges Decision Federal Government	Introduction of emission-related take-off and landing charges at German airports; Goal: Improvements in energy efficiency	not specified	no information as yet	no information as yet
Promotion of renewable energy sources Decision Federal Government	Promotion of use of renewable energy sources in production of automotive fuels; Goal: Substitution for fossil fuels	in force	-3.0	
Total impacts on direct CO_2 emissions			**-14.0**	
Direct CO_2 emissions with measures			**184.8**	
Direct CO_2 emissions without measures			**198.8**	
CO_2 emissions in base year			**158.8**	

V.2.2.4. Trade, Commerce, Services

The sector “Trade, Commerce, Services and miscellaneous consumers (TCS)” (known until 1995 as “small consumers”) comprises in this context all end-use energy consumers that do not belong to the sectors industry, private households, transport and military units. This is a very heterogeneous sector with a large proportion of small and medium enterprises in the fields of light industry, commerce, craft trades, agriculture[58], building trade and private services. The sector also includes all public

[58] Note: Section V.2.2.6 Agriculture contains a description of the measures to avoid non-CO_2 greenhouse gases. The CO_2 emissions from farm operations are not included in this sector; it is not possible to show them separately, as no suitable data were available at the time of preparing this report.

buildings and facilities. Over the period 1990 to 2003, CO_2 emissions in this sector fell by around 30 million tonnes. This development was due in particular to the restructuring in the trade sector in the New *Laender* and the very high level of demolition and replacement compared with the residential buildings sector.

V.2.2.4.1. Carbon dioxide (CO_2)

The catalogue of measures for the trade, commerce, services (TCS) sector for reducing CO_2 emissions in the buildings sector shows a large measure of overlap with the list for industry. For this reason this section confines itself to quantifying the impacts of the measures. Detailed descriptions of the individual measures have already been given in Chapter IV.2 and in Sections V.2.2.2 (industrial sector) and V.2.1 (cross-sectoral measures). The emission reduction potentials in the TCS sector that have to be ascribed to CHP, and the indirect CO_2 emissions due to electricity and district heating are merely mentioned for information here, since they are accounted for in the energy sector. In view of technical estimation difficulties, the impact of the assistance for renewable energies in heat generation is assigned to the household sector.

Energy Saving Ordinance (EnEV)

The share of energy consumption accounted for by space heating is considerably higher in the TCS sector than in industry. The estimate of the impacts of the Energy Saving Ordinance in the TCS sector is based on a share of 65 percent for space heating. Apart from this, the assumptions made in the reference scenario are the same as for the industrial sector.

As a result of the much larger share due to space heating in the TCS sector, the CO_2 reduction effect brought about by the Energy Saving Ordinance is considerably larger than for industry. A reduction of around 5.2 million tonnes in direct CO_2 emissions is expected by the year 2010. To this must be added savings of around 12.3 PJ in district heating and nearly 0.8 TWh in electricity. As in the industrial sector, there is reason to expect the Energy Saving Ordinance to have a continued impact on reducing CO_2 emissions in the TCS sector after 2010.

Ecological tax reform

The CO_2 reduction impact of the ecological tax reform in the trade, commerce, services sector is quantified in the same way as in the industrial sector. In the TCS sector, however, the reduction in CO_2 emissions that is due to the ecological tax reform is larger than in industry, the reduced tax rates are of no significance for most businesses, with the exception of the agricultural sector.

The following emission reductions by 2010 are assumed for the areas assigned to the TCS sector:

- Agriculture: -2.03%;
- Buildings: -7.35%;
- Services: -6.32 %;
- State: -2.86 %.

For the entire TCS sector, pro rata weighting of the energy consumption figures for the sub-sectors as a share of total consumption in the TCS sector yields a reduction in direct CO_2 emissions of around 5.5 percent or 3.6 million tonnes which is attributable to the first stages of the ecological tax reform.

In addition, it is also necessary to take account of the impacts of the Act concerning the continued development of the ecological tax reform, which entered into force on 1 January 2003. For the agricultural sector this means in particular the trebling of the reduced tax rates from 20% to 60%. Owing to the moderate impact of the ecological tax in the agricultural sector that is assumed above, and in view of the small proportion of energy consumption in the TCS sector that is due to agriculture, the resulting additional CO_2 reduction effect from 2003 onwards is likely to be only slight (approx. -0.1 million tonnes). By contrast, the 63-percent increase in the tax rates on natural gas and liquefied gas and the 72-percent increase in the tax on heavy fuel oil should create additional incentives in the entire sector to reduce energy demand and achieve corresponding CO_2 reductions. In the TCS sector these gases and heavy fuel oil are responsible for about 50 percent of the energy consumption giving rise to direct CO_2 emissions. For the period 2003-2010 the revised ecological tax can be expected to have an additional CO_2 reduction effect of around 1.4 million tonnes.

All in all, this means a reduction of around 5 million tonnes in CO_2 emissions in the TCS sector by 2010 as a result of the stages of the ecological tax reform that have already been implemented. Further impacts of the ecological tax beyond the year 2010 are difficult to assess at present, as they depend on the continued development of the ecological tax reform.

Voluntary undertaking by industry, measures to promote CHP

No precise record of electricity and heat generation in CHP plants is available for the TCS sector. The reduction expected for 2010 is included in the figures for the industrial sector (cf. Section V.2.2.2). The development of the situation is as described there. Moreover, a much more pessimistic view is taken of the market-driven economic expansion of CHP plants in the TCS sector.[59] Nevertheless, in view of the replacement potential after 2010 and an assumed increase in external electricity prices, the measures to promote CHP are expected to have a growing influence in the period leading up to 2020.

Table V - 15 CO_2 emissions in the scenarios with and without measures, compared with the base year

	Actual 1990	**With measures 2010**	**Without measures 2010**	**Difference 2010**
	mill. t CO_2			
Trade/Commerce/ Services	**90.5**	**57.9**	**68.1**	**10.2 - 6.9**
Source: estimates by Fraunhofer ISI.				

59 Cf. study “Klimaschutz in Deutschland bis 2030”, p. 82.

V.2.2.4.2. Halogenated hydrocarbons (HFC, PFC) and SF_6

See also Section V.2.2.2.3.

Stationary and mobile air-conditioning systems

One efficient measure for reducing HFC emissions from stationary refrigeration and air-conditioning systems (with more than 1 kg HFC as refrigerant) is the introduction of compulsory servicing. Under a regulation on certain fluorinated greenhouse gases which was proposed by the European Commission in 2003, this area will in future be covered by Community legislation. The introduction of this measure is therefore planned as an implementation of the planned EU Regulation on fluorinated greenhouse gases. In addition to a servicing requirement, it also envisages a requirement for low-emission disposal and minimum requirements regarding prevention of system leaks.

Since it proved impossible to put the servicing obligation into effect on 1 January 2004 as originally planned, the emission reduction effect assumed for 2010 will be reduced.

Mobile air-conditioning applications in vehicles make a considerable contribution to total HFC emissions. This is primarily due to the rapid increase in the number of new vehicles equipped with air-conditioning systems, and is not compensated for by the improvements in system leakage prevention. For some years now, however, there have been signs that CO_2 can be used as a halogen-free substitute, and this is likely to come onto the market in the foreseeable future. The size of the longer-term impact on emissions (2010/2020) is critically dependent on the date of the widespread introduction of this technology . Emission estimates to date are based on a market launch of CO_2 technology in or after 2008. The above mentioned proposal by the European Commission lays down 1 January 2011 as the starting date for phasing out HFC, but allows HFC with a GWP (Global Warming Potential) of up to 150 to be used as a substitute.

The measures described for stationary and mobile refrigeration systems are assumed to result in a total reduction of 4 million tonnes CO_2 equivalent in 2010. This figure could be lower, depending on when the measures are implemented. As yet there are no estimates on the basis of the new implementation dates.

Replacement of metering aerosols containing HFC

This measure relates among other things to the replacement of HFC used as a propellant gas in medical aerosols (e.g. for the treatment of asthma). Although the market share of alternative powder inhalers has increased in recent years, there is still a need for action. In view of the special aspects that have to be taken into account in medical applications, the Federal Government continues to regard voluntary measures as particularly appropriate in this field. A reduction of up to 0.5 million tonnes CO_2 equivalent is expected by 2010.

Replacement of HFCs is technically possible for other aerosols as well. They are therefore included in the current discussion of measures. While regulatory bans on the use of HFCs can be considered for certain areas (e.g. cosmetic products), voluntary replacement is also a possibility for other areas (e.g. technical sprays).

Other measures are also under discussion, especially for new applications (e.g. fire extinguishers); but their implementation is still an open question.

Use of SF_6 in sound-insulating windows
Sound-insulating windows are currently the largest single source of SF_6 emissions. The slight improvement in sound insulation that is achieved with SF_6 is accompanied by a reduction in heat insulation performance. Use of this gas has been on the decline since the mid 1990s, and established alternatives exist.

A draft regulation put forward by the EU Commission contains a ban on this application. However, SF_6 emissions from this application will show a further marked increase towards 2020 because of emissions arising from disposal of end-of-life sound-insulating windows. Since the EU Regulation cannot be expected to enter into force before 2006, the effect for 2010 will be lower than was expected in 2000. The current expectation is a reduction of 1 million tonnes CO_2 equivalent.

Filling of car tyres with SF_6
Another source of SF_6 emissions is car tyres, which are filled with SF_6 for image reasons – the improvement in pressure constancy is not relevant in practice. In view of the climate relevance of SF_6, tyre manufactures have stopped publicising this application. This has resulted in a marked reduction. Most emissions today originate from old tyres. The proposed EU regulation provides for a ban on use immediately on its entry into force. Achievement of the effect estimated for 2010 depends on when the ban is introduced. It will probably prevent greenhouse gas emissions corresponding to 0.7 million tonnes CO_2 equivalent in 2010.

V.2.2.4.3. Summary

The following overview summarises the measures in the TCS sector.

Table V - 16 Measures in the trade/commerce/services sector

Description of Policy / Measure	**Objectives / Impact**	**Green-house gas**	**Status**	**Implemen-ting institution**	**Expected effect 2008/ 2012 (mill. t CO_2 equiv.)**	**Outlook 2015**
Energy Saving Ordinance (EnEV)	Merges and tightens up existing requirements of the Heat Insulation Ordinance (WSchV) and the Heating Installations Ordinance (HeizAnlV) with the aim of reducing energy requirements in new buildings by an average of 30% and exploiting energy-saving potential in existing buildings	CO_2	ongoing since 1.2.2002	Federal Government	direct emissions –5.2; *for info*: electricity– 0.77 TWh, district heating – 12.3 PJ	continuing to rise in step with building renewal rate
Promotion of renewable energies	Promotion of the use of renewable energies in heat generation	CO_2	ongoing	Federal Government	included in private household sector	

Description of Policy / Measure	Objectives / Impact	Green-house gas	Status	Implemen-ting institution	Expected effect 2008/ 2012 (mill. t CO_2 equiv.)	Outlook 2015
Act on the Ecological Tax Reform	Phased introduction and raising of tax rates on individual energy sources (electricity, gas, automotive fuels, heating oil) with simultaneous relief for the factor labour; reduced tax rates for manufacturing industry	CO_2	ongoing since 1.4.1999	Federal Government	direct emissions –5.0	constant to rising, depending on develop-ment of tax rate
Declaration by German industry on global warming prevention II	Update of voluntary declaration by German industry	CO_2	ongoing since 9.11.2000	Federal Government, industry	low (included in industry)	
Incentives for expansion of industrial CHP generation: Ecological Tax Reform, Renewable Energies Act, CHP Act	The measures cited promote CHP indirectly, because they result in higher electricity prices for externally purchased electricity and thereby make industrial CHP plants more economic	CO_2	ongoing	Federal Government	*for info*: -0.3	rising
Stationary and mobile air-conditioning systems	a) compulsory annual servicing for refrigeration and air-conditioning systems with HFC as refrigerant, b) HFC air-conditioning systems in cars to be superseded by CO_2 systems from 2011; Goal: reduce use of climate-relevant gases	HFC	under discussion	Industry	-4	Trend continues, especially for b)
Replacement of metering aerosols containing HFC	Promotion of market share of powder inhalers, e.g. for asthma treatment, with the aim of reducing applications using HFC as propellant gas	HFC	Promotion of alternative methods planned	Industry	-0.5	Savings on same scale possible
Sound-insulating windows	Replacement of SF_6 technology by modified glass structures	SF_6	with effect from 1.1.2006	Industry	-1	small residual potential
Non-use of SF_6 for filling car tyres	Ban on use effective from entry into force of EU Regulation on certain fluorinated greenhouse gases	SF_6	V ongoing, R with effect from beginning of 2006	Industry	-0.7	Potential exhausted
Total impacts on direct CO_2 emissions		**CO_2**			**-10.2**	
Direct CO_2 emissions with measures		**CO_2**			**57.9**	
Direct CO_2 emissions without measures		**CO_2**			**68.1**	
CO_2 emissions in base year		**CO_2**			**90.5**	
Sum of direct impacts on non-CO_2 greenhouse gas emissions For accounting in relation to base year see Chapter 3.10		**HFC, SF_6**	(stated in CO_2 equivalent)		**-6.2**	no sector-specific time series available

(Calculation method for CO_2 emissions based on classification in German energy accounts)

V.2.2.5. Private households

In the housing and buildings sector there is basically still great technical potential for CO_2 reductions, but when assessing the possibilities it is also necessary to take economic and ownership aspects into account. Roughly three quarters of household energy consumption is used for space heating. Exploitation of the energy-saving potential in this sector is therefore particularly urgent.

V.2.2.5.1. Carbon dioxide (CO_2)

CO_2 emissions by private households fell by around 3 million tonnes from 1990 to 2001, although the number of new residential buildings increased substantially in the same period and the total living area was up 5 percent in the 1990 figure. This additional requirement is due among other things to the following factors:

- Population growth in the "Old *Laender*", with a corresponding growth in demand for living space and infrastructure.
- Faster nationwide growth of per capita living space requirements in the late 1990s owing to demographic factors. The baby-boom years from the 1960s moved from rented apartments to owner-occupied homes, and this was accompanied by corresponding growth in the building of detached and semi-detached houses.
- The "remanence effect", where the parents' space requirements expand to fill the available space when the children leave home.
- Rapid increase in newly designated residential areas in the "New *Laender*" owing to the backlog of demand for home ownership. This – in combination with population losses – resulted in large numbers of apartments standing empty, which considerably reduced the energy efficiency of the buildings affected.
- Since the mid 1990s there has been a marked nationwide decline in new building. This emphasises the relative importance of the existing supply of homes. Energy-related measures for new buildings alone cannot make their effects felt until after a lengthy introductory phase, and their total effectiveness cannot compete with the potential of measures for existing buildings. It is therefore necessary to focus more strongly on measures geared to existing buildings.

<u>The ecological tax reform</u>

The ecological tax reform as a fiscal instrument has contributed to reducing energy consumption and the associated CO_2 emissions of private households. As a result of the ecological tax reform alone these emissions showed, depending on the energy source in question, a decrease of between 0.3 and 9.8 percent by the end of 2003. (DIW study 2001, p. 140). Moreover, an up-to-date study by the Federal Environmental Agency (2005) comes to the conclusion that for roughly half the respondents the ecological tax reform provided a strong or very strong motivation for reducing their energy consumption.

<u>Strategies for reducing electricity consumption</u>

According to a study commissioned by the Federal Economics Ministry, electricity requirements for information and communication systems in households (including their infrastructure) can be expected to rise from 22,517 GWh in 2001 to 30,891 GWh in 2010 – which represents an increase of nearly 37 percent.[60] The explanation for this trend is that as well as household appliances and home entertainment systems, devices in the field of information and communications technology are coming to play

[60] Centre for Energy Policy and Economics und Fraunhofer ISI (Ed.) (2003): Der Einfluss moderner Gerätegenerationen der Informations- und Kommunikationstechnik auf den Energieverbrauch in Deutschland bis zum Jahr 2010 - Möglichkeiten zur Erhöhung der Energieeffizienz und zur Energieeinsparung in diesen Bereichen. Zurich, Karlsruhe.

an increasingly important role in electricity consumption. The study also indicates that considerable amounts of energy are lost in households as a result of stand-by operation of equipment. For this reason the Federal Government is increasingly focusing not only on technical facilities in the devices themselves, but also – in particular – on an improved information policy designed to bring about changes in consumer habits (cf. Chapter IV.2).

V.2.2.5.2. Other greenhouse gas emissions

All other greenhouse gas emissions in the household sector are allocated to the sectors: energy, industry, agriculture and waste management.

V.2.2.5.3. Summary

Table V - 17 Measures in the household sector

The following overview summarises the impacts in the "with-measures" scenario for the household sector. It makes it clear that emission reductions of 18.6 million tonnes CO_2 by 2010 can be expected compared with the without-measures scenario.

Description of Policy / Measure	**Objectives / Impact**	**Green-house gas**	**Status**	**Implemen-ting institution**	**Expected effect 2008/ 2012** (mill. t CO_2 equiv.)	**Outlook 2015**
KfW programmes to reduce CO_2 / space heating and hot water segments	Low-interest financing of investments in energy saving and CO_2 reduction; promotion of passive houses and energy-saving houses;	CO_2	ongoing	Federal Government	-8.4	depending on programme duration
Energy Saving Ordinance (EnEV)	Merges and tightens up existing requirements of the Heat Insulation Ordinance (WSchV) and the Heating Installations Ordinance (HeizAnlV) with the aim of reducing heating requirements in new buildings by an average of 30% and exploiting energy-saving potential in existing buildings	CO_2	ongoing since 1.2.2002	Federal Government	included in impact assessment of KfW programme s	rising with building renewal rate
Promotion of renewable energies, see Section V.2.1.2	Promotion of the use of renewable energies in heat generation	CO_2	ongoing since 29.3.2000	Federal Government	-7	rising
Measures and independent savings outside the KfW programmes	Ecological Tax Reform, information and guidance offerings, urban development promotion programme, measures under First Federal Immission Control Ordinance, conversion of night storage heaters	CO_2	ongoing	Federal Government, *Land* governments and local authorities	-3.2	rising
Total impacts on direct CO_2 emissions		**CO_2**			**-18.6**	
Direct CO_2 emissions with measures		**CO_2**			**129.8**	
Direct CO_2 emissions without measures		**CO_2**			**148.4**	
CO_2 emissions in base year 1990		**CO_2**			**129.3**	

Sources: Estimates by STE/ FZ Jülich and DIW Berlin in "Klimaschutz in Deutschland bis 2030"

V.2.2.6. Agriculture

Emissions of the greenhouse gases CO_2, CH_4 and N_2O in the agricultural sector all originate – with the exception of the energy-induced emissions arising from the production or use of operating equipment – from natural processes that can only be influenced to a limited extent. Although agricultural policy is largely determined by the EU, it is not only the Common Agricultural Policy (CAP) that has an impact on emissions of greenhouse gases, but also national measures such as those relating to organic farming, soil conservation or agro-environmental measures, agricultural investment assistance and the cross-sectoral measures relating to renewable energies. As a rule, however, quantitative allocation is not possible.

V.2.2.6.1. Carbon dioxide (CO_2)

According to the system used in the energy accounts, farms are counted as belonging to the TCS sector. The energy-induced CO2 emissions by agriculture are thus included in the TCS sector (cf. Chapter V.2.2.4). Since there are few individual areas for which separate information is available, these CO_2 emissions by agriculture cannot be shown separately.

As explained in Chapter V.2.1, biomass is acquiring increasing importance as an alternative source of energy. According to the study “Policy Scenarios III”, about 85 percent of heat generated from renewable energies in 2003 was due to the use of biomass. However, the CO_2 reduction resulting from savings of fossil fuels is attributed to the private household sector. The situation is similar for automotive fuels from biomass, which are allocated to the transport sector (3 million tonnes CO_2 from biodiesel).

To this must be added CO_2 emissions connected with the use of operating equipment (cf. remarks under V.2.2.6.2).

V.2.2.6.2. Methane (CH_4)

Package of measures: Renewable Energies Act (EEG), Biomass Ordinance

The Renewable Energies Act (EEG) promotes the replacement of fossil fuels by biomass and other fuels (cf. also Chapter IV.2 and Section V.2.1.2), thereby helping to reduce emissions of methane (use of biomass, landfill gas, sewage gas and mine gas under the Renewable Energies Act). In this connection the Biomass Ordinance regulates technical details and environmental requirements. The Renewable Energies Act in conjunction with the Biomass Ordinance will lead to an increase in biomass utilisation (systems for burning solid biomass, small biogas systems). Although estimates of the potential are basically quite optimistic, it is still necessary to ensure meaningful use of the heat produced. Agricultural biogas plants can be expected to have a relatively low heat demand potential of only about 20 percent of the heat output of a CHP plant. The effect of these measures is put at 4 million tonnes CO_2 equivalent.

Package of measures in the agricultural sector

CH_4 and N_2O emission reductions in the agricultural sector have been achieved among other things through the expansion of organic farming, which is characterised by particularly resource-conserving and environmentally friendly land management, such as diversified crop rotation, livestock farming with low stock densities tied to specific areas of land and, as far as possible, closed nutrient cycles using farmyard-produced manure and fodder.

Agricultural use of biogas is estimated to make a saving of 1.4 million tonnes CO_2 equivalent. To avoid double counting, this figure is halved for calculation purposes, and the other half is attributed to the impact of the Renewable Energies Act.

This results in a total of 1.8 million tonnes CO_2 equivalent, made up of 1.1 million tonnes CO_2 equivalent due to the expansion of organic farming (mainly N_2O, see below) plus the relevant share of 0.7 million tonnes due to increased use of agricultural biogas (CH_4).

V.2.2.6.3. Nitrous oxide (N_2O)

Natural processes in the soil (nitrification, denitrification) inevitably lead to emissions of N_2O. The smaller the inputs of N due to mineral fertilisers, organic manure or atmospheric sources, the less N_2O will be emitted. Targeted impacts can be achieved by using the following measures:

- Reduce fertiliser application by using nutrient-efficient and climatically adapted crop varieties.
- Ensure that use of organic and mineral fertilisers is better tailored to crop nutrient requirements.
- Ensure better management of fertiliser use by reducing losses during application of fertiliser (emission-minimised application technology for organic manures).
- Further develop low-emission livestock systems appropriate to the animals in question, and continue to reduce excessive local concentrations of animals without adequate land for using the resulting organic manure in accordance with “good professional practice” to ensure better utilisation of nitrogen from animal dung.

V.2.2.6.4. Summary

In the agricultural sector there are on the one hand the CO_2, CH_4 and N_2O emissions, which are mostly due to natural processes and can hardly be influenced, and on the other hand the replacement of fossil fuels by using renewable raw materials. The opportunities for reducing N_2O emissions must be exploited by reducing inputs of N. A special role is played here by improvements in N fertiliser application, N-efficiency of the plants and N-efficiency in livestock farming. An assessment of these measures can be found in “Policy Scenarios III”. This is summarised in the following table.

Table V - 19 Measures in the agricultural sector

Description of Policy / Measure	Objectives / Impact	Green house gas	Status	Implemen-ting institution	Expected effect 2008/ 2012 (mill. t CO_2 equiv.)	Outlook 2015
Package of measures in the agricultural sector	Organic farming, expansion of biogas use[61] and measures in the livestock sector	CH_4, N_2O	ongoing	Federal Government	-1.8	further reductions possible
Renewable Energies Act (EEG), Biomass Ordinance	Promotion of use of renewable energies; replacement of fossil fuels; here: avoiding emissions of methane, especially in the use of biomass, landfill gas, sewage gas and mine gas under Renewable Energies Act	CH_4	ongoing since 29.3.2000	Federal Government	-4 (for info)	low potential for further reduction of CH_4 emissions
Total impacts on direct CO_2 emissions		**CO_2**			included in the sectors TCS and House-holds	no sector-specific time series available
Sum of impacts on non-CO_2 greenhouse gas emissions		**CH_4 N_2O**	(stated in CO_2 equivalent)		**-5.8**	no sector-specific time series available

Source: Politikszenarien III

V.2.2.7. Land use, land use changes and forestry

Various measures aimed at sustainable management of forests and maintenance and expansion of forest areas are used in Germany to safeguard carbon stocks in forests. Owing to the following factors, the emission impact and the sink function of land use, land use changes and forestry are not shown separately here:

- Greenhouse gas emissions and CO_2 fixation figures from the land use change and forestry sectors are not used for calculation of the assigned amount units. This sector is therefore shown separately. The energy-related greenhouse emissions by agriculture and forestry are included in the other sectors (especially Transport and TCS).

[61] To avoid double counting of the effects of using renewable energies (measure: Renewable Energies Act), a statistical deduction of 50% is made from the contribution due to agricultural use of biogas.

- Apart from its general measures to conserve forests, Germany has not taken any measures in the forestry sector that are specifically motivated by climate considerations. Germany does however give assistance for initial afforestation and for a number of forestry measures designed to increase the stability of forests and enhance their natural character. Conversion of forests to other forms of land use is subject to strict rules and requires approval under the Forest Acts at federal and *Land* level. There has therefore been a further net increase in areas under forest since 1990.

Between 1990 and 2003 Germany's forests immobilised some 76 million tonnes CO_2 a year. This contrasted with CO_2 emissions of around 44 million tonnes CO_2 from agricultural soils, resulting in a net sink of around 32 million tonnes CO_2 for the sector land use, land use change and forestry as a whole.

The above mentioned net fixation in forests already includes the removal of biomass due to wood harvesting. The use of wood as a material and fuel also helps to avoid emissions from fossil sources. For example, the production of timber system walls emits 73 to 147 kg CO_2 less per m² of wall area than the production of masonry walls with comparable heat insulation properties. Use of biogenic fuels (wood, biofuels etc.) avoided 17.5 million tonnes of CO_2 emissions in 2002 . These substitution effects are reflected in the greenhouse gas emissions of other sectors, e.g. energy industry, industry and TCS.

With the "Wood Charter" the Federal Government is supporting a 20-percent increase in the use of wood in the next 10 years. This is expected to bring a corresponding increase in substitution effects.

No decision has yet been taken on whether Germany will make use of the additional activities under Article 3 paragraph 4 of the Kyoto Protocol to meet its reduction commitment. Under the provisions of the Marrakesh Accord[62] (Decision 11/CP.7), the CO_2 credits that can be achieved through forestry measures are limited to approx. 4.5 million tonnes CO_2 per annum.

V.2.2.8. Waste management, recycling, materials efficiency

In recent years, substantial reductions in emissions of climate-relevant gases have been achieved in the field of waste management, recycling and recovery. The measures aimed at this sector have an impact that is particularly "all-embracing" in terms of greenhouse gases and is also felt in other sectors.

The main focus was on avoiding methane emissions from landfill sites by reducing the use of untreated biodegradable waste as landfill. During the period 1990 to 2003, methane emissions from landfill sites were reduced by a total of around 20 million tonnes CO_2 equivalent, which represents a reduction of about two thirds.

[62] The central result of the 7th conference of the parties to the Framework Convention on Climate Change in Marrakesh at the end of 2001 (COP 7) was "The Marrakesh Accords", a package of 15 decisions on the execution and implementation of the Kyoto Protocol, including decisions on the compliance control system, the use of the Kyoto mechanisms, the crediting of sinks and the promotion of climate protection in developing countries.

Since March 2003 the Waste Wood Ordinance has banned landfill of waste wood, and under the Waste Deposition Ordinance it has been illegal since June 2005 to deposit untreated biodegradable waste as landfill. Thanks to the increased use of waste wood and biogenic waste for energy purposes in waste incineration plants – mostly in the context of combined heat and power generation – the waste management sector has achieved considerable CO_2 savings.

V.2.2.8.1. Carbon dioxide (CO_2)

Additional CO_2 reductions are possible by means of measures to improve material efficiency (intensification of use, lower specific input of material, material substitution, e.g. through use of biogenic raw materials) and intensive recycling (goal: closed cycles). This savings potential has not been considered in the preceding sections. Special consideration must be given here to non-energy uses of fossil raw materials for the production of plastics, synthetic fibres etc. (emission potential currently around 78 million tonnes CO_2). Moreover, intensification of use and material recycling result in longer “conservation” of the process energy contained in the products. In the event of thermal recovery at the end of the product’s useful life, this substitutes for other sources of energy. The problems that may be associated with such measures (e.g. increased energy requirement during the use phase, additional pollutant emissions) must be weighed up against these advantages.

The following legal provisions since 1998 have an effect on this sector:

- End-of-life Vehicles Ordinance (obligation on manufacturers of cars and light commercial vehicles to take back vehicle free of charge, definition of specific recovery rates for individual materials),
- the amended Waste Oil Ordinance (lays down priority for reprocessing of waste oil to obtain base oil in conjunction with financial assistance),
- Commercial Waste Ordinance (increased requirements for recovery of commercial municipal waste and certain types of building and demolition waste),
- Waste Wood Ordinance (uniform requirements for disposal of waste wood, classification by degree of pollutant contamination, definition of permitted recovery and disposal methods),
- the amended Packaging Ordinance (including extended deposit requirement to promote environmentally favourable beverage packs and recovery optimisation), and
- Electrical and Electronic Equipment Act (recovery of end-of-life equipment by manufacturer, with specified recovery rates; implementation from 2006; transposition of EG Directive on end-of-life electrical and electronic equipment).

There is also the Europe Commission Directive on ecodesign requirements for energy-using products. This aims at a broadly based material efficiency policy with an approach geared to the entire life cycle of a product. The impacts are difficult to quantity, because the very wide range of instruments has yet to be specified. In the long term the Directive will bring about a substantial reduction in energy requirements.

As a result of the measures taken since 1998, additional savings of 8 million tonnes CO_2 can be achieved by 2010. This figure includes 5 million tonnes in the field of non-energy consumption of fossil raw materials. Also included in the 8 million tonnes

– but not quantified – is the CO_2 reduction due to replacement of fossil fuels by thermal use of biogenic waste.

V.2.2.8.2. Methane (CH_4)

The Waste Deposition Ordinance, the Landfill Ordinance and the Bio Waste Ordinance all serve to avoid greenhouse gases, especially methane, arising from landfill sites due to deposition of untreated waste.

The Waste Deposition Ordinance lays down that as from 1.6.2005 municipal waste may only be disposed of as landfill if it is no longer biodegradable and cannot therefore endanger the achievement of the greenhouse gas emission reduction targets. The ordinance also provides for extensive collection and use of landfill gases for energy purposes in the case of existing landfill sites (avoidance of CH_4 emissions, replacement of fossil fuels, see above). The Landfill Ordinance regulates the field of special waste.

Furthermore, the Bio Waste Ordinance in force since 1998 stops considerable quantities of biodegradable waste being deposited on landfill sites. The ordinance ensures proper treatment of the waste and the use of the resulting compost on land used for agricultural, horticultural and forestry purposes.

In total, this package of measures permits reductions in excess of 10 million tonnes CO_2 equivalent.

V.2.2.9. Summary

V.2.2.9.1. Overall impact of measures in 2010 compared with base year 1990

The following table summarises the findings of the impact analysis of the climate protection policy measures used in the various sectors. It sets out the changes in CO_2 emissions for the scenarios with and without measures for 2010 (representing the period 2008-2012) compared with the base year 1990. This period thus symbolises the first commitment period under the Kyoto Protocol.

On this basis, energy-induced CO_2 emissions in 2010 “with measures” work out at nearly 836 million tonnes; this is 15.3 percent less than in 1990. Together with the CO_2 emissions from industrial processes the combined level is around 860 million tonnes, which corresponds to a reduction of 15.2 percent compared with the base year 1990.

Thus the climate protection policy measures have already had a considerable impact. The total contribution of the measures to reducing CO_2 emissions is estimated at around 76 million tonnes. This means that without the Federal Government’s climate policy, in other words in the “scenario without measures”, CO_2 emissions in Germany in 2010 would not be 860 million tonnes, but around 936 million tonnes. This would be only 7.7 percent less than in 1990; compared with 2002 it would actually mean an increase of 9 percent.

At this point it is important to remember that the projections used here do not take into account the Federal Government's latest measures or the massive increase in crude oil prices that began in 2005 and is still continuing, and the resulting overall economic impacts. The Federal Government is having the existing scenarios and forecasts updated. It does not endorse the findings of the forecasts and scenarios used, but does take account of them in its deliberations.

Table V - 18 Summary: Forecast of CO_2 emission trend with and without measures by 2010 compared with the base year 1990

Shares	Actual data (non-adjusted)	**Scenario with measures** (=reference scenario)				Impact of individual measures	**Scenario without measures**		
	1990	2010	90/02	02/20	**90/10**		2010	02/10	**90/10**
	CO_2 emissions in million t		Change in %			CO_2 emissions in million t		Change in %	
Industry	169.3	110.5	-35.6	1.3	**-34.7**	7.0	117.4	7.6	**-30.6**
TCS	90.5	57.9	-34.8	-1.9	**-36.0**	10.2	68.1	15.3	**-24.8**
Households	129.0	129.8	-7.1	8.3	**0.6**	18.6	148.4	23.8	**15.0**
Transport (nat.),	158.8	184.8	8.7	7.0	**16.3**	13.5	198.3	14.9	**24.8**
Total, end-use energy sectors	547.6	482.9	-15.9	4.8	**-11.8**	49.3	532.2	15.5	**-2.8**
Energy sector	439.2	352.8	-15.1	-5.4	**-19.7**	17.7	370.5	-0.7	**-15.6**
Sectors, total	**986.8**	**835.7**	**-15.5**	**0.3**	**-15.3**	**67.0**	**902.7**	**8.3**	**-8.5**
Total energy-induced emissions	986.8	835.7	-15.5	0.3	**-15.3**	75.0	910.7	9.2	**-7.7**
Process-induced emissions	27.6	24.4	-11.6	0.0	**-11.6**	1.0	25.4	4.3	**-7.8**
Total CO_2 emissions	**1014.4**	**860.1**	**-15.4**	**0.2**	**-15.2**	**76.0**	**936.1**	**9.1**	**-7.7**

Source: Politikszenarien III

The CO_2 emission scenarios do not reflect current developments in the buildings sector.

Including non-CO_2 emissions, in other words the greenhouse gases CH_4, N_2O, HFC, PFC and SF_6, which add up to around 143 million tonnes CO_2 equivalent in 2010, total greenhouse gas emissions in 2010 under the "with-measures" forecast came to 1,003 million tonnes CO_2 equivalent (see Table V - 19).

Table V - 19 Summary: Kyoto greenhouse gas emissions as forecast for 2010 under the scenarios with and without measures

Treibhausgase (THG)	Ist-Werte [1]							Mit-Maßnahmen-Szenario [3]				Wirkung der Einzel-maß-nahmen	Ohne-Maßnahmen-Szenario [3]		
	Basis-jahr [2]	1990	1995	2000	2001	2002	2003	2010	Basis/03	03/10	Basis/10		2010	03/10	Basis/10
	Emission in Mio. t CO_2-Äquivalenten								Veränderungen in %			Emission in Mio. t CO2-Äquivalenten		Veränderungen in %	
CO_2	1015,0	1015,0	902,2	860,1	873,9	863,9	865,4	860,1	-14,7	-0,6	-15,3	76,0	936,1	8,2	-7,8
CH_4	132,1	132,1	104,9	82,9	79,3	76,5	75,2	70,4	-43,1	-6,4	-46,7	18,1			
N_2O	86,4	86,4	80,9	62,2	62,5	61,8	63,7	54,6	-26,3	-14,3	-36,8	2,0			
HFC	6,4	3,5	6,4	6,6	8,1	8,2	8,2	14,4	29,7	74,6	126,4	6,5			
PFC	1,8	2,7	1,8	0,8	0,7	0,8	0,8	0,2	-55,3	-74,6	-88,6	1,8			
SF_6	6,6	4,0	6,6	4,0	3,3	4,2	4,2	3,2	-36,7	-23,8	-51,8	2,5			
Summe Nicht-CO_2	233,2	228,7	200,6	156,5	154,0	151,5	152,1	142,8	-34,8	-6,1	-38,8	30,9	173,7	14,2	-25,5
Summe THG	1248,3	1243,7	1102,8	1016,6	1027,8	1015,4	1017,5	1002,9	-18,5	-1,4	-19,7	106,9	1109,8	9,1	-11,1
THG-Ziel 2010								988,0			-21,0		988,0		-21,0
Differenz: THG-Ziel 2010 ./. Summe THG								-14,9			-1,3 %-Punkte		-121,8		-9,9 %-Punkte

1) Angaben Stand Nationaler Inventarbericht (NIR) 25.1.2005; ohne Landnutzungsänderung und Forstwirtschaft (LUCF, nur für CO_2 relevant).- 2) Basisjahr für CO_2, CH_4 und N_2O ist 1990, für HFC, PFC und SF_6 ist es 1995.- 3) Szenario-Berechnungen des DIW für CO_2 auf der Basis des Nationalen Inventarberichts 2003; Abweichungen zu aktuelleren NIR-Ergebnissen beeinflussen das Berechnungsergebnis nur unerheblich (vgl. Tab. 3.11-1).-

Quellen:UBA, Nationaler Inventarbericht 2005; AG Energiebilanzen; UBA; FZJ; Fhg-ISI; Öko-Institut; DIW Berlin.

In relation to the base year[63], in which greenhouse gas emissions totalled 1 248 million tonnes CO_2 equivalent, the emission reduction by 2010 amounts to about 231 million tonnes CO_2 equivalent, which represents a reduction of 18.5 percent. On this basis the current assessment indicates that a further 2.5 percentage points are needed to reach the target figure of -21 percent for 2008 to 2012 by 2010.

The biggest contribution to the overall reduction in CO_2 emissions that results from the measures (difference between the scenarios with and without measures) is made by the energy sector (energy conversion) itself, but the end-use energy sectors Transport, Households, TCS and Waste Management also play a considerable role. In absolute terms, the reduction rate in the industrial sector is comparatively low. It is worth noting that simply as a result of promoting the use of renewable energies in the electricity sector, CO_2 emissions will be reduced by an estimated 72.3 million tonnes by 2010. Also substantial is the emission reduction contribution made by the other five greenhouse gases as a result of the measures, which totals about 31 million tonnes CO_2 equivalent.

Thus climate protection policy measures by the government, industry and households have contributed nearly 107 million tonnes CO_2 equivalent to the reduction in emissions. In the “without-measures” scenario, greenhouse gas emissions in 2010 would be around 1 110 million tonnes CO_2 equivalent – only 11 percent less than in the base year.

63 The base year for CO_2, CH_4 and N_2O is 1990; for HFC, PFC and SF_6 it is 1995.

V.2.2.9.2. Presentation of results in accordance with Annex III

The following table gives an overview of the indicators[64] for assessing the probable progress of policies and measures for the “with-measures” forecast by 2010.

Table V - 20 Indicators for assessing the progress of policies and measures

Indicators for projections to monitor and evaluate progress with policies and measures			
	Unit	**2000**	**2010**
CO_2 intensity of GDP	kt CO_2/Mio. €$_{1995}$	0.427	0.342
Transport: CO_2 emissions from passenger cars, kt	kt	106733	105540
Number of kilometres by passenger cars	Billion Pkm	775	881
Transport CO_2 emissions from freight transport	kt	63151	68334
Freight transport Mtkm	Billion tkm	483.1	607.4
Industry energy related CO_2	kt	119	110.5
Industry: Energy related CO_2 intensity (tCO_2/Gross value-added)	t CO_2/Mio. €$_{2000}$	0.328	0.251
Households: CO_2-emissions	kt	133000	130000
Households: specific CO_2-emissions	t CO_2/dwelling	3.61	3.28
Services	t CO_2/Mio. €	Not available	Not available
Electricity production: CO_2-Emissions	kt	309750	304800
Transformation (Specific CO_2-emissions of public power plants)	t CO_2/$TJ_{el(net)}$	0.163	0.152
Agriculture (fertiliser, manure)	kg N_2O/kg	Not available	Not available
Agriculture (cattle production)	kg CH_4/kg	Not available	Not available
Waste	kg CH_4/landfill kt	Not available	Not available

Source: Calculations commissioned by the Federal Environmental Agency on the basis of the study “Klimaschutz in Deutschland bis 2030”, Federal Environmental Agency 2005.

V.3. Forecast of greenhouse gas emissions to 2020

V.3.1. Methodology

According to Decision 280/2004/EC, a forecast is to be made of greenhouse gas emissions up to 2020. The decision requires a forecast “with measures”, which takes account of all measures taken since 1998, and a forecast “with additional measures”, which also takes in the impact of planned measures. This chapter is based on the scenarios in the study “Klimaschutz in Deutschland bis 2030” (“Climate protection in Germany to 2030”). These scenarios are currently being updated and further

[64] Indicators in accordance with Annex III of Commission Decision 2005/116/EC implementing Decision 280/2004/EC

developed. In their estimates, the existing results do not take adequate account of current developments in energy prices on the world markets. Furthermore, it is important to note for the transport sector that they do not reflect the real impact on filling station prices. For example, the study worked on the assumption of filling station prices without taxes.

Forecast with measures
The “with-measures” scenario described above, which was drawn up in the study “Climate Protection in Germany to 2030” and which the Federal Government does not endorse, is used for the forecast of greenhouse gas emission until 2020 with measures.. As already described, the “with-measures” scenario was generated on the basis of simulation-aided expert estimates with the aid of the detailed reduction potentials for the individual measures. It focuses primarily on the period to 2008/2012.

The “with-measures” forecasts for the year 2020 are to be seen as extrapolations of the estimates for 2008/2012, the figures for 2015 being interpolated on a linear basis.

Forecast “with additional measures”
The forecast “with additional measures” makes use, among other things, of the “reduction scenario II” which was also developed in the study “Climate Protection in Germany to 2030”. However, this scenario differs from the “with-measures” scenario in several methodological aspects: This scenario works on the assumption that greenhouse gas emissions are to be reduced by 40 percent by the year 2020. In its national climate protection policy 2005 the Federal Government suggested that the EU declare its readiness to make a 30-percent reduction in its greenhouse gas emissions by 2020 compared with the base years 1990/1995. If this is done, Germany will seek to achieve a larger reduction. To achieve this target, it would be necessary to take additional reduction measures.

Whereas the forecast “with measures” has more of a predictive character, the forecast “with additional measures” is largely based on the “reduction scenario II” which was generated with the aid of an energy system model (see the following background information on the method).

For this reason comparisons between the forecast “with measures” and the forecast “with additional measures” are only of limited value. Comparisons should only be made with regard to the relative reductions.

Background information on method

The energy system model used for reduction scenario II is a dynamic linear optimisation model (IKARUS-MARKAL), which represents all areas of the overall economic system as a network of technologies and works on the lines of a “perfect foresight” philosophy. The target function of the IKARUS model contains the entire discounted system costs for the period considered. The result is an energy system in which the demand for energy services is met at minimal cost from an overall economic point of view under the defined framework conditions (e.g. energy prices, coal policy etc.) – without regard to actions or constraints, except where these are dictated by certain limit values. It should be noted that this model is not a forecast instrument. It was developed to make it possible to use scenario techniques to indicate, for example, the impacts of economically optimal action strategies (in the sense of technological measures) for climate protection and hence to identify cost-effective fields of action. To be able to analyse the effects of a reduction scenario, it is compared with a basic scenario which is also model based (model base scenario), which is to be interpreted as a “business as usual” situation.

Comparability of with-measures scenario and model base scenario

The model base scenario is an open, i.e. exploratory, scenario in which – unlike in the reduction scenario – no target is specified for development of CO_2 emissions. The implemented measures contained in the with-measures scenario are also part of the model base scenario, and it is therefore to be interpreted as a “scenario with measures”. To ensure the greatest possible compatibility with the with-measures scenario, the framework data assumed (e.g. economic development, energy prices, demographic trends etc.) are the same as in the with-measures scenario. The results of the with-measures scenario are nevertheless different from those of the model base scenario (see Table V-24). This is due to the fact that they work with different philosophies. The optimisation model indicates an optimal-cost development which is usually not subject to any constraints, whereas the with-measures scenario takes account, for example, of individual economic decisions, market imperfections and constraints. Thus the with-measures scenario has a more predictive character and does not show a development in which costs are optimised from an overall economic point of view. This means the differences are an intrinsic part of their design.

The same factors also explain the discrepancies between the figures determined using model-based scenarios and the historical figures of the energy and emission accounts. Divergences from historical figures are also due to differences in the delimitation of sectors, and to temperature adjustment.

V.3.2. Framework data and description of the forecast “with measures”

The framework data and results of the forecast with measures are set out in Section V.3.4. Extensive use is made of the parameters listed in Annex IV to the implementing regulations for Decision 280/2004/EC (“mandatory parameters” and “recommended parameters”). These framework data are the same as those used for the “without-measures” scenario in Section V.2 and, with few exceptions, for the forecast “with additional measures” which is explained below. The assumptions include in particular assumptions on long-term population development, national and sectoral production, development of living space, traffic levels in passenger and goods traffic, and prices of imported energy sources. The principal assumptions made in the study are outlined below.

- The population of Germany will show a relatively slight drop from around 82 million today to 80.8 million in 2020. Only then will the figure start to fall faster.
- During the period 2000 to 2020 the gross domestic product (GDP) will grow by an average of 1.8 percent a year.
- Total living space will continue to increase by the year 2020. It will be about 25 percent higher than in 2000. The number of dwellings will also increase much faster than the number of households. The reason is the growing number of second dwellings for commuters and the increase in pensioner households. This will cause the number of dwellings to rise from 36.8 million (2000) to 41.6 million in 2020.
- An average annual price increase of 1.7 percent is assumed for oil, 1.9 percent for natural gas and 0.9 percent for coal for the period 2000 to 2020.

- The projection works on the basis of a long-term tertiarisation trend. There will be a marked decline in the shares of agriculture and forestry, mining, the manufacturing industry, energy and water supply and the building trade, whereas above-average growth will be seen in the fields of commerce, hospitality, transport and other services in particular.
- Total passenger traffic will increase to around 1 138 billion Pkm by 2020, which is about 17 percent higher than the figure for 2000. Even more marked is the increase in freight traffic, which will grow by about 2 percent per annum. At 732 billion tkm, the absolute figure for 2020 will be more than 50 percent higher than at present.
- Consumption of domestic coal and lignite is expected to be at least 750 PJ and 1 400 PJ respectively in 2010 and around 500 PJ and 1 400 PJ in 2020.
- The shares for a number of renewable energy sources are specified. This applies above all to wind energy, with an installed capacity of around 19 GW in 2010 or 25 GW in 2020. As a result, the share of electricity generation accounted for by renewable energies is around 10 percent in 2010 and nearly 15 percent in 2020.
- Use of nuclear energy is being phased out under the agreement between the Federal Government and NPP operators, and in accordance with the relevant revision of the Nuclear Energy Act.
- From 2002 onwards, new buildings must comply with the Energy Saving Ordinance (latest version 02.12.2004). In Germany the energy-saving requirements for new buildings are already at a high level. The same applies to remediation measures carried out on existing buildings. For the following years the study assumes that these requirements will be tightened up even further in updated versions of the Energy Saving Ordinance. The requirements and corresponding updates of the ordinance are assumed for remediation measures in the existing buildings sector as well.
- No account is taken of CO_2 release and landfill.
- It is assumed that the upper limits (cap) of the National Allocation Plan until 2010 will be complied with.

The results of the estimate “with measures” for the target year 2010 are described in Section V.2. The emission figures determined as a result of the update to 2020 are included in Section V.3.4 below. At this point it should merely be noted that under the framework conditions defined in the “with-measures scenario”, which serves as the model base scenario for the medium-term forecast, there is no further emission reduction in the period up to 2020. The presentations in accordance with Annex III and Annex IV of the implementing regulations on Decision 280/2004/EC can be found in the Appendix.

V.3.3. Framework data and description of the forecast “with additional measures”

V.3.3.1. Background facts and figures

With few exceptions, the framework data for the forecast “with additional measures” are identical to those for the forecast “with measures”. One difference is an easing of the minimum lignite consumption quantities.

An important point, however, is that here the projection works on the hypothetical assumption that CO_2 emissions are to be reduced by 40 percent by the year 2020 (for method see Section V.3.1).

The calculations show the kind of technical and economic optimisation that would theoretically arise from complete internalisation of all costs, e.g. within the framework of an emissions trading scheme that is functioning ideally from a macroeconomic point of view. The measures described in Chapter V.3.2 were developed on the basis of the technical standard achievable in the individual field (sector, product, plant type). The additional measures are developed from the following point of view: “What would have to be done to exploit the technical reduction potentials?”

The main results of the forecast can be characterised as follows:

- Compared with the forecast with measures, the largest additional reduction contribution is due to additional measures by the conversion sector. With a 70 percent share of the total emission savings by 2030, this sector makes a major contribution to achieving the reduction target. The reduction in the conversion sector is largely due to a decline in the generation of electricity from coal. The place of coal is taken by electricity generation in highly efficient and cost-effective natural gas fired gas-and-steam plants, which from 2010 onwards will increasingly take the form of CHP plants.
- Compared with the reference trend, natural gas and (according to the assumptions) renewable energies are of growing importance. The share due to renewable energies in 2030 is about 15 percent of total primary energy requirements. Moreover, increasing use will be made of energy-saving measures that will ultimately result in substantially lower primary energy consumption than in the reference situation.
- Roughly 30 percent of the emission savings compared with the model base scenario are achieved in the end-use energy sectors. The household sector is of central importance here, with its greatest savings potential in the field of heat insulation. Compared with the reference situation, specific space-heating requirements (averaged over all types of house) are nearly 30 percent lower in 2030, largely as a result of improved heat insulation in both new and existing buildings. The forecast calculates a similar trend for the TCS sector (trade, commerce, services). Here too the greatest savings are achieved thanks to improved heat insulation.

V.3.3.2. Additional measures to reduce CO_2 emissions

According to the results of the scientific studies, additional measures would be needed to meet the reduction targets assumed in these studies by 2020. At present, however, the Federal Government currently has no concrete plans regarding the necessary policy framework requirements. The measures conceivable for the individual sectors are set out below.

Table V - 21 Reduction potential by sectors

Sector	Reduction potential
Energy sector	75%
Industrial sector	3%
Trade, Commerce, Services	3%
Private households	15%
Transport	3%

Source: Politikszenarien III

In summary, scientific investigations work on the assumption that the reduction potential up to 2020 will be divided roughly as follows among the individual sectors:

V.3.3.2.1. Energy sector

Renewal of existing power plants

The renewal of conventional, fossil-fired power plants holds considerable potential for the reduction of CO_2 emissions. This involves replacing coal-fired power plants with high-efficiency natural gas fired steam-and-gas plants, using renewable energies and – since Germany cannot in the medium term do without electricity generated from coal – improving efficiency in coal-fired power plants, which can result in considerable emission reductions.

To exploit the technical opportunities, the Federal Government therefore intends to place special emphasis in its new energy research programme on promoting research and development in the field of modern power plant technology for coal and gas.

In the course of transposing the EU Emissions Trading Directive, the Federal Government has already created effective incentives to speed up the replacement of old and inefficient power plants with highly efficient plants, in the Transfer Rule (Section 10 Allocation Act 2007) and the Malus Rule (Section 7 paragraph 7 Allocation Act 2007).

Assuming that the emissions trading scheme is continued beyond the first Kyoto commitment period 2008/2012 with ambitious climate policy objectives, Policy Scenarios III reveals that the continuation of the emissions trading scheme will provide a considerable stimulus for substitution processes in favour of highly efficient natural gas power plants and the use of renewable energies.

Additional economic incentives for increased use of natural gas for electricity generation (e.g. by means of high-efficiency gas-and-steam plants) could be provided by the abolition of tax on products used in electricity generation which is planned in the context of transposing Directive 2003/96/EC (Energy Tax Directive) into national law.

The study also suggest that the widespread introduction of decentralised fuel cell systems and the establishment of systems networked over large areas could contribute to the restructuring of existing power plants that is desirable from a climate policy point of view. The aim of such systems, through coordinated control of many small decentralised generating units (micro CHP plants, wind energy systems, photovoltaic systems, fuel cells) and electricity customers, is to integrate these power sources by means of intelligent networking and thereby operate distributed large power stations (a “virtual power plant”).

Expansion of local and district heating supplies on the basis of CHP generation

Further reduction potential in the energy sector can be exploited by stepping up the expansion of CHP generation:

- by increasing infeed of heat from CHP generation and exploiting new heat supply potential
- by expanding local heating supplies with decentralised CHP plants
- by focusing CHP promotion on exploitation and utilisation of economic heat potential
- by giving priority to grid connections for CHP plants, imposing an obligation to take CHP electricity and refunding grid usage costs saved.

In order to speed up the expansion of CHP generation, various measures are suggested in the scenario analysis “Policy Scenarios III”:[65]

- Extend the existing CHP Act to all CHP plants regardless of operator, and also to additional plants (expansion of CHP), with considerably longer assistance periods and larger bonuses.
- Introduce a quota system for CHP electricity. Against the background of the commitment given by German industry in connection with the CHP Agreement, the Federal Government refrained from using such an instrument in 2001.
- Promoting decentralised energy generation through regional planning, and promotion of local and district heating networks
- Incentives for electricity network operators to promote the installation of CHP plants in their networks by recognising avoided electricity flows in network operation costs and imposing an obligation to exempt CHP plants from avoided network usage costs.

Increased assistance for the use of renewable energies

The use of renewable energies also possesses considerable potential for CO_2 emission reductions. In the medium term one option is wind energy, where there is still considerable potential left to exploit in the offshore sector in particular. In the study “Policy Scenarios III” it is assumed that an output of between 20,000 and 25,000 MW can be achieved in the offshore sector in the medium to long term (i.e. 2030). A recent study indicates that an output of about 12,000 MW can be expected by 2020.[66]

In the medium term it is also possible to expand the use of biomass and biogas. In the heat sector there is also considerable scope for expanding the use of solar collectors. Potential is also offered by the use of geothermal energy.

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[65] For details, see “Klimaschutz in Deutschland bis 2030 – Politikszenarien III”, p. 429 ff.
[66] Ausbau erneuerbarer Energien im Stromsektor bis zum Jahr 2020, p. 17

The proposals in the study in question include not only promoting research and development and reducing institutional obstacles, but also using the following instruments to promote the use of renewable energies:

- Subsidies (investment or operating grants, guarantees, reduced-interest loans, possibly with residual debt relief, tax concessions);
- Statutory minimum remuneration rates with equalisation of burdens (cf. Renewable Energies Act);
- Statutory remuneration bonuses with equalisation of burdens (cf. CHP Act);
- Minimum quotas and trading in green allowances;
- Tender procedures with competition between bidders;
- Voluntary commitments to use renewable energies;
- Markets for (certified) green energy.

The Federal Government has gained favourable experience with the statutory minimum remuneration under the Renewable Energies Act, and it plans to continue using this instrument while gradually reducing the remuneration rates granted. The remuneration rates for the various energy production technologies are to be continuously adjusted to facilitate dynamic addition of new plants while avoiding overheating of individual markets and excessive assistance for individual technologies. To this end the Federal Environment Ministry will report to the Bundestag by the end of December 2007 about the situation regarding the market introduction of systems for generating electricity from renewable energies and the development of electricity prices in such systems, and will, if necessary, propose an increase in the remuneration rates under Sections 6 to 12 and in the rates of decrement in view of the technological and market developments for systems put into service after this date.

V.3.3.2.2. Industrial sector

Further reductions in CO_2 emissions due to energy production in the industrial sector can also be achieved by replacing carbon-rich fossil fuels. However, in view of the large proportion of industrial energy consumption already accounted for by gas and electricity, roughly 70 percent (in 2000), the further potential for substitution is limited.

In addition, however, considerable reductions in CO_2 emissions are possible by saving energy in production processes.

In large operations with thermal applications in the high-temperature range (above 200°C and especially above 500°C), the following measures can be considered:

- Above all, a closer R&D focus on the criterion of energy efficiency can contribute to better exploitation of longer-term technical potential.
- Improved design of emissions trading or of voluntary undertakings in industry can also contribute to greater exploitation of the economic savings potential.
- Furthermore, IT-based energy benchmarking that permits comparisons with similar operations can improve motivation to undertake energy-saving measures.

In small and medium enterprises (SMEs) with thermal applications under 200°C, the following measures are conceivable:

- Energy guidance (energy audit).
- Incentives to implement energy efficiency measures.
- Range of suitable loan programmes.

In the field of cross-sectional thermal technologies (essentially industrial steam/ hot-water generators), one could also consider coordinated EU-wide awareness-raising programmes (ARP) in conjunction with economic incentives and regulation (ERP) (see also the following section on the electricity sector).

In addition to thermal energy, significant savings potential also exists in the use of electrical energy (in 2001 the industrial sector accounted for around 43 percent of total electricity consumption in the end-use energy sectors).

In the field of cross-sectional electrical technologies there are already approaches at EU level (e.g. Motor Challenge Programme and GreenLight Programme[67]) and at national level (e.g. compressed air campaign[68]). These would have to be better coordinated and possibly provided with better financial resources. Other programmes for fans, pumps, other electrical drive systems and lighting could be based on a similar model.

For information and communication technologies, possibilities include market transformation programmes and procurement rules for energy-efficient equipment that take account of life cycle costs.[69]

Cross-sectional technologies used in various branches of industry can be used to take advantage of currently unexploited potential.

V.3.3.2.3. Trade, Commerce, Services

Unlike the industrial sector, the greater part of energy consumed in the TCS sector is used for space heating. Substantial CO_2 reductions can be achieved by means of appropriate energy-saving measures.

Particularly in the buildings sector, energy-saving measures to the building envelope and in the heating field can still bring about considerable emission reductions. These measures are described in detail in the Section V.3.3.2.4 “Private households”.

For new buildings the new EU Directive on energy efficiency in buildings[70] will be of special relevance in future. This provides in particular for the requirements in force to be tightened at five-year intervals. Moreover, electricity-related building functions are increasingly to be included in the regulation. To increase overall energy efficiency, the study “Climate protection in Germany to 2030” also proposes voluntary energy audits for public and possibly also for private non-residential buildings.

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[67] See energyefficiency.jrc.cec.eu.int/Motorchallenge/index.htm and www.eu-greenlight.org/index.htm

[68] See www.druckluft-effizient.de/index.php

[69] For details, see “Klimaschutz in Deutschland bis 2030”, p. 346 ff.

[70] Directive 2002/91/EC of the European Parliament and of the Council of 16 December 2002 on the overall energy efficiency of buildings.

One possibility for the implementation of energy-saving measures in SMEs in particular is *contracting* or *operator models*. Here an external company handles the planning, technical execution and financing of energy-saving measures (e.g. heat insulation, heating system replacement), and the project is financed by the energy costs saved. It is also possible for the operation including servicing and maintenance to be taken over by the contractor. To date, however, businesses have been hesitant in their acceptance of these models.

In the field of cross-sectional electrical and thermal technologies, attention can be drawn to corresponding measures in the industrial sector (see above).

In the case of office/IT equipment the German Energy Agency (dena), under the Energy Efficiency Initiative, offers guidance on purchasing energy-efficient equipment with an online database of particularly efficient office equipment (www.office-topten.de). It includes computers, monitors and image output devices such as copiers or printers. In the course of the current negotiations on the future use of Energy Star, a US energy-saving symbol, the present mild requirements will be tightened up considerably. The energy-saving symbol of the GEEA (Group for Energy Efficient Appliances) demands much more stringent standards than Energy Star, but is not so widespread.

V.3.3.2.4. Private households

In private households, the greater party of the energy is likewise used for space heating purposes. The greatest CO_2 reductions in this sector can therefore be achieved primarily by means of energy-saving measures in buildings – especially existing buildings.

<u>Existing buildings</u>
The greatest reduction potential lies in measures to improve heat insulation, increase the efficiency of heating systems, switch to different fuels and, where possible, connect to local or district heating networks based on CHP generation. Further CO_2 reductions can also be achieved in the field of private electricity consumption.

According to the study by Forschungszentrum Jülich, a trend analysis of measured figures indicates that emissions of around 125.3 million tonnes CO_2 can be expected in the private household sector in 2005.

As a savings scenario, a reduction of around 5.3 million tonnes CO_2 to 120 million tonnes CO_2 per annum is possible by 2008-2012 compared with the trend figure 2005.

To achieve this, the following measures need to be taken:

CO_2 savings potential of the financial assistance measures up to 2010:

- Continuation of the present assistance programmes of the KfW CO_2 building remediation programme yields considerable savings.
- Compulsory introduction of energy certificates for existing buildings, which will provide a transparent picture of the energy-saving quality of the individual

building. Economic modernisation recommendations are an integral part of the energy certificate. Energy certificates will increase the demand for properties with good energy characteristics. Further guidance on energy matters will give an additional boost to remediation projects.

- Strengthen the function of the German Energy Agency (dena) as a national centre of expertise for energy efficiency. One major task of dena is to present a differentiated picture of the necessity for and feasibility of energy-saving remediation of existing buildings for all target groups (investors, craft trades, planners, owners). By means of trade fair appearances, guidance, information brochures, targeted specialist congresses and support for pilot projects designed to save energy in existing buildings, dena will, as in the past, make energy-saving remediation of existing buildings a focal point of its activities.
- The Federal Ministry of Transport, Building and Urban Affairs is to considerably step up its research in the building field with the aim of identifying innovation potential and implementing measures to improve energy efficiency.
- Public relations campaigns to increase the energy-saving remediation rate. Targeted approaches should be made to owners of residential buildings, especially detached and semi-detached houses. An important actor on the public relations front is dena.
- The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety launched the climate protection programme in 2002 and modified it in 2004 on the basis of experience gained. In its present form the climate protection campaign provides an opportunity to reach people in private households via a dense network of multipliers in various sectors and to keep them constantly informed. The Federal Environment Ministry will continue its systematic pursuit of this initiative.
- In order to improve the quality of execution from an energy point of view, a further training and quality offensive for both new and existing buildings is planned in the craft trade sector. At the same time greater importance will be attached to compliance with implementation in accordance with the Energy Saving Ordinance.
- Great progress has been made with energy-related improvements to building products and innovations in the field of operating technology and use of renewable energies. Since economic use of these products is also favoured by the continuing rise in energy prices, the possibility of updating the energy requirements in the Energy Saving Ordinance for new and existing buildings should be investigated.
- The use of public-private partnerships (PPP) as an option for the expansion of energy-saving contracting in public building projects should help to exploit savings potential in existing buildings. Private finance permits timely implementation of economic measures designed to save energy and reduce CO_2 emissions. Amendment to Home Ownership Act with the aim, among other things, of facilitating energy-saving remediation measures to bring the property up to a modern standard under a resolution passed by a majority of the owners (hitherto only possible under a unanimous decision by all owners).
- In recent years instruments such as the Renewable Energies Act, the “100,000 Roofs” solar energy programme and the market incentives programme have given a boost to the use of renewable energies in private households.

The following section sets out the fields of action and packages of measures that can, according to “Policy Scenarios III”, be used to exploit further reduction potential.

Improving implementation

- More effective checks on implementation. These tasks can be performed by official representatives, private appraisal experts and specially trained craft trade personnel, who are increasingly acting as energy consultants.
- Introduction of energy certificates for buildings and advice for consumers
- Improvement of cooperation between federal and *Land* authorities with the aim of better harmonisation of measures and a coordinated approach
- Assistance programmes
- Information and motivation programmes for better implementation by all actors (planners, architects, craftsmen and owners/users)

More efficient system technologies

This applies to heat generation, control and distribution. Examples include:

- Increased use of high-efficiency condensing boiler technology (especially for existing buildings)
- Better adjustment of distribution system in existing buildings to replacement heat generators, and use of low-consumption heating circuit pumps
- Use of improved or automated control systems (especially for existing buildings)
- Information and education in more efficient technologies for all actors

Increased use of renewable energies for heat generation

This applies in particular to the use of solar energy for hot-water generation and heating support and, where it is possible and makes sense, use of biomass.

Revised Energy Saving Ordinance (EnEV)

Although the regulations on heat insulation in buildings have already been tightened up considerably over the last 30 years, there is still a certain potential for further improvements. In this connection it is worth noting the introduction of energy certificates for existing buildings, which is required under EU legislation, and various scientific studies and recommendations concerning the "3-litre house"[71].

Information and motivation

Additional potential can be exploited by means of information and motivation campaigns on implementing energy-saving measures, especially in the course of remediation of existing buildings.

Electricity consumption

The reduction potential in the field of private electricity consumption can be exploited by the following means:

- Manufacturers offer a broader range of energy-saving electrical equipment.
- Better consumer information and improved labelling of energy-saving electrical equipment, including the home entertainment and computer segments.
- Information and motivation campaigns to encourage people to buy more efficient equipment and save energy.

[71] Cf. for example www.3-Liter-Wohnhaus.de

- Further reduction potential can be exploited in particular by replacing electricity for supplies of heating services (space heating, hot water and cooking) with less CO_2-intensive energy sources (e.g. gas, district heating, solar thermal energy).

V.3.3.2.5. Transport

Additional efforts are also needed in the transport sector to achieve further emission reductions. A variety of instruments can be used for this purpose.

Possibilities exist above all in the technical optimisation of vehicles and fuels, and in switching to environmentally friendly means of transport. The following section gives a more detailed explanation of the measures possible in the individual fields of action as set out in the study “Policy Scenarios III”:

Vehicle efficiency improvements

If the existing voluntary undertaking by the automobile industry for the period to 2008/2009 is successful, it should be developed further. The Federal Government is also implementing further measures aimed at technical improvements to vehicles and fuels and at promoting alternative fuels and innovative drive systems. These were laid down in the Federal Government’s fuel strategy and the national climate protection strategy 2005. To counteract the general trend towards increasingly powerful vehicles with auxiliary equipment that increases consumption still further, incentives to manufacture and use more economical vehicles must be strengthened.

Promotion of alternative fuels and innovative drive technologies

In its fuel strategy, the Federal Government has presented a strategic overall concept for the period to 2020 which supports the market launch of alternative and renewable fuels and innovative drive systems.

Efficiency improvements in both petrol and diesel engines are of central importance here. Even in the short term, efficient drive technologies open up considerable potential for reducing CO_2 emissions. Innovative technologies like hybrid drive and fuel cells in conjunction with optimised materials can offer further improvements in efficiency in the medium or long term.

Alternative fuels also play an important role. At present conventional biofuels such as biodiesel and bioethanol as admixtures to petrol and diesel fuels are making an important contribution, as are natural gas and liquefied gas. By 2020 renewable fuels could reach a total market share of 10 - 20%.

Voluntary undertaking by the automobile industry

A further boost to reductions in CO_2 emissions by road traffic is provided by the automobile industry’s voluntary undertaking. In 1995 the German Automobile Industry Association promised to make a 25% reduction in the average fuel consumption of newly registered cars by 2005 – compared with the figure for 1990. The European Automobile Industry Association also undertook (like the Japanese and Korean automobile industries) to reduce average CO_2 emissions by newly registered cars to 140 g/km by 2008. The industry is making good progress towards achieving its self-imposed reduction targets. There is a need for further development of this voluntary undertaking by the automobile industry, which expires in 2008.

Strengthen environmentally friendlier means of transport
Walking and cycling are by far the most environmentally friendly forms of transport. In the medium term it would seem possible to step up cycling as a share of total passenger transport. Other measures above and beyond the planned promotion of cycle traffic by the National Cycle Traffic Plan are conceivable, but these do not fall within the responsibility of the Federal Government: they include speedier infrastructure development, increased assistance for supporting measures – especially public relations work – and more comprehensive integration of cycle and pedestrian traffic in traffic and settlement concepts.

Local public transport can also make a significant contribution to CO_2 reductions. This presupposes a well developed route network, efficient modern vehicles and a high-quality and customer-oriented range of transport services.

On average per passenger-kilometre, railways cause roughly half as much CO_2 emissions as car traffic, and roughly half the CO_2 emissions caused by air traffic. More efficient railways and better utilisation could further improve the environmental benefits of the railways. In addition to the structural reform of the railways and the introduction of controlled competition in local passenger rail traffic, there is a need to improve the framework conditions for railway transport.

On average, goods transport by road can cause up to six times more CO_2 emissions than rail transport, and nearly twice the CO_2 emissions of inland waterway transport. Depending on distance, type of goods and destination, switching freight traffic from road to rail and inland waterway can contribute to reducing CO_2 emissions. The HGV toll supports the objective of transferring goods to rail and water where this makes economic and environmental sense, and thus makes a contribution to climate protection, as does linking different modes of transport, e.g. by expanding multimodal transport. To make it possible to achieve the CO_2 reduction targets by 2008-2012, the climate protection programme 2005 suggests as one possible measure that the HGV toll could be developed into a genuine road pricing system with toll rates differentiated by time and place.

Safeguard mobility – Spare the environment
As the present and predicted traffic situations show, the reduction in specific emissions and the switch to more environmentally friendly means of transport are not sufficient to ensure a suitable reduction in CO_2 emissions in the transport sector.

The following measures could make a contribution here:

- Promoting traffic-avoiding settlement structures by means of inter-authority planning and abolition of environmentally harmful subsidies (reducing distance allowance and home ownership grants)
- Promoting environmentally friendly holiday and leisure habits, e.g. through better local leisure offerings and attractive holiday opportunities in Germany and Europe, in order to counteract the trend to long-distance trips.

Limiting the climate impacts of air transport
Air transport currently has by far the fastest growth rate of all carriers and is already the second-largest emitter after road traffic. Moreover, owing to the emissions of NO_x, water vapour and other factors (e.g. vapour trails), the contribution air transport

makes to the greenhouse effect is between two and four times higher than the contribution of its CO_2 emissions. Since the reduction commitments of the Kyoto Protocol do not take account of the greenhouse gas emissions by international air transport, the Federal Government is looking into supplementary international regulations that could be used to restrict greenhouse gas emissions by aircraft.

In this connection discussions are in progress at EU level about the possibility of introducing a European distance-related emission charge for flights. Furthermore, the European Commission, in its communication "Reducing the Climate Change Impact of Aviation", has stimulated further discussions about measures in this sector.

Moreover, in 2004 the Federal Environment Ministry started the "atmosfair" project. This gives every airline passenger the opportunity to compensate for the emissions caused by a flight by making an equivalent contribution to financing specific climate protection projects.

Information and motivation

In the transport sector too, targeted information and motivation campaigns aimed at resource-conserving transport behaviour can bring about additional emission reductions.

V.3.3.3. Additional measures to reduce non-CO_2 emissions

The following section gives an estimate of the emission situation for non-CO_2 greenhouse gases up to 2020 and names measures that the above mentioned study proposes for achieving the reduction targets.

As far as the non-CO_2 greenhouse gases are concerned, the greatest emission reduction potential can be expected in the case of CH_4, followed by HFCs.

V.3.3.3.1. Agricultural sector (CH_4 and N_2O)

In view of agricultural policy developments, we can expect to see a further decline in livestock numbers and a consequent reduction in CH_4 emissions. There is also expected to be an increase in the quantities of organic manure used in biogas systems. Furthermore, a reduction in N_2O emissions by means of various measures to increase N-efficiency is both possible and necessary.

V.3.3.3.2. Further reductions in HFC, FC and SF_6 emissions

Analysing a further decrease in HFC emissions by 2020, the study "Climate change in Germany to 2030" works on the following assumptions:

- Further development of systems and further replacement of HFCs by halogen-free refrigerants in miscellaneous refrigeration/air-conditioning systems
- Gradual phasing out of HFCs in foam production
- Complete discontinuation of HFCs in technical aerosols, extensive discontinuation in metering aerosols (substitution, alternative application technologies)
- No further introduction of fire extinguishers based on HFCs.

According to the analysis in the study "Policy Scenarios III", additional conversion of all aluminium production to the low-emission point-feeder technology from 2009 onwards could bring a 75-percent reduction in FC emissions by 2010 compared with 1995.

Finally, in the case of SF_6 emissions the study shows that if the nonferrous metal industry implements its substitution offer by 2009, a total emission reduction of 56 percent compared with 1995 could be achieved.

V.3.4. Summary: Results of projections

The following section compares the greenhouse gas emissions in the individual projections of the scientific studies mentioned earlier. It should be noted that in view of differences in method, comparisons between the forecasts "with measures" and "with additional measures" are only of limited value (cf. Section V.3.1). In fact the model base scenario should be taken as the reference development for the forecast "with additional measures".

The presentation of results in accordance with Annex III (Indicators for projections), Annex IV Item 1 (Mandatory Parameters) and Annex IV Item 2 (Recommended Parameters) can be found in the Appendix.

Table V - 22 Development of greenhouse gas emissions in Germany to 2020[72]

shares	Actual values (adjusted)		Model base scenario			With measures			With additional measures		
	1990	2000	2010	2015	2020	2010	2015	2020	2010	2015	2020
	CO_2 emissions in million t										
Industry	171	119	115	115	109	110	108	106	113	109	103
TCS/Households	241	201	188	185	179	188	185	182	176	154	140
Trade/Commerce/Services	96	65	65	64	60	58	57	55	63	55	53
Households	145	136	123	121	118	130	129	127	112	99	86
Transport (national),	158	178	196	194	190	185	181	177	196	190	184
Total end-use energy sectors	570	498	499	494	478	483	474	465	485	453	427
Total energy sector (energy conversion)	443	365	312	320	337	353	370	386	256	216	180
Total energy-induced CO_2 emissions	1014	864	812	814	815	836	844	851	739	669	607
Process-induced CO_2 emissions	28	26	no data			24	24	24	24	23	22
Total CO_2 emissions	1042	890	no data			860	868	875	763	692	629
Total non-CO_2 emissions	233	157	no data			143	138	138	138	134	128
Total greenhouse gas emissions	1275	1047	no data			1003	1006	1013	901	826	757

Sources: Study "Klimaschutz in Deutschland bis 2030", under: Enquete-Kommission, AG Energiebilanzen, UBA, FZJ, Fhg-ISI, Öko-Institut, DIW Berlin; Nicht-CO_2-Emissionen 1990, 2000: NIR 25.1.2005 and estimate 2010 Table 3.11-2 (Chapter 3.11)

72 CO_2 emissions based on system used in energy accounts. Differences in totals due to rounding.

The development of greenhouse gases shown in the table does not correspond to current information.

V.3.5. Results of sensitivity analysis

In the study a large number of parameters were varied in sensitivity analyses to assess their influence and impacts. This applies to energy service demand figures (e.g. transport demand), economic growth, energy price trends and coal policy.

The principal results of the sensitivity analysis are listed below:

- The forecast without additional measures assumes a trend to increased generation of electricity from natural gas. However, it appears that the optimisation model reacts very sensitively to relative price increases: even if the price path for natural gas is raised by only one percent, a marked trend to increased use of coal for electricity generation sets in. This is even more marked if the prices are raised by up to two percent. Compared with the original price variant, this switches about 50 TWh of electricity generation from gas to coal power plants, which is about 10 percent of total electricity production. The use of other types of power plant is virtually unaffected by this variation. The great sensitivity of electricity prices can also be seen if the discount rate is reduced from 5% to 4%. This makes the more capital-intensive coal power plants more attractive, because it enables electricity prices to be reduced below the level of natural gas power plants.
- Varying the energy-determining demand shows that transport demand plays a major role. A reduction in transport demand of 8 percent for passenger traffic and 3 percent in goods traffic, as stated by the DIW in an earlier sustainability scenario[73], produces a reduction in CO_2 emissions in the transport sector of about 9 percent (2020).
- In the forecasts with additional measures, the restrictions imposed on coal were relaxed compared with the forecast without additional measures. Using the same coal restrictions results in considerable limitations on the reduction potential in the conversion sector. As a result, other sectors have to make a much larger contribution to emission reductions. The TCS and Household sectors are particularly affected. In total, they would have to reduce CO_2 emissions by a further 25 percent by 2020 in order to achieve the reduction target set.
- In a further sensitivity analysis the rates of growth of gross value added were lowered for all branches of industry. This results in a drop of 0.2 percent in CO_2 emissions by the industrial sector (2020). The results make it clear that the overall effect is relatively small.

The sensitivity analyses make it clear that it is always important to consider the results of the forecasts only in the context of the framework assumptions and the

[73] Cf. Hopf, R.; Voigt, U.: Nachhaltige Verkehrsentwicklung erfordert verstärktes Handeln. DIW Wochenbericht No. 47/2002, p. 820 - 829. This paper includes a short version of a study commissioned from Hopf and Voigt by the Bundestag Office for the Assessment of Technology Consequences. The title of the study is: Hopf, R.; Voigt, U.: Instrumente und Maßnahmen zur Realisierung einer nachhaltigen Energieversorgung - Entwicklungspfade im Bereich Mobilität. Gutachten im Auftrag des Deutschen Bundestages, vorgelegt dem Büro für Technikfolgen-abschätzung beim Deutschen Bundestag. Berlin 2001

energy policy restrictions imposed. The analyses also show that in response to changes in the energy policy framework (e.g. the role of coal) it is sometimes necessary to alter the focus on the spectrum of measures to be taken. It can also be seen that the specified demand figures, and transport demand in particular, have a substantial impact on CO_2 emissions. In addition to the technical options available for CO_2 reduction, this must be taken into account when planning political measures.

VI. Vulnerability, impacts of climate change, and adaptation measures

VI.1. Expected impacts of climate change

VI.1.1. Preliminary remarks

Projections of regional impacts of climate change are difficult because:

- The scale, speed and in some cases direction of the climate changes – especially where rainfall is concerned – is still uncertain in many regions.
- The resolution of regional climate models is still very coarse.
- It is not clear whether the present regional climate variability will continue.
- The impacts of climate change are overlaid by other components of global change, such as substance inputs, land use changes and other factors.

Moreover the impacts may reinforce each other or cancel each other out. The model results are therefore subject to relatively large uncertainties with regard to their regional and seasonal distribution, and these have an influence on future climate impacts. Further research efforts are needed to narrow down these uncertainties, especially in the field of regional modelling of climate change and climate impacts. These uncertainties must also be seen as risks to sustainable development of our society. If risks due to future climate changes are to be minimised and opportunities that may arise from such changes are to be exploited, it will be necessary to take responsible risk management decisions even in the face of existing uncertainties.

VI.1.2. Agriculture

It is regarded as certain that the changes in the climate will have impacts on the many and various interactions in the agro-ecosystems and hence on locational factors and yields. These impacts will affect ecological interaction structures and above all the plants themselves. For example, a compilation of the impact and financial assessment of the crop failures due to the extremely hot and dry summer of 2003, which was commissioned by the reinsurance company Münchner Rückversicherung, identified losses of nearly EUR 300 million for wheat and EUR 166 million for barley. Apart from the risks to crops as a result of extreme weather events– such as floods, drought – and changes in the incidence of pests and diseases, there will in particular be changes in the suitability of individual locations for growing certain crops. Crop reactions to different aspects of future climate changes could overlap in various ways. For example, an increase in the duration of the vegetation period could result in desirable growth and improved maturity, but a simultaneous change in the spectrum of pathogens could counteract this effect if the plant itself is not sufficiently resistant. Increased growth may produce more biomass, but does not necessarily affect fruit formation to the same extent. Summer drought during the main growing period has the effect of reducing the yield of winter grain. However, climate change may also hold opportunities for farmers, since an increased supply of CO_2 can – given sufficient available soil water – offset temperature-induced reductions in wheat yields, for example. Thus projections for some parts of Germany might indicate improved yields, while in other regions there might be an increased risk of crop failures due to extreme weather events.

Changes in CO_2 concentration, temperature and the availability of water or minerals influence plant growth and can therefore result in changed interactions between weeds and crops. It is possible that certain plant diseases and weeds may move into areas where they are not to be found at present. However, the spread of pests and pathogens depends on how well the crops adapt to the new climatic conditions and how the farming community responds to them with its growing practices (e.g. crop rotation). Furthermore, the larvae and eggs of pests could survive milder winters better, thereby increasing the pressure of pest infestation.

One of the most important consequences of global warming is the northward spread of growing areas. Longer growth phases must be responded to with corresponding growing methods and selection of appropriate crops. Yields are expected to be more variable, which means greater yield risks. Individual regions – for example locations with sandy soils that are already dry – will be particularly badly affected by climate change. Here crop failures of up to 30 percent are expected.

In addition, indirect damage due to climate change could arise because ground cover is uneven, because conditions for erosion by wind and water are favourable, because nutrient uptake is affected during stress periods, or because a need for additional agricultural cultivation operations results in increasing soil compaction. If the harvest conditions are unfavourable – e.g. because the crop harvested contains too much moisture – further complications can occur in the downstream sector. It may be necessary to use additional energy for artificial drying of the crop before storage.

The farm animals found in Germany can perform equally well even under different climatic conditions. However, climate change still has an impact on livestock farming, because our high-performance animals depend on constant production of high-grade fodder.

VI.1.3. Forests

The results of the nationwide forestry condition survey in 2004 show that the condition of the crowns of forest trees has deteriorated considerably. The proportion of trees with marked thinning of the crown increased by 8 percentage points to 31 percent. The unusual weather conditions in 2003 and the associated delayed effects probably played a considerable role here. In 2003, forest ecosystems that were substantially weakened by long periods of acid and substance inputs from the atmosphere were hard hit by drought stress and high ozone levels. Extreme events of this kind give an indication of the sort of forest ecosystem behaviour that could also occur as a result of climate change.

As described in Chapter 11.4, a regional temperature increase of between 1.6 and 3.8°C is expected by 2080, with a change in seasonal rainfall distribution to the disadvantage of the vegetation period. For forest structure and the species composition of forests, changes in water availability (which is more difficult to project) are more significant than temperature changes. Forest development scenarios are subject to great uncertainties, especially because when assessing the consequences of changed climatic conditions on forest ecosystems it is important to know what supply region the trees at a particular location lie in and whether the changes take place close to the optimum of a locational factor or in a critical range. For the beech tree, assuming a temperature rise of 1.5 to 2°C and no change in precipitation, one can expect its area of natural occurrence to shrink from the northeast, resulting in a limitation of its occurrence to coastal areas and the central uplands. By contrast, it is assumed that the same temperature rise in Bavaria would not exceed the heat tolerance of this tree species in many areas. In cool mountain areas one could even expect favourable effects on the growth of the beech.

Spruce reacts very sharply to changes in temperature in the growing season and only tolerates a range of about 5 to 8°C in the mean annual temperature. In many regions of central Europe with spruce stands, the range is already around 7.0 to 7.5°C. Here even a slight increase in temperature would take the spruce to the upper limit of its temperature tolerance.

On the other hand forest communities of tree species that like warmth and are tolerant of dry conditions, such as oak, small-leaved lime and hornbeam and also pine, can be expected to spread westwards. The latest findings indicate that the pine displays extreme ecological resistance to heat and drought.

Nevertheless, even for parts of Brandenburg in which the water situation is already difficult today, a transition to a Mediterranean water balance regime and resulting forest communities is ruled out in the next 50 years.

Under present-day climatic conditions, Germany is almost entirely potential forest country. Forests only reach their limits in high mountain areas because of the cold, in marshy areas because of the wet, in the poorest sandy soils for trophic reasons, and on rocky and dune sites because of lack of water. In view of the existing low rainfall with annual precipitation figures of around 500 mm, the lowlands of East Brandenburg, the dry region of central Germany (rain shadow of the Harz mountains), the Thuringian basin, the Keuper region of the Franconian Main, and the rift valley of the Upper Rhine are boundary areas for the successful growth of continuous forest. In these areas, given climate warming and reduced rainfall and/or seasonal redistribution with reduced summer rainfall, one can expect to see a breaking up of continuous forest structures, a decline in net primary production, a drastic reduction in the formation of new groundwater, and serous changes in species diversity.

In the German lowland and hill country, and also in the lower mountain regions, more frequent drought stress will probably favour lower-yield tree species such as oak and pine at the expense of the high-yield species such as spruce and beech. The risk of forest fires will increase. Warming in regions with stronger Atlantic influence and in mountain areas with sufficient rainfall could rest in an increase in net primary forest production. Improved growth conditions (increased supply of heat/radiation, adequate precipitation, higher CO_2 content of the air) could result in an upward shift in the altitude limits of the tree species in the mountains. The spectrum of tree species in mixed mountain forests will probably remain unchanged, but there could be a change in composition, with an increase in the proportion of beech and a decrease in the proportion of pine.

It is not possible to predict the impact of extreme windstorm events. In recent decades these have affected widely differing parts of Germany and have destroyed even apparently stable and near-natural forest ecosystems. Spruce stands on periodically wet sites are particularly at risk of storm damage and also susceptible to drought, and should therefore be converted as soon as possible. The protective function of forests, especially the protection they provide against avalanches, detritus falls and water erosion in mountain areas, is not seen to be at risk, assuming that such regions do not suffer devastating storm damage and are only subject to low levels of pollution that can be absorbed by the ecosystem. In all regions of Germany, changes can be expected in biological diversity and in the spectrum of harmful organisms.

VI.1.4. Biological diversity

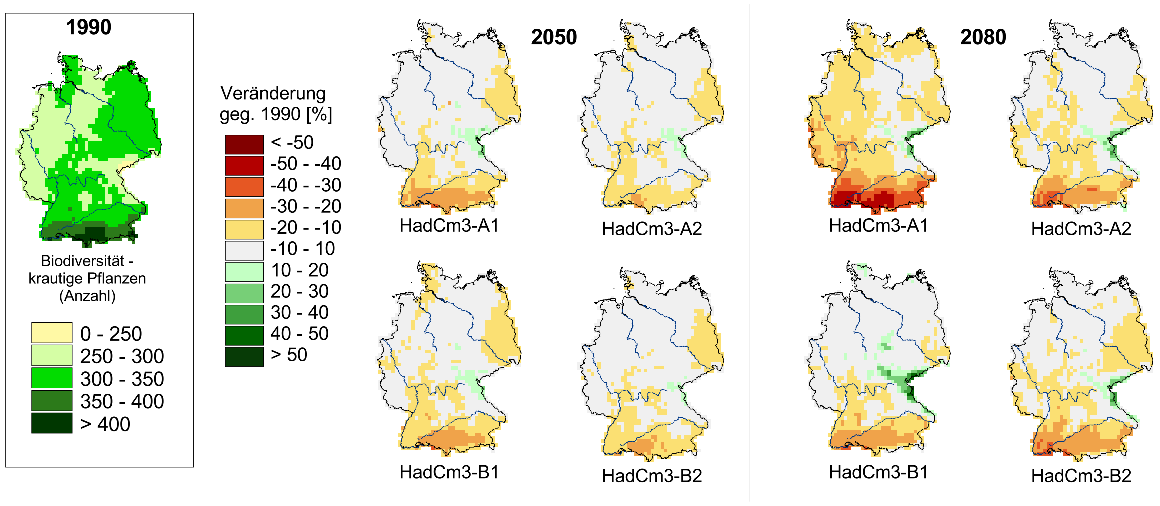
Numerous studies have found evidence that climate changes already observed are influencing species and ecosystems in Germany. Among other things, this influence can be seen in the seasonal patterns of the life processes of animals and plants, especially in the spring (e.g. extension of growing season, shift in life cycle of insects), in the behaviour of animals (e.g. changes in overwintering and migration habits of birds and bats), and in the reproduction rate and survival expectancy of species (e.g. occurrence of a second generation per year for certain insect species, lower winter mortality of non-migratory birds). Regarding the distribution of species, a clear trend can be observed towards a northward and eastward spread of species with higher temperature requirements. In the central uplands and high mountain areas, community boundaries have been observed to shift some 50 – 100 m upwards. In a few cases evidence has also been found of a decline in the frequency and distribution of species adapted to cold conditions.

A significant proportion of the flora and fauna native to Germany can be expected to undergo marked changes in frequency and distribution in the coming decades, which will also result in many species dying out. At the same time there is an increasing probability that hitherto non-native species will spread due to natural immigration or human activity. The potential of imported species (for example in parks and gardens) to spread autonomously may increase. In the course of these changes one can also expect a loss of genetic diversity in the declining species and a restructuring of ecosystems and the formation of new biocenoses. One important uncertainty factor is the ability of species to reach suitable new geographic areas. In view of the speed of climate change, this capacity to spread could become a limiting factor for their occurrence.

The model calculations performed as part of the joint international project ATEAM show that a decline in biological diversity can be expected in Europe under all the scenarios used. For up to 5 percent of all plant species there might no longer be any suitable habitats by the year 2050. On the (pessimistic) assumption that they do not spread into new habitats, an average of up to 50 percent of species in south and east Germany could be lost by 2080.[74]

For the herbaceous plant group the number of species in Germany will, depending on the emission scenario, decline by an average of 4-14 percent by 2080 (Fig. VI - 1). On this basis, the decline in the Alpine region and southwest Germany is particularly marked, with a drop of up to 36 percent.

Fig. VI - 1 *Relative change in the number of species of herbaceous plants compared with 1990. The data is based on 1350 selected herbaceous plants of European distribution*



Source: Cramer, W.; et al. (2005) Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

All in all, in view of the great fragmentation of the countryside and the large proportion of species already endangered, it is probable that between 5 and 30 percent of all plant and animal species in Germany will be lost in the coming decades as a result of climate change.

In addition to the direct impacts, indirect impacts due to climate protection or adaptation measures in other sectors are of great importance. Examples include the growing of new crops, other types of farming and land use shifts, forest conversion, changed leisure habits (winter sports activities), flood control and coastal protection measures, cultivation of energy crops for biomass utilisation, the use of energy from wind and water, and afforestation projects. Depending on how such changes are designed and implemented, they may have positive and/or negative consequences for nature conservation. To date such issues have hardly been considered in projections.

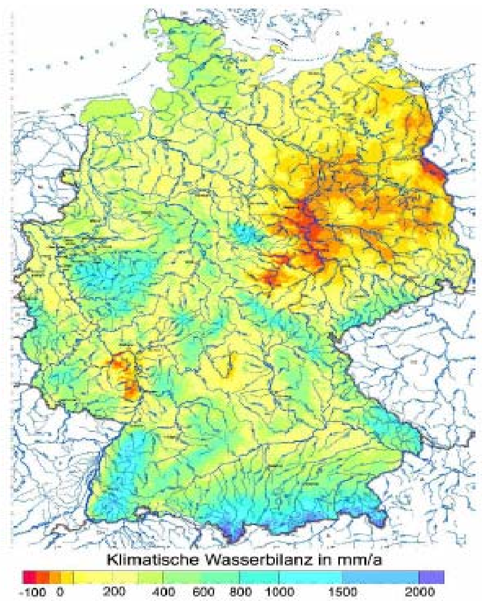
VI.1.5. Water resources

The available water resources depend to a large extent on the climatic water balance (difference between precipitation and potential evaporation). Whereas in the Alpine region and the central uplands considerably more water falls than evaporates

[74] Schröter et al. (2004): ATEAM Final Report 2004. Section 5 and 6. - PIK Potsdam.

(positive climatic water balance), the climatic water balance in large parts of eastern Germany is negative (Fig. VI - 2). In the summer months there is a negative balance in large areas of Germany. These areas potentially have low available water resources and are therefore more at risk from drought and dryness than other areas. The hot, dry years in the 1990s, and above all 2003, showed that Germany can be affected by low water and drought. Among other things, this resulted in restrictions on inland waterway traffic and on the operating times of thermal, hydroelectric and nuclear power plants. According to estimates by Münchner Rückversicherung, total losses – including forest fires and agricultural losses – came to more than EUR 1.2 billion[75]. However, drinking water supplies were not threatened in 2003[76].

Fig. VI - 2 Climatic water balance in Germany



In view of the expected future shift of precipitation from summer to winter and the general increase in evaporation as a result of higher temperatures, climate change is expected have an impact on water resources. In particular, hydrological components such as evaporation, seepage water, groundwater, river flow rates and the water level in surface waters will be affected by these changes.

In Brandenburg future higher temperatures will bring a slight increase in evaporation in the spring. At the same time decreasing precipitation will cause a reduction in the available soil water in the summer. For this reason, summer evaporation will show a marked decrease in spite of climate warming.[77] The decrease in seepage water

75 Eisenreich, S.J. (2005): Climate and the European water dimension. Joint Research Center - European Commission, Ispra.

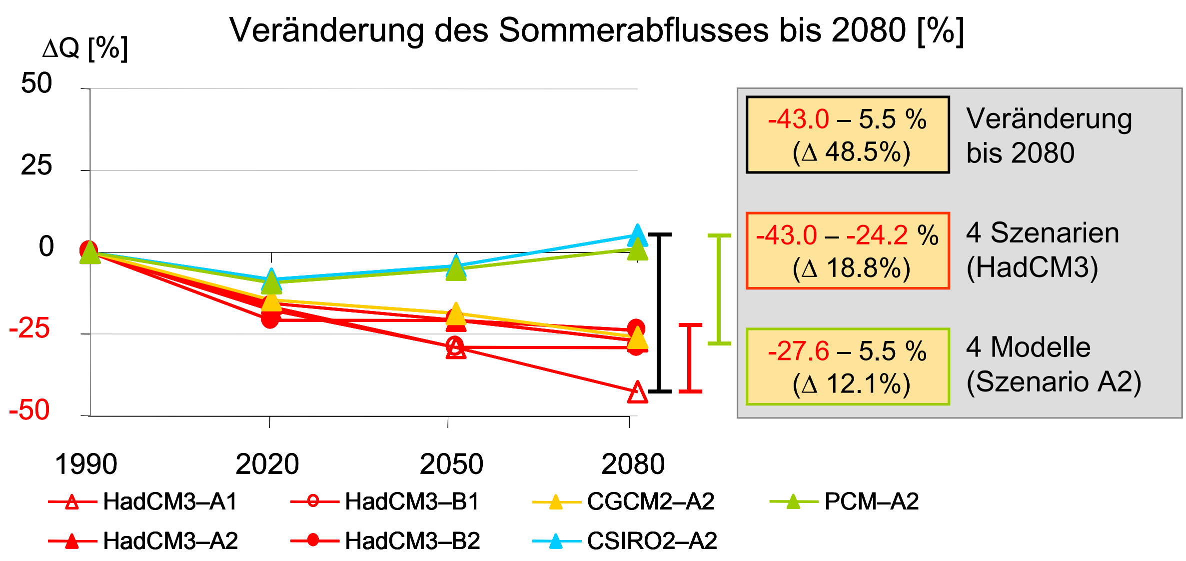
76 Demuth, N. (2004): Niedrigwasser und Dürre – Eine Europäische Perspektive; Kurzbericht des Sekretariats für IHP (International Hydrological Programme of UNESCO) und HWRP (Hydrology and Water Resources Programme of WMO). BAfG, Koblenz.

77 Bronstert, A.; Lahmer, W.; Krysanowa. V. (2003): Klimaänderung in Brandenburg und Folgen für den Wasserhaushalt. Naturschutz und Landschaftspflege in Brandenburg 12 (3): 72-79. Gerstengarbe, F.-W.; Badeck, F.; Hattermann, F.; Krysanova, V.; Lahmer, W.; Lasch, P.; Stock, M.; Suckow, F.; Wechsung, P.; Werner, P. C. (2003): Studie zur klimatischen Entwicklung im Land Brandenburg bis 2055 und deren Auswirkungen auf den Wasserhaushalt, die Forst- und

quantities that can already be observed today is expected to spread to the whole of Brandenburg. In 2055 this would amount to a reduction of about 57 percent in the annual mean, compared with the situation today. As a consequence, groundwater levels may drop, thereby impairing land ecosystems that depend on groundwater, e.g. lowland bog, alder fen forests. In addition there may be regional problems with rising salt-rich deep groundwater. Initial information on the quantitative status of the groundwater in Germany is supplied by the inventory under the EC Water Framework Directive. This considered it probable that 95 percent of the groundwater bodies in Germany could achieve a good quantitative status by 2015. In the event of regional over-utilisation, e.g. aquifers in coastal areas, it is possible that salt-rich deep groundwater may rise and impair the groundwater quality.

If one merely considers the impacts of climate change on runoff (decrease in seepage water quantities, seasonal shift of precipitation, increased evapotranspiration), there is a slight reduction in annual runoff in the north and northeast, and a slight increase in the south. The differences in summer runoff are greater. During the summer there will be much less water available than at present. Between 1990 and 2080 the runoff in summer – depending on the climate model used and the emission scenario considered (Fig. VI - 3) – will show a decrease of up to 43 percent.[78] Rivers with a markedly Alpine runoff regime will also be affected by other components, such as accelerated melting of glaciers or permafrost soils and changes in the stability and thickness of snow cover.

Fig. VI - 3 *Changes in summer runoff in Germany up to 2080 compared with 1990, calculated with four different climate models and four different emission scenarios*



Source: Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

Landwirtschaft sowie die Ableitung erster Perspektiven. Potsdam Institut für Klimafolgenforschung (PIK) PIK Report No. 83; 78 pp.

78 Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

In surface waters, low water levels can result in impairment of water quality and of aquatic biocenoses, as this raises nutrient and pollutant concentrations and reduces the solubility of oxygen due to increased temperatures. Low water levels can exacerbate conflicts between uses and cause economic and social problems. Examples include restrictions on inland waterway traffic especially at low water, restricted use of water for cooling purposes because the water returned to the river is too warm or the quantity is much reduced (excessive evaporation losses in the cooling process), losses in the generation of hydro power and – in extreme cases during lengthy dry periods – problems with the security of drinking water supplies.

In the past, extreme rainfall events have repeatedly led to flood disasters involving great damage (Rhine 1993/1994, 1995, Oder 1997 and Danube and Elbe 2002). The Elbe floods alone claimed 20 lives and caused damage totalling more than EUR 9 billion.[79] One of the possible causes discussed for the increasing incidence of flooding is the demonstrable increase in the frequency of heavy rainfall events in the winter.[80] In addition to climate influences, other factors that play an important role in the risk of flooding are reduced retention due to straightening of watercourses, the construction of weirs, the loss of water meadows and wetlands, and increased surface sealing. Future climate changes are expected have an impact on flooding as a result of changes in rainfall characteristics.[81] Especially in the winter and spring months, there is therefore expected to be an increased risk of flooding in most river basin areas.[82] On the other hand some peak runoff situations could be eased by lack of meltwater resulting from reduced accumulation of snow.[83]

VI.1.6. Transport and tourism

Snow, ice, fog, hail and storms are major factors that impede road and rail transport and air traffic. For example, such weather conditions make it necessary to reduce speed; they also give rise to jams and delays and an increase in the accident rate. Frost also causes damage to roads and bridges. Higher temperatures in the winter therefore bring benefits in that they reduce the risk of accidents due to snow and ice, which means there are fewer cases of loss or damage or personal injury. Heavy rainfall can cause traffic problems as a result of poor visibility and wet road surfaces. Landslides and undercutting result in destabilisation and destruction of route sections. Trees blown down by windstorms can cause obstacles and damage roads, railway tracks and power lines. By contrast, summer heatwaves have in a negative impact on the accident statistics. Drivers tire more quickly at higher temperatures and their concentration falls off. The infrastructure also suffers from prolonged heat. High surface temperatures on asphalt can soften the road surface, resulting in tyre ruts and long-term damage. Rail traffic is impeded by forest fires and especially by grass fires.

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[79] Federal Institute of Hydrology (2002): Das Augusthochwasser 2002 im Elbegebiet. BFG, Koblenz.

[80] Grieser, J. & Beck, C. (2002): Klimatrends in Deutschland. In: Klimastatusbericht 2002 (Ed. DWD – Deutscher Wetterdienst). DWD (German Weather Service), Offenbach. Schönwiese, C.-D. (2005): Wahrscheinlichkeiten für das Eintreten von klimatologischen Extremereignissen - UBA Bericht FKZ 201 41 254, Berlin.

[81] Bronstert, A. (1996): River flooding in Germany: influenced by climate change? Phys. Chem. Earth, 20, 445-450.

[82] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

[83] Eisenreich, S.J. (2005): Climate and the European water dimension. Joint Research Center - European Commission, Ispra.

Impacts on inland waterway traffic can also be observed. Heavy rainfall and prolonged rainy or dry periods influence river water levels. Here the Rhine, Elbe, Main and Danube are particularly important. Even today, the water levels in German rivers display great variations. The variations could increase still further as the climate changes. During dry periods the water levels fall below a critical point that makes it impossible to guarantee the necessary draft for the barges. Flooding also imposes restrictions on the navigability of watercourses. Canals and regulated rivers are less affected, because their water levels are maintained at a navigable level. But this is only true within certain critical limits If these are exceeded in either direction, the infrastructure is at risk here too. Seaports and coastal shipping may be affected by the rise in sea level. Moreover, there is reason to expect that traffic flows will change in response to shifts in agricultural growing areas and changes in leisure and holiday habits due to climate change. This could have both positive and negative impacts.

The milder winters expected in the future will have measurable impacts on the important winter sports segment, for example: in the Alpine region it is thought likely that if winter temperatures rise by 2°C by the year 2050, only skiing regions above about 1500 m will be able to rely on the necessary snowfall. As a consequence of the reduced reliability of snow at lower levels, tourists can be expected to switch to resorts at higher altitudes. Since the German Alps have a shortage of skiing regions that include altitudes of 2000m or more, winter sports enthusiasts can be expected to head for other Alpine countries. Owing to their low altitude, the skiing districts in the central uplands of Germany are particularly affected by climate change. For example, winter sports conditions in the Fichtelgebirge have deteriorated considerably since 1960. During the period 1972 – 2002, there was a significant drop in the number of days of snowfall at 13 out of 14 destinations examined. By the middle of this century, assuming a regional increase in winter temperatures of 0.4°C per decade, winter sports might only be possible in a maximum of two out of six skiing districts studied (Fig. VI - 4). As early as 2025 the conditions for winter sports in the Fichtelgebirge region will show a clear negative trend of this kind. In these circumstances, economic skiing operations would seem to be extremely improbable after 2025.[84] Studies for other regions come to similar conclusions.[85]

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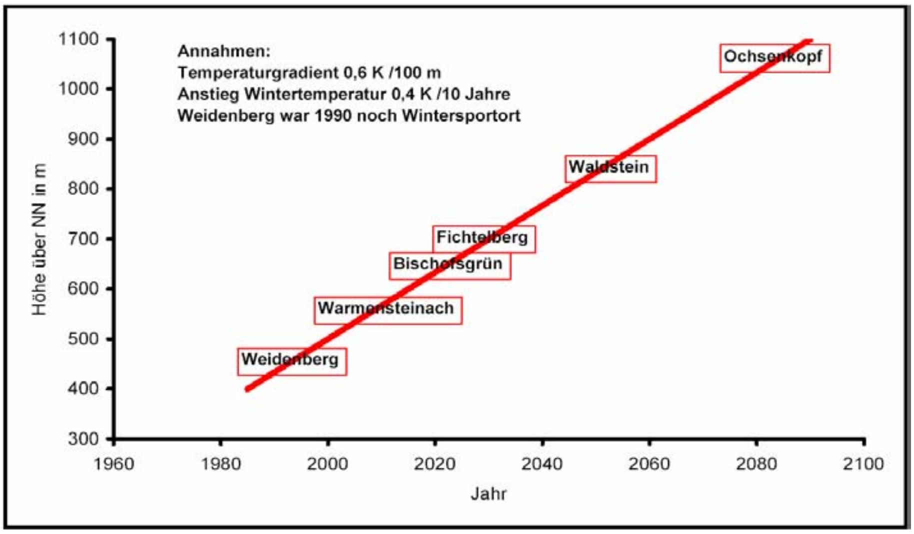
[84] Seifert, W. (2004): Klimaänderung und (Winter-)Tourismus im Fichtelgebirge – Auswirkungen, Wahrnehmung und Ansatzpunkte zukünftiger touristischer Entwicklung, Diplomarbeit. University of Bayreuth.

[85] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

Fig. VI - 4 Lower limit for winter sports in Fichtelgebirge region



Source: Seifert, W. (2004): Klimaänderung und (Winter-)Tourismus im Fichtelgebirge – Auswirkungen, Wahrnehmung und Ansatzpunkte zukünftiger touristischer Entwicklung, Diplomarbeit. University of Bayreuth.

Many Germans spend their summer holidays in the Mediterranean countries. In fact the total stream of holidaymakers from central and northern Europe to southern Europe, with around 116 million arrivals, is the biggest tourist migration worldwide, and accounts for 41 percent of internal tourism within Europe. Since there is an increasing probability that southern Europe will experience daily maximum air temperatures of 40°C or more during the high season, travellers can expected to suffer increased heat stress, which can have unfavourable effects on the well-being of older persons and children. In Germany, by contrast, rising temperatures and less rainfall in the summer could tend to favour tourism, for example because of an increase in the length of the summer season. Even in Germany, however, summer temperatures could also rise – at least in individual years – to levels that were not conducive to certain forms of active holidays. This was the case in the heatwave summer of 2003 in particular. In Baden-Württemberg considerably fewer visitors to museums and leisure parks were reported in that summer, whereas outdoor swimming baths and beer gardens did particularly well[86].

VI.1.7. Health

Climate changes and their direct and indirect consequences also have an impact on human health. Direct results of climate change with immediate consequences for humans include injuries caused by extremes of temperature and weather-induced disasters, such as storms, floods, avalanches or landslides. The influence of heatwaves on mortality is revealed by a study on 2003 from Baden-Württemberg. Here there were about 2000 additional deaths, as many as 900-1300 of them in August 2003 alone. There are no figures for Germany as a whole. Projections indicate the likelihood of at least 7000 additional deaths. It is assumed that the mortality rate in Germany in the summer of 2003 would have been considerably higher if the relative humidity had been higher.

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[86] Cramer, W. et al (2005): Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klima-sensitiver Systeme, OBA Bericht FKZ 201 41 253, Berlin.

Higher temperatures in the winter, on the other hand, can reduce health risks due to hypothermia and respiratory and cardiovascular disease, though it must be remembered that such health risks are closely connected with socio-economic factors such as poor living conditions.

Examples of health consequences of storms, heavy rainfall and flooding include injury and even death. Secondary consequences may include health problems due to mould growth in houses affected by flooding, and stress, anxiety or depression resulting from the destruction of essential infrastructure and individual property.

Indirect health impacts may arise from unfavourable changes in environmental conditions as a result of climate change. They include, for example, adverse changes in the quality and quantity of drinking water and food, changes – possibly increases – in the incidence of airborne allergens due to different or longer pollen periods, increased formation of secondary pollutants such as ozone in response to greater insolation, and changes in the ecosystems that people need for recreation purposes.

Another possible indirect consequence is increased eutrophication of waters, leading to health problems due to toxic substances produced by blue-green algae (cyanobacteria). Such contamination of the water may affect its use for drinking water purposes, increase treatment costs and restrict its use for recreation purposes. Contact with contaminated water – especially swallowing it – can also result in illness. In the heatwave summer of 2003 numerous bathing beaches on the North Sea and Baltic coasts were closed as a result of the increase in algal blooms. In recent years, moreover, one cyanobacterium species hitherto classified as tropical and subtropical (Cylindrospermopsis raciborskii) has been clearly observed to be invading temperate climate zones. This species may contain a toxin that primarily occurs dissolved in water and cannot be eliminated by filtration processes. It therefore represent a different risk to drinking water supplies than the cyanobacterial toxins hitherto encountered in Germany, which are linked to the cyanobacterium cells.

Climate changes may also lead to changes in the distribution, population and infection potential of disease transmitters (vectors) such as bloodsucking insects, ticks or rodents. The cause-and-effect relationships between the diseases transmitted by such vectors and climate change are still not entirely clear. However, increasing temperatures bring an improvement in the conditions for their spread and transmission, so the risk can be expected to increase. An analysis of the present situation has shown that many non-native heat-loving vectors have already been accidentally introduced into Germany. There are however also other factors, such as the international trade in animals and the growth in goods and passenger transport, that result in an increased risk of accidental importation of vectors[87].

[87] Maier, W.A.; Grunewald, J.; Habedank, B.; Hartelt, K.; Kampen, H.; Kimmig, P.; Naucke, T.; Oehme, R.; Vollmer, A.; Schöler, A.; Schmitt,C. (2002): Mögliche Auswirkungen von Klimaveränderungen auf die Ausbreitung von primär humanmedizinisch relevanten Krankheitserregern über tierische Vektoren sowie auf die wichtigen Humanparasiten in Deutschland, UBA Bericht FKZ 200 61 218/11, Berlin.

VI.1.8. Coastal regions

The consequences of climate change and of a faster rise in sea level have been investigated above all in the interdisciplinary joint projects “Climate change and Lower Weser region” (KLIMU) and “Climate change and preventive risk and coastal protection management on the German North Sea coast” (KRIM). These assessed the sensitivity of nature and society to such changes by restricting and/or developing various functions of the natural region. They found that several functions of the coastal region investigated will suffer a slight to strong negative impact as a result of climate change. Temperature increases slightly restrict the function of rivers in coastal regions as a cooling water reservoir for power plants and industrial operations and as receiving streams (decreasing oxygen concentration). The reductions in oxygen concentrations as a result of intensified metabolism slightly affect the quality of the water in these rivers. Where foreland areas used for farming are not enclosed by summer dykes, the yield potential of such land will be severely limited by the rising sea level. For example, about half of such land currently farmed in the Weser estuary region will have to be abandoned. Furthermore the rise in sea level will increase the probability of dyke failures, resulting in severe impairment of long-term prospects in the areas affected; this can ultimately lead to major limitations on the quality of life in coastal regions due to the loss of “a secure place to live”.

The change in climate can also have slight positive impacts on coastal regions. For example, there could be slight improvements in the usability of rivers in coastal regions as navigable waterways, though here the usable depth of water depends more on political decisions than on natural changes. There could also be slight improvements in the agricultural yield potential of inland areas; this would however be accompanied by a simultaneous increase in expenditure on water management measures (increased energy for pumps). The proportion of near-natural habitats in the foreland would increase owing to the forced abandonment of agricultural use in the face of rising sea levels. Tourism in coastal regions will also be slightly favoured by longer periods of sunshine and rising water temperatures. Improved wind availability offers opportunities for the use of wind energy.

In summary, the ecological and economic consequences of climate change and rising sea levels are on the whole regarded as relatively slight. The principal need for action is in the field of coastal protection. If no appropriate measures are taken to adjust to the new situation, the change in climate will result in a marked increase in the risks to the coastal population.

VI.2. Adjusting to climate change

In order to minimise future risks due to climate change and seize any opportunities it offers, it is necessary to take measures to adjust to climate change. It therefore makes sense to step up the debate in society about climate change, uncertainties and regional consequences. It is important to raise awareness of changing natural limiting conditions and to implement the precautionary approach on a widespread basis. Regional sensitivity is also influenced by measures such as the development of waterways, land use changes etc., which are not at first sight keyed to adjusting to climate change. In future, therefore, regional planning should also examine all measures to determine whether they increase or decrease the capacity to adjust to climate change. For example, instruments of regional planning, coastal protection and water resources management must maintain and develop the capacity to adjust. Changes in social and economic structures must be so designed that climate change adjustment measures form an integral part of them (mainstreaming). The further development of economic strength provides society with a basis for a strong capacity to adjust.

VI.2.1. Agriculture

A well developed long-term precautionary approach is a characteristic of an agricultural sector geared to adjustment to possible climate changes. This applies in particular to plant breeding and crop growing measures that are designed to implement sustainability strategies. Site-appropriate soil conservation and measures such as changes in sowing dates, appropriate choice of crop species and design of crop rotation, including the growing of catch crops, bring further improvements in the adjustment process. In view of the large number of varieties available, crop growers will be able to adjust to climate change quickly and at low cost by switching to appropriate varieties, especially in the case of annual plants. In order to be better prepared for prolonged dry periods, it will be necessary to adjust the composition of the vegetation on permanent grassland to include more drought-resistant grass varieties. In the livestock sector too, the process of adjustment to climate change can be expected to be largely trouble-free in view of the ongoing breeding work on the breeds currently in use. Breeding organisations constantly adjust their species-specific and breed-specific breeding programmes to take account of changing framework conditions (environment, consumer wishes), and in parallel with this they also maintain the content and focus of their performance testing and breeding-value appraisals in line with the latest requirements. A survey of experts revealed that growing of adapted varieties was already considered to have been partially implemented. Reasons stated for this development included the variability of weather and soil conditions, and also increasing drought stress. Cultivation of new crops is currently under discussion. Implementation shows marked regional variations, and has already partly taken place in Brandenburg and Saxony. Appropriate irrigation methods are on average considered to be partly introduced, with a large measure of implementation in the east of Germany, which is already affected by dry conditions. New growing methods designed to conserve the soil and save water are generally regarded as partly introduced. Reasons stated apart from adaptation to climate change were cost savings, erosion reduction, soil conservation, water savings and safeguarding yield stability. Although risk-spanning measures such as insurance and financial reserves in the agricultural sector are highly effective, both measures have yet to move beyond the discussion stage. Insurance solutions (hailstorm policies) are already common practice in all the *Laender*, but this is not true of the creation of financial reserves.[88]

In addition to new growing technologies, plant varieties and animal breeds, one can also expect to see changes in price structures and hence in consumer habits. Here the demand side should be stimulated by means such as education measures and campaigns to promote sustainable consumer behaviour.

There are a large number of assistance programmes and legal provisions in Germany that can be used to promote the implementation of adaptation measures:

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[88] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

Assistance programmes

- Common Agricultural Policy (CAP): extensive forms of land use are promoted by decoupling direct payments. Furthermore the agro-environmental measures, which will be expanded in the context of increased modulation, result in a form of agricultural production that is particularly environmentally friendly.
- Federal Organic Farming Programme: this assistance programme is intended to improve the framework conditions for organic farming.
- Programme for promoting renewable raw materials: further expansion of the use of renewable raw materials for energy purposes and hence replacement of fossil fuels.

Laws

- Federal Soil Protection Act, Federal Nature Conservation Act and Direct Payment Obligations Act: Ban on ploughing of grassland in certain places (organic soils), maintenance of permanent grassland at regional level (*Laender*) according to a multi-tier procedure.

VI.2.2. Forests

The longevity of forests presupposes a certain balance in environmental conditions. If the speed of climate change is moderate and the climate stabilises at a new level, adjustment measures hold promise of success, but rapid and persistent change can cause problems. In addition to preserving forests as a form of vegetation, adjustment measures are concerned with safeguarding the function of forests as an important element of land use. Adaptation of near-natural forests requires the presence of tree species adapted to future conditions. It takes place over very long periods through shifts in the proportions of the tree species while the forest community basically continues to exist. Replacement of increasingly unstable non-natural coniferous stocks by means of ecological forest conversion is possible over reasonable periods. Between 1998 and 2004 the Federal Government provided assistance for work on implementing future-oriented forest management in five model regions of Germany under the programme “Research for the environment”. This showed among other things that it is possible to stabilise the climate system by using forest conversion measures to increase net storage of carbon, and to considerably improve the water balance of the countryside in large areas of the north German plain by using different tree species. The success of forest conversion measures will depend critically on knowledge about the adaptability of the source material and its availability during forest renewal. The federal and regional authorities provide financial assistance for forest conversion as part of the “Joint Task of Improving Agricultural Structures and Coastal Protection”.

In the short and medium term, ecological stabilisation of the great majority of forest areas can be achieved by means of various measures: further reductions in substance inputs, with cautious compensatory fertilising in individual cases, resource-oriented control of horizontal and vertical stand structure and stand density having regard to local site differences, effective monitoring and control measures in relation to harmful organisms and forest fires, game densities appropriate to natural grazing conditions and habitats, and economically justifiable utilisation strategies designed to conserve stands and soils.

The knowledge and information necessary for this purpose is being generated in the network of permanent environmental control observation areas in forests under Forest Focus (Regulation of the European Parliament and of the Council on the monitoring of forests and environmental interactions in the Community) and through the forest inventories (federal forest inventory, soil condition survey, forest status survey). This research work includes scientific further development with the aim of adapting existing regulations and requirements to changed environmental conditions.

VI.2.3. Biological diversity

One aspect of special importance is the conservation and improvement of opportunities for species migration. The establishment of the biotope network system on 10 percent of Germany's land area, which was laid down by the Federal Nature Conservation Act in 2002 and is currently under development, can also improve the opportunities for species migration. In addition to its own national biotope network, Germany supports international initiatives for linking habitats, such as safeguarding the European Green Belt. The reduction of land appropriation for settlement and transport to 30 ha per day which is targeted by the German sustainability strategy also makes an important contribution to preserving the remaining propagation opportunities and migration corridors.

The protective strategies of nature conservation, which is largely focused on small-scale protected areas, do not take into account the fact that target species will migrate in response to climate change. Flexible protected area boundaries that migrate with the occurrence of a target species could be a solution. However, an expert survey shows that this option is not being discussed in Germany, since there is currently a legal obligation to define the boundaries of protected areas.[89] Especially for the wetlands particularly threatened by climate change, possible options are re-waterlogging measures or impounding concepts tailored to the interests of nature conservation. Experts consider that suitable water resources management concepts have been partially to completely implemented. This means that water resources management concepts, unlike other adaptation measures investigated, display the greatest measure of implementation in the context of nature conservation. Existing nature conservation concepts must however be supplemented by concepts geared to protecting the processes of natural systems. These processes, such as migration, succession, natural rejuvenation or fires are important for adaptation to climate change in particular. Process protection is regarded by experts as an effective measure that permits not only changes in species and biotope diversity, but also changes in the landscape balance. The respondents regarded this measure as partially implemented.

In order to improve cooperation and the flow of information between experts in the fields of climate protection and nature conservation and between academic, political and practical circles, the Federal Agency for Nature Conservation has initiated a dialogue process on the basis of expert meetings. A review and adjustment of nature conservation strategies against the background of regional climate forecasts is already taking place at working level in individual cases (e.g. adapting measure planning in the Spreewald major nature conservation project to the projection on the future development of the water balance).

[89] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

In addition, the basis of information for nature conservation must be further improved through systematic analysis of existing data on sizeable species groups and species of special nature conservation importance, as must long-term monitoring of climate-induced changes.

VI.2.4. Water resources

Measures to adapt the management of water resources to future changes in climate should take into account not only extreme events such as flooding and low water, but also the need for a steady balance ensuring the availability of water in appropriate quality and quantity.

Flood control should in future take account of possible increases in frequency and probable increases in discharge volumes. For example, Baden-Württemberg and Bavaria – following studies in the Neckar catchment area which revealed for 2050 an increase of around 40 to 50 percent in small and medium flood discharges and of around 15 percent in "hundred-year" floods – introduced a "climate change factor" which is to be taken into account in any new plans for flood control measures. For a discharge HQ_{100} this additional allowance is 15 percent, resulting in a figure of $HQ_{100+\text{"climate"}}$ for the crest of the discharge.

Basically, appropriate flood precautions should ensure adequate retention of floodwater on suitable areas and give preference to a precautionary approach to land designation that restricts building and other uses on flood plains, encourages a preventive line in building and other aspects of human behaviour, and takes in disaster prevention and technical flood control. In a survey of experts, most of the flood control measures were regarded as already partially introduced, though preventive building was still at the planning stage and technical flood control was almost completely implemented[90]. There are however great differences in implementation between the individual *Laender*. These are partly due to regional differences in the flood risk. Moreover, there is a need for further implementation of the flood prevention measures already discussed – including the Flood Control Articles Act which entered into force in May 2005. These include improvements in short-term forecasts of high and low water, the designation of flood areas, and implementation of hydraulic engineering and maintenance measures in a manner that has a neutral impact on flooding and takes account of environmental criteria.

Dyke retrenchment measures, restoration of flood-plain forests and re-connection of old river arms are regarded by experts as effective flood control measures for rivers. These measures are regarded as partially implemented. Restrictions on use in flood areas, such as restrictions on new building and on handling substances dangerous to water – e.g. non-use of oil-fired heating systems – are already regulated by law.

Low water and dryness require not only sustainable land-use management that safeguards the residence time of the water in the countryside, but also appropriate infrastructural precautions, such as adequate water stocks in reservoirs or facilities for making sufficient water available in the areas affected by means of long-distance water pipelines. The public must be made familiar with sensible water saving

[90] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

measures. Agriculture and forestry should prepare for possible water shortages by using crops adapted to drought stress and modern water-saving irrigation systems. Industry should exhaust all possibilities of water-saving production and – where possible – reduce power plant capacities and use modern cooling technologies to reduce water requirements. Experts estimate that such water-saving measures are already partially introduced. Catering for weather-related risks such as flooding or drought-induced crop failures by means of insurance ("weather derivatives") and establishing reserves for loss compensation payments are meaningful adjustment measures.[91] Insurance for flood damage is already possible. The insurance industry assesses the risk of damage to a building on the basis of a zoning system that takes into account not only the flood risk itself, but also the risk of torrential rainfall and backwater build-up. To date, however, there has been little demand for such damage policies.[92] Nevertheless, since insurance for flood damage is a significant factor in the context of individual flood control precautions by the public, the possibility of introducing compulsory insurance for damage due to the elements, such as flooding, hail and windstorms, has already been discussed – most recently in the wake of the Elbe floods in August 2002.

VI.2.5. Transport and tourism

To date there has been little research into the infrastructure and transport sectors. This is particularly true of changes in traffic streams. Knowledge about adaptation measures is therefore limited. A survey of regional transport experts on the subject of climate change revealed little awareness of adaptation measures. Possible examples here might be protection of road and railway routes against extreme events, in the inland waterway sector technical safeguards for and control of water levels, switching waterway goods to the railway, and risk-spanning measures such as insurance and the creation of reserves. These options were regarded by the experts as effective, but they are not currently the subject of discussion in the sector. This can be taken as an indication that little attention has so far been paid to the topic of adapting to climate change, and that little progress has been made with adaptation in the transport sector in Germany.[93]

One measure that the tourist industry employs to counteract the lack of reliable snowfall is artificial snow. However, the production of artificial snow is only economic at temperatures below –4°C. In the context of climate change, therefore, artificial snow in German ski regions will only be economic on a short to medium-term basis and only at higher altitudes. In view of the high capital cost, the equipment is only economic for much frequented slopes and where large transport capacity exists. In many German ski regions these requirements are not met. Since the high energy input for such equipment conflicts with climate protection considerations in particular, and since the thin snow cover has adverse effects on vegetation and soil due to compaction of the soil, tourism operations should give preference to other adaptation measures. For example, the range of products should replace or supplement winter sports offerings with new offerings such as walking or cultural holidays. To permit

[91] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

[92] Schwarze, R.; Wagner, G. (2202): Hochwasserkatastrophe in Deutschland. Über Soforthilfen hinaus denken. Wochenbericht des DIW Berlin 35/02.

[93] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

better adaptation to future climate change, tourism operations should make their offerings as varied as possible to ensure a flexible response that safeguards the profitability of the business.

A survey of regional experts showed that measures to adapt to climate change can build on many measures that already exist or are in preparation for other reasons – such as measures to extend the seasons or generally to make the region more attractive. Climate change is evidently hardly seen as a problem in this sector, and the implementation of adaptation measures is already considered to be well advanced. In many cases the pressures of day-to-day business result in the strategic challenges being ignored or put off.[94]

VI.2.6. Health

The health risks resulting from the consequences of climate change can be reduced by means of various precautionary measures, such as improved flood control. Other effective measures to adapt to heatwaves include improved warning systems, information and education about appropriate behaviour, improved emergency plans, and better heat insulation and cooling of buildings. Responsibility for precautions in the health sector with regard to future extreme weather events rests predominantly with the *Laender*. Initiatives exist, for example at the level of the working association of the highest *Land* health authorities. The Federal Government actively supports the development of suitable concepts devised by the *Laender*. For example, the Federal Ministry of Health and Social Affairs (BMGS) commissioned the Working Alliance of Scientific Medical Specialist Associations to undertake an assessment of the risks arising from heatwaves in Germany and to draw up recommendations. Among other things, the working alliance recommends establishing a system under which dangerous heatwaves trigger a warning that causes institutions in the health and social sectors to take action in response to imminent dangers. The German Weather Service (DWD) has therefore developed a heat warning system that extends down to the level of administrative districts. Since May 2005 warnings have been issued if certain threshold values of perceived temperature are exceeded, depending on the season and region. Differentiated warnings are issued for individual administrative districts and for altitudes below and above 400 m above sea level. The information supplied by the DWD is aimed on the one hand at the general public, but also directly at the institutions in the *Laender* health sectors and the headquarters of the interior ministries for further dissemination. This means that in future nursing homes and hospitals will be able to take appropriate action at an early stage. To this end the establishments in the health and social sectors should possess specific knowledge about the prevention and treatment of heat-related disorders, e.g. through suitable information sheets from the health authorities or specific further training. Individual *Laender* have already implemented measures. Improved emergency plans are in force in Baden-Württemberg, and education and information has been improved in Thuringia and Hesse. In cooperation with the German Weather Service, a phased warning system has been introduced in Hesse, with first-stage warnings addressed to nursing and similar homes, home supervision authorities and health authorities, and second-stage warnings aimed at doctors, emergency services, hospitals and the general public.

[94] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

A survey of experts revealed that the implementation of measures to adapt to vector-based diseases was considered more advanced than in the case of measures to adapt to heatwaves. On average, education about vector-based diseases and related warning systems was regarded by the respondents as partially implemented, and relevant vaccinations as specifically planned. Public education about vector-based health risks is already implemented in some *Laender*. Reasons given for introducing these measures included preventive health measures, statutory notification requirements under the Infectious Diseases Act, and reports of spring-summer meningoencephalitis and borreliosis. Climate change did not play any part in the introduction of these measures.[95]

VI.2.7. Coastal regions

To safeguard the present level of protection in the long term it is necessary to adapt the coastal protection systems to the changing demands. For example, the faster rise in sea level must be taken into account when determining the height of dykes, any areas that are potentially necessary must be kept free, and different coastal protection strategies must be compared. The first aspect, for example, is being implemented by Lower Saxony. Here a new coastal protection strategy requires that, in addition to the periodic increase of 25 cm in the height of the dykes, a further 60 cm increase due to climate change must be taken into account when planning coastal protection structures. Necessary further development of the coastal protection strategy into an integrated risk management system should be accompanied by cost-benefit analyses.[96]

VI.3. Vulnerability

VI.3.1. Agriculture

There are a number of scenarios for future climate developments, but all contain such substantial statistical errors that it is not possible to draw up targeted adaptation strategies on this basis. In general, it is important to investigate the extent to which it is possible to apply experience from production locations where the situation regarding temperature, water balance and carbon balance is already similar to the future situation in Germany.

VI.3.2. Forests

The faster and more marked the changes are, and the more the tree species making up forest stands are already in marginal ecological situations, the lower is the adaptability of the forest ecosystems. Even under present climatic conditions, some two thirds of the area under forest shows evidence of a discrepancy between the ecological demands of the stands and the existing site conditions. According to the findings of the second Federal Forest Inventory, 35.2 percent of the forests in Germany are to be classified as near-natural or very near-natural on the basis of the tree species composition of the natural forest community. It can be assumed that

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[95] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

[96] Schirmer, M. et al. (2005). : Klimawandel und präventives Risiko- und Küstenschutzmanagement an der deutschen Nordseeküste (KRIM). Vortrag zum Abschlusssymposium des Deutschen Klimaforschungsprogramm (DEKLIM), 10.-12.05.2005, Leipzig.

these forests are most likely to be relatively stable in the face of shifts in climatic factors. By contrast, 64.7 percent are only classified as not very natural, fairly artificial or predominantly artificial. Stand maintenance therefore requires considerable silvicultural efforts, such as regulation of mixture and growing space, monitoring and control of harmful organisms.

The climate changes expected in future may result in a loss of stability. This affects forest ecosystems where structures and species representation on more than half of the area under forest are largely fixed until well beyond the middle of the century, and for which there are economic limits to their approximation to natural forest structures. From an economic view the most significant impact for central Europe would appear to be the reduction in areas under spruce and beech and the corresponding expansion of pine and oak. The resulting economic consequences for forestry operations depend to a large extent on the time scale of the transition. Rapid transitions imply particularly high costs and serious financial loss. The change in tree species will in the medium and long term result in marked changes in the performance of forestry operations, since the heat-loving and drought-tolerant species can be expected to be economically less profitable than the species prevailing at present. Against this background it is important for the forestry sector to prepare itself in good time for the changes with which it will be confronted in the long term.

VI.3.3. Biological diversity

Although in Germany, thanks to its geographical situation, biological diversity will be under less pressure than in other parts of Europe (e.g. Mediterranean region), the conditions for species to survive by spreading into new habitats are extremely unfavourable in view of the high population density, intensive land use and the resulting severe fragmentation of quality habitats. In particular, species adapted to cold conditions in the upper reaches of Alpine and central upland areas will be greatly at risk from global warming, as will ecosystems with long development periods, such as highland bog and old natural forests. The changes in amounts of precipitation and their seasonal distribution give cause to expect regional adverse effects on the water balance and water quality of inland waters and wetlands, with corresponding unfavourable consequences for the species living there. Species characteristics that indicate a high degree of vulnerability to climate changes include a low breeding rate, poor capacity to spread, low abundance, a small geographical range, limited ecological amplitude or a high degree of specialisation with regard to habitat and food requirements. Since these characteristics are typical of many species that are already endangered, there is reason to fear that species of importance from a nature conservation point of view will make up a disproportionately large share of the “losers” in the process of climate change.

VI.3.4. Water resources

Those areas that already have an unfavourable water balance and possess low water retention capacity as a result of their geological situation and soil conditions are particularly sensitive to dry periods and drought. This applies especially to the central parts of eastern Germany. Here it is mainly the agricultural and forestry sectors that are affected. Small areas in the immediate vicinity of rivers are threatened by flood water, especially in districts without adequate retention areas and with high building density. Most of the adaptation measures that experts consider suitable are said to be partially implemented. There are however very great differences between the individual *Laender*. Measures that have already been implemented are in the minority. They will probably not be sufficient to cope with the future challenges in the water management sector, for hardly any of them were introduced – even partially – on the basis of climate change considerations. As the impacts of climate change have hitherto played little or no role in the planning of measures, the water measurement sector in most *Laender* is not yet adapted to climate change.[97]

VI.3.5. Transport and tourism

At present it is virtually impossible to estimate the influence of steady long-term climate changes on traffic flows. Extreme weather conditions, however, can have a direct influence on the safety, economics and reliability of the transport infrastructure and means of transport. Especially in view of the highly interlinked structure of industry in Germany, which is currently largely based on just-in-time production, problems with the transport infrastructure can quickly have direct economic consequences. However, in academic, administrative and planning circles there has not yet been any systematic confrontation with the topic of adapting to climate change.[98] In general, the tourism industry in Germany could tend to profit from climate change. However, how the situation develops in the future will depend to a large extent on its capacity to adapt and on the development of other framework conditions. Climate change is only one of the driving forces that will influence the tourism industry in the future. Other factors, such as changes in leisure habits, demographic trends and economic developments have a great influence on tourism in Germany. The main reason for the tourism industry's present lack of awareness of the need for adaptation measures is the failure to get to grips with the topic of climate change. Other issues, such as the economic situation or the competitive position, often seem more important, and arguments and actions are based on relatively short-term thinking.[99]

VI.3.6. Health

It is highly probable that prolonged hot periods will occur more frequently in the future. Likewise, the conditions exist in Germany for the occurrence of new diseases such as forms of encephalitis, dengue fever, yellow fever, malaria or leishmaniasis, because both familiar and new pathogens have been found in Germany and neighbouring countries. This also applies to suitable animal vectors.[100] Measures to adapt to these situations are not yet implemented everywhere. The existing and planned measures in the German health sector are not sufficient to meet the challenges presented by climate change. Since a survey of experts reveals that

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[97] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

[98] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

[99] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

[100] Maier, W.A.; Grunewald, J.; Habedank, B.; Hartelt, K.; Kampen, H.; Kimmig, P.; Naucke, T.; Oehme, R.; Vollmer, A.; Schöler, A.; Schmitt,C. (2002): Mögliche Auswirkungen von Klimaveränderungen auf die Ausbreitung von primär humanmedizinisch relevanten Krankheitserregern über tierische Vektoren sowie auf die wichtigen Humanparasiten in Deutschland, UBA Bericht FKZ 200 61 218/11, Berlin.

climate change has played virtually no part in the introduction of any of these measures, and since the impacts of climate change have hardly been taken into account in the planning of measures to date, there is a need to ensure greater adaptation of the health sector in most *Laender* to climate change, in order to prevent and contain harmful effects on public health.[101]

VI.4. Summary

The impacts of climate change have already been observed in Germany and will become more marked in the future. In Germany climate change is expected to give rise to risks, in particular for agriculture, forestry and water resources management, biological diversity, health, transport and tourism and the coastal regions, but in certain circumstances to new opportunities as well. The impact on agricultural yields is heavily dependent on the individual crop and the water supply. In dry regions of eastern and southwest Germany the risk to yields is expected to increase. Increasing risks will also result in future from extreme weather events and greater climatic variation. Compared with other sectors, the opportunities for farmers to adjust to the new situation are quite varied, which means that – assuming increasing implementation of the available adaptation measures – the vulnerability of this sector is relatively low. Yields in the forestry sector also depend strongly on the water supply and the temperature tolerance of the tree species, but also on future management practices. The danger of forest fires will increase, and at the same time there will be growing pressure from pests and extreme weather conditions. In particular, species such as beech and spruce which are not adapted to the locality will be vulnerable. Regions particularly affected are again eastern and southwest Germany. Since the drought-resistant, heat-loving tree species are less profitable than species used to date, this will have an adverse impact on the economic performance of forestry operations. Climate change is expected to bring a decline in biological diversity in Germany of up to 30 percent. Demanding species and specialists with low tolerance, especially in wetlands, isolated habitats, and upland and mountain regions, are particularly endangered Here it is necessary to minimise the risks by introducing alternative protected area concepts that take account of species migration, for example. The danger of flooding will increase, especially in the winter and spring. A number of flood control measures are already available. Greater efforts must be made to press ahead with their widespread implementation with the aim of reducing vulnerability to floods. At the same time there will be a decrease in the water resources available in summer – especially in eastern Germany. There is thus a growing risk of droughts, and water tables will drop. Priority must therefore be given to improving landscape water balance and water retention over large areas. Greater attention must also be given to implementing water-saving measures not only in industry, energy production and agriculture, but also in the household sector. To minimise future health risks from heat stress and new diseases there is a need for information campaigns, and heat warning systems introduced on a regional basis should be expanded to cover the whole country. The transport infrastructure is primarily at risk from extreme weather events which can affect the safety, cost-effectiveness and punctuality of the transport networks. Shifts in agricultural growing areas and changes in leisure and holiday habits in response to climate change may bring about changes in traffic flows. In the tourism sector it is primarily the lower-lying winter sports destinations in the central uplands and the Alps that will be affected by

[101] Cramer, W.; et al. (2005) : Klimawandel und Klimaanpassung in Deutschland - Vulnerabilität klimasensitiver Systeme, UBA Bericht FKZ 201 41 253, Berlin.

climate change. On a European comparison, those German destinations that are visited outside the field of winter sports could tend to profit from climate change. On the other hand there is a need to raise awareness of the need for adaptation measures in future in order to exploit the opportunities and minimise the risks of climate change for transport and tourism.

Climate change will make it necessary to abandon land used for farming on the seaward side of dikes. There is an increasing probability of dyke failure, which – in the absence of suitable adaptation measures – may severely impair the quality of life owing to the lack of “a secure place to live”. There is therefore a need for action above all in the field of coastal protection, which must take climate change into account as an aspect of global change.

VII. Financial support and technology transfer

VII.1. Basic principles and priorities in cooperation with other states

The fact that environment and development are inextricably linked was the major message to issue from the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. The declarations and conventions agreed there, the Rio Declaration, Agenda 21 and the global conventions on biodiversity, climate change and desertification bear witness to the shared responsibility of industrialised and developing countries for promoting sustainable development. The World Summit on Sustainable Development in Johannesburg in 2002 translated this principle into more concrete terms, and re-affirmed the vision of sustainable development to be shared by the entire international community.

The development policy of the German government also follows this vision, with the Federal Ministry for Economic Cooperation and Development (BMZ) shouldering the main burden of responsibility. Collaboration on the production of international rules and regulations and supporting developing countries in their efforts to put these into practice is an important contribution to global structural policy. Development cooperation helps create an enabling environment, without which it would be quite impossible to achieve global environmental and development goals. In this way too the German government is meeting its commitments under a growing number of international agreements and conventions.

Environmental protection and conservation of natural resources is a cross-cutting task of German development policy, and at the same time a sectoral priority, which the German government seeks to incorporate into cooperation with individual partner countries. The preservation of the natural environment is always an integral part of the objectives of development cooperation projects and programmes. For example, all development cooperation projects must therefore undergo compulsory environmental impact assessment.

The percentage of funding allocated to environmental protection and natural resource conservation projects has been rising steadily, and now accounts for about one-third of the entire bilateral development cooperation of the Federal Ministry for Economic Cooperation and Development (BMZ).

Climate protection has been becoming increasingly important in development cooperation since the 1992 UN Conference on Environment and Development in Rio de Janeiro and the Framework Convention on Climate Change signed there. Developing countries are particularly at risk from the consequences of climate change, which can be forecast ever better, if not precisely, thanks to the progress made in developing regional climate models. When disaster hits, it is always the poorest of the poor who suffer most from the consequences of rising mean land and water temperatures, extreme weather events (storms, floods, droughts), the forecast rise in sea levels, drought-related poor harvests and the more rapid spread of tropical diseases.

Rough estimates put the global cost of climate change at hundreds of billions of dollars. The forecasts of the Intergovernmental Panel on Climate Change (IPCC) in its Third Assessment Report pose a challenge for development cooperation by the German government too: in order not to jeopardise decades of development work, climate protection in the form of worldwide emission reductions is urgently needed, and is thus an important goal of official German development assistance. Binding emission reductions in industrialised countries are a priority instrument in efforts to initiate a long-term climate protection process. Given the global nature of the challenge and the potentially disastrous consequences of climate change, climate protection measures in developing countries too must be stepped up with the support of the industrialised countries. In this context, and in the short term, the Clean Development Mechanism (CDM, see also Chapter VII.2.3) is a sound instrument, but in the long term we will have to consider how developing countries that are important in terms of climate policy (in particular those which already have high absolute emission levels and those whose emission levels are rising rapidly) can be involved to a greater extent at international level in policies to reduce emissions and protect carbon sinks. To this end, BMZ is also making every effort to engage in dialogue with its partner countries in order to explore possible forms of a post-2012 climate regime, and to enhance the willingness of developing and transition states to accept specific commitments in the field of climate protection.

Because the impacts of climate change are already visible, especially in poor countries, it is not enough simply to reduce greenhouse gas emissions, although this will continue to be a priority of the climate protection of the future in an effort to avoid further damage and in line with the tenets of the precautionary principle.

Adjustment to climate change has been an important topic at international level, at least since the eighth session of the Conference of the Parties in New Delhi, and for some years now it has also been a central issue in bilateral and multilateral development cooperation. In particular the possibility of an increase in extreme weather events is posing new challenges in this context: in addition to the provision of effective assistance in the wake of natural disasters, efforts must focus on preventive measures and on improving disaster preparedness in the face of new risks. Equally, necessary measures to adjust to climate change must always be taken into account in relevant projects in the fields of water supply, ecosystem management, agriculture, infrastructure and health. Adjustment to climate change is part of the German government’s Programme of Action 2015, which is its contribution to halving global poverty.

Climate policy is thus becoming one of the most urgent tasks of long-term-oriented, sustainable development.

The German government sees the main thrust of its climate-relevant development policy actions in so-called no-regret or win-win measures. These are projects or programmes which cut costs thanks to lower consumption of power and raw materials, thus enhancing economic competitiveness, while at the same time reducing emissions, waste water or solid waste, and hence cutting pollution and reducing negative impacts on the global climate. Successful climate protection measures should, wherever possible, generate benefits at both local and global levels. Small-scale, decentralised photovoltaic plants in sun-rich countries and steps to boost the efficiency of older power stations, for instance, can help protect the climate by cutting emissions, improve local air quality, provide the rural and urban population with affordable electricity and reduce the use of fuelwood, thus protecting forests. Circumspect planning of settlements or the selection of appropriate varieties of grain crops can minimise the impact of extreme weather on people today.

Partner countries are to be enabled to play an active and responsible part in climate protection and in adjustment to climate change. Industrialised countries can help create the enabling environment, overcome financial constraints and establish environmentally sound economic systems that use natural resources well through capacity building and the use of modern, appropriate technologies.

The demand on the part of partner countries for environmental protection and natural resource conservation projects has risen sharply in recent years against this backdrop.

In this context it should be emphasised that developing countries are already making massive efforts in the fields of climate protection and adjustment to climate change today, although they are not yet expressly obliged to do so. These are the kind of efforts that the German government prefers to support. If climate-relevant projects and programmes are to be effective in the long term, it is vital that they be firmly incorporated in national action programmes and sector strategies. In particular, existing sustainable development strategies or other action programmes (on desertification or biodiversity, for instance) must be used or built on. Without this sort of linkage, there can be no catalyst or synergy effects, and it will prove impossible to achieve the political coherence that is so essential.

In the field of climate protection in developing countries, close cooperation between industrialised and developing countries is of paramount importance. In terms of the ongoing climate negotiations this means that the framework conditions and structures for international climate protection must take account of the interest of developing countries in economic and social development.
The German government attaches particular importance to the Clean Development Mechanism (CDM). Through the CDM, developing countries are involved in the emission reductions pledged by industrialised countries in the Kyoto Protocol (see also VII.2.3).

In the multilateral arena, the Global Environment Facility (GEF) is an important instrument in financing climate protection and integrating it into the political objectives of developing countries and the promotion goals of other development cooperation institutions (see also VII.3). The German government is a strong advocate of strengthening the GEF and consolidating its tasks.

VII.2. Bilateral cooperation

Environmental protection and natural resource conservation is one of the focuses of the German government's bilateral cooperation. About one-third of all bilateral financial support provided by the Federal Ministry for Economic Cooperation and Development (BMZ) goes to environmental projects. Of this, a significant part is accounted for by climate protection measures. In order to make its contribution to preventing and coming to terms with climate change, the German government helps developing countries in their efforts to meet the commitments they have entered into to implement the Framework Convention on Climate Change, and does what it can to prepare them for the negative impacts of climate change. The German government is thus making an important financial and conceptual contribution to strengthening climate protection. Measures devised jointly with partner countries are targeting sectors which are particularly relevant to reducing emissions of greenhouse gases, pursuant to Article 4.1.c of the Framework Convention on Climate Change: energy, waste management, traffic and transport, industry, agriculture and forestry. One important instrument is the support provided to partner countries to help them make use of the Clean Development Mechanism (CDM).

Although it is rarely possible today to put an exact figure on the quantities of greenhouse gases reduced thanks to individual bilateral development cooperation projects, many serve the goals of the Framework Convention on Climate Change. The German government reports regularly on these projects to the Secretariat of the UNFCCC. They include projects in the field of renewable energies such as wind power and small-scale hydropower, the use of biogas and solar cook stoves, the rehabilitation of power stations, gas-steam power stations, the rational use of energy, transport, solid waste management, afforestation and forest conservation.

In future, the German government intends to take global environmental concerns into account to an even greater extent in bilateral cooperation, i.e. to continue raising the percentage of all measures making a contribution to climate protection. This is the focus of the initiative "Securing the Future through Climate Protection". In two priority areas, renewable energies and tropical forests, additional funds were pledged in 2000, and funding is to be retained at this high level. Currently, German development cooperation allocates a minimum of EUR 100 million every year to measures designed to increase energy efficiency. The promotion of renewable energies is also promoted to the tune of at least EUR 100 million per annum, while another EUR 125 million is earmarked for measures to protect tropical forests. A special credit facility for renewable energies and energy efficiency has also been established, with funding totalling EUR 500 million for the period 2005 – 2009.

VII.2.1. Convention project "Climate Protection Programme for Developing Countries"

In order to help developing countries meet their commitments as laid out in the Framework Convention on Climate Change, to allow them to make full use of the concomitant development opportunities, and to support them in integrating measures that allow them to adjust to climate change into their development strategies, the German government has since 1992 been promoting the convention project “Climate Protection Programme for Developing Countries”. To date, a total of EUR 12.5 million has been allocated to the programme. One major focal point was measures to prepare for the realisation of the Clean Development Mechanism (CDM). These included in particular support for the building of human and institutional capacities for the implementation of the CDM in partner countries (see following ChapterVII.2.2). Another main thrust of the project can be seen in the field of adjusting to the negative impacts of climate change, where capacities are being built in particular in the least developed countries (LDCs) (see Chapter VII.2.8). The project is also increasingly supporting partner countries, helping them make an active contribution to the further development of the post-2012 international climate regime. Efforts target especially those parties to the convention which already have high levels of greenhouse gas emissions or which are particularly badly hit by climate change. Work builds on the experience and contacts of German development cooperation.

The Climate Protection Programme supports projects on various scales in partner countries in the following priority areas: reducing emissions of greenhouse gases (including the CDM) and adjusting to climate change. One main focus is the integration of climate-relevant considerations into German development cooperation as a whole and thus also involving climate protection in the efforts of partner countries to attain sustainable development.

The spectrum of partner organisations addressed by the Climate Protection Programme, with whom climate-policy dialogue processes have been launched and concrete results achieved, goes from government level to local non-governmental organisations. The experience gained in these climate protection activities flows directly into German climate policy and is fed into the international climate process.

VII.2.2. Strengthening human and institutional capacities

For developing countries, capacity building (i.e. strengthening human and institutional capacities) is particularly important. Measures of this sort aim to build the potential of individuals, organisations and institutions such that they can conduct urgently needed measures, while at the same time recognising environmental problems in good time and increasingly resolving these independently.

To this end, a wide spectrum of instruments is available to development cooperation: knowledge transfer, organisational development, advisory services, training and upgrading services for national specialists and managers, for instance for decision-makers in politics and industry on environmental management issues. In addition, a whole series of parallel measures, conducted within the framework of the German government’s financial cooperation, strengthen individual and institutional capacities.

Some particularly important elements of these participatory and process-oriented projects include environmental management, environmental communication and conflict resolution methods, as well as the use of market-economy instruments in the field of environmental policy. Knowledge is transferred and processed together so as to enable the networking of various actors from the state and non-governmental sectors. Environmental and climate problems generally affect a large number of sectors and a wide range of stakeholders with, in some cases, divergent interests.

This calls for cooperation, but also a reconciliation of divergent interests and indeed conflict management among stakeholders.

The strengthening of institutional and individual capacities within the scope of the Framework Convention on Climate Change is an important precondition for having developing countries meet their commitments and make the most of the opportunities offered by the Convention and the Kyoto Protocol. In particular the least developed countries (LDCs) need this support, for they are least able to conduct their own climate protection policy and adjust to climate change. Thus, the German government helps partner countries to establish and expand their scientific and technical infrastructure, promoting technology centres, research institutes and also economic promotion institutions.

VII.2.3. The Clean Development Mechanism

The Clean Development Mechanism (CDM) opens up a new avenue for development cooperation in the field of climate protection. Industrial country actors can invest in projects to cut greenhouse gas emissions in developing countries or can purchase certified emission reductions from climate protection projects of this sort, which are then counted towards their own reduction obligations under the Kyoto Protocol.

The German government accords special importance to the CDM, since it helps achieve two mutually complementary goals, climate protection and sustainable development. For developing countries, the CDM offers an opportunity, among other things, to modernise their energy supply and waste management facilities. To a limited extent, afforestation and reforestation activities can also be conducted. Germany considers it very important that high-quality emission reductions be achieved, that the general public be involved in project planning and appraisal at an early stage in the proceedings and that an environmental impact assessment be conducted, to ensure that other ecological and social factors are not overlooked.

Through its convention project “Climate Protection Programme for Developing Countries”, the German government supports partner countries in their efforts to make use of the opportunities offered by the CDM. National CDM strategies, sector studies or project approaches are drawn up. Moreover, the institutional and organisational foundations must be laid so that CDM projects can be approved and processed efficiently. Further training measures such as workshops at which many countries can share their experiences in the field of climate protection in developing countries, on the methodical fine-tuning of the CDM and on project monitoring, help build human resources capacities.

Capacity building measures can enhance equality of opportunity in the competition among developing countries to attract CDM projects. The German government supports partners on the ground, helping them identify and prepare projects suitable for CDM support, on an exemplary basis.

The actual project financing for emission reduction certificates, however, ought to come from the private sector. Official development assistance (ODA) funds should not be used for this purpose. The German government is endeavouring to lay the foundations for an increased private-sector commitment to the CDM, for instance through public-private partnerships (PPP).

The KfW, with its Climate Protection Fund, has launched a programme to purchase certificates both under the CDM and under the Joint Implementation Mechanism (which involves the certification of emission reductions in transition states). The programme aims to help private businesses in particular acquire climate protection certificates from projects. In this way, the Fund also serves to mobilise private funds for sustainable development in developing countries. Projects in the fields of renewable energies and energy efficiency measures will play a pivotal part, as expected. The special facility is expected to generate huge synergy spin-offs, which should be actively exploited.

With its first invitation to businesses to submit bids for the purchase of certificates from CDM projects in developing countries, which are helping to reduce greenhouse gas emissions, the KfW Group has officially kicked off the KfW Climate Protection Project. To date, applications have been received for some 60 projects or so, and these are currently being examined by KfW for feasibility. At the same time, moves are afoot to put in place JI projects in industrialised and transition states.

All in all, a programme volume of EUR 50 million is planned. KfW has pledged up to EUR 10 million of its own funds. The Federal Ministry of Economics and Technology will provide up to EUR 8 million from the budget item "Export Promotion for Renewable Energies".

VII.2.4 Energy

As we enter the 21st century, the industrialised countries are still the largest producers of greenhouse gases. The per capita emissions of industrialised countries are between five and ten times as high as those of developing countries. The unabated rise in global emissions, however, can also be traced back to developing countries. Even if the industrialised countries were to meet all their commitments under the Kyoto Protocol, global emissions of greenhouse gases during the first commitment period (2008 – 2012) would still top the 1990 levels because of the rising emissions generated by developing countries. As their consumption of fossil fuels, such as oil and coal, rises to generate power and for use as fuel, the developing countries as a group will generate about half of all greenhouse gases by 2025, giving them a larger share of the responsibility for climate change. Because of their legitimate need to catch up with the industrialised countries, developing countries too will account for a large percentage of the forecast doubling in primary energy consumption over the next fifty years.

Thus, major efforts to save energy, ensure efficient use of energy, and step up the use of renewable energies are needed not only in industrialised countries, but increasingly also in emergent countries and developing countries. Development cooperation can and must make a contribution to minimising this increase. Since half of the greenhouse effect can be traced back to emissions in the energy sector, efficient use of energy and renewable energies are vitally important to ensure a sustainable energy supply. These are also integral parts of any ecologically sustainable policy. The German government has thus set itself the goal of slowing the rise in energy-related emissions through measures to be implemented in cooperation with developing countries. The measures selected should, at the same time, foster development. The German government thus supports the application and dissemination of sustainable and decentralised power generation techniques, in particular the use of renewable energies, and is working to achieve more efficient power generation and distribution, and for consumers to use energy more efficiently.

The objectives of cooperation with partner countries are as follows:

- Meeting energy needs to improve living conditions
- Securing ecologically, economically and socially sustainable economic development
- Strengthening the technological performance capacity of developing countries in the energy sector
- Reducing the dependence of developing countries on imported fuels
- Helping developing countries put into practice the resolutions of the UN Conference on Environment and Development, in particular the United Nations Framework Convention on Climate (UNFCC) and the results of the international conferences on renewable energies (renewables 2004, BIREC 2005).

There are still a great many obstacles to using renewable energies and to ensuring efficient use of energy. A wide spectrum of approaches is thus needed in order to achieve the crucial strategic impacts. Alongside economies of scale, which can be achieved through greater dissemination of relevant technologies and the concomitant more affordable supply of power, the approaches aim to create sufficiently strong markets, provide access to long-term loans, and in rural areas in particular, to boost the purchasing power of the population. The German government is thus continuing to work for the reform of sector strategies and cross-cutting policies with a view to establishing an enabling environment in developing countries and initiating greater private-sector involvement.

At the same time, the German government is providing funds for the long-term financing of new technologies; these are earmarked firstly for energy supply (e.g. using renewable energies) and secondly for demand-related sectors (e.g. boosting energy efficiency, introducing new fuels for transport, etc.). Advisory support is also provided to help partners identify ways of maximising the productive use of energy. Partner counties are supported in their endeavours to establish technical and institutional resources and to develop sustainable energy policies.

VII.2.5. Industry and SMEs

Important and integral parts of the climate-relevant activities of the German government in developing countries include measures to improve energy efficiency in industry, as well as introducing elements of product recycling. These include, in particular, new clean process technologies but also, where appropriate, the use of end-of-pipe technologies. In addition to technological improvements, the introduction of cost-covering energy prices is a focus of efforts. They are an effective way of helping save energy, since the re-fitting and modernisation of plants generally only pays off once energy prices have been adjusted such that tariffs cover costs.

Another key instrument advocated is the utilisation and dissemination of target-group-specific environmental management instruments. Competence centres, multiplier training, and cooperative approaches involving private businesses, local authorities and other stakeholders can safeguard a broad and lasting impact.

A new instrument now being used is the environmental credit line to local development banks, which are intended to advise and provide financial support to small and medium-sized enterprises, in particular in their efforts to adopt environmentally sound production processes.

VII.2.6. Agriculture and forestry

Because of its disastrous impact on the world's climate, on biodiversity and on the habitats of local populations, the destruction of tropical forests (rainforests, arid forests, etc.) is one of the most serious environmental problems worldwide. The most recent assessments of the IPCC once again underline the magnitude of the problem. Forest fires and forest clearance destroy the forests' biomass, which binds carbon, acting as a natural CO_2 sink. The greenhouse gases released are a major source of emissions in many developing countries, and cause irreversible damage, not only to the climate. Large-scale processes of soil erosion and desertification are also linked to deforestation, the natural water balance is upset and wood that is needed as fuel and for other purposes becomes scarce, jeopardising the existence of many millions of people living in rural parts of developing countries. For these reasons, the German government welcomes the decision made at the 11th Conference of the Parties in Montreal to review the extent to which the topic of deforestation in developing countries could be more effectively integrated into the international climate regime, for instance by creating more incentives to preserve forests.

The preservation of existing forests has a particularly important place in development cooperation. Sustainable forestry management methods and the development of buffer zones are important way of protecting forests. Stemming the destruction of forests caused by forest clearance, forest fires, illegal logging or flooding is particularly difficult because of the many different causes involved and the interaction between them. The worldwide dangers and impacts of deforestation in the tropics and arid forests, as well as the complex causes and backgrounds, make it essential for the countries affected and the international community to take rapid and vigorous action to counter destruction. In this context, renaturing of forests is of crucial importance, as are reforestation measures.

This is why the conservation of tropical forests has for many years been a priority area of German development cooperation in the environmental sector. The German government is working in numerous developing countries to help elaborate and realise national tropical forest programmes. In 2003, the German government provided some EUR 102.75 million, and in 2004 some EUR 109 million for relevant projects in developing countries, making Germany the largest bilateral donor in the field of tropical forest conservation programmes.

Within the framework of bilateral cooperation, the German government plays an important financial part in multilateral initiatives to preserve the tropical forests. The German contribution to realising the international pilot programme to protect Brazil's tropical rainforests (PPG7) is particularly important. The programme owes its existence to the calls of the German government in 1992. To date, the various donors have together provided USD 409.54 million (as at 2003) for the core projects of

PPG7, with Germany bearing the lion's share of more than USD 211.27 million. At international level the pilot programme is considered an excellent example of an overarching programme approach and coordinated action on the part of industrialised and developing countries in order to preserve the tropical rainforest.

The forests will only be preserved, however, if sustainable forest management is more lucrative than any alternative form of use or clearing the land. When elaborating regional and national forest utilisation strategies, all approaches which are not compatible with the goals of the people living in or from the forest have thus proved ineffective in the past. For this reason, development cooperation with its programmes and projects is working to ensure that these people, especially the local population, indigenous peoples and non-governmental organisations, are involved in the planning of forest management to an appropriate extent and that they share the benefits accruing from forest utilisation. Projects promoted along the lines of forestry cooperation must take account of the goal of preserving the forest and achieving sustainable forest management, while respecting the needs of the rural population. A major foundation for this is regional and national land use planning, which rarely exists to date, as well as integration of the tenets of sustainable forestry into relevant national development strategies.

Close links exist not only between climate change and the tropical forests and biodiversity protection, but also with agriculture and rural development. In arid areas, in particular, there are major interactions between the impacts of climate change and desertification. Sub-tropical, semi-arid or arid areas, or areas vulnerable to flooding, drought and desertification are particularly susceptible to the negative impacts of climate change. While not even the results of the third report of the IPCC can clearly forecast what effect the rising percentage of greenhouse gases in the atmosphere will have on the spread of desertification, it is today clearly evident that changes in temperature, evaporation and precipitation are in many areas speeding the process of desertification. Equally, desertification has an impact on the local climate in particular. The degradation of the land generally leads to reduced surface humidity, meaning that more energy is left over to heat the soil and thus also the lower layers of the atmosphere. Eroded soils and sparse vegetation then in turn bind less CO_2.

Since the mid-1980s desertification control has been a priority area of the German government in its promotion work, and in cooperation with developing countries.

VII.2.7. Traffic and transport

The meteoric rise in traffic volumes in both developing and industrialised countries is responsible for an increasing percentage of the total volume of greenhouse gas emissions. The exhaust fumes of private cars and trucks alike contain precursors of ozone (NO_X and VOC), which magnify the greenhouse effect. About 40 percent of energy consumption in developing countries is accounted for by transport. To protect the climate it is thus of crucial importance to improve energy intensity in the transport sector, while at the same time improving quality, It has emerged that the promotion of local public transport must have priority. To this end, the German government is promoting, projects for instance in Buenos Aires, Shanghai, Canton, Jakarta, Surabaya and Santiago de Chile. With the expansion of public transport networks, especially rail-based networks in cities, improvements in traffic and transport planning and training measures across the board from decision-makers to automotive technicians, German development cooperation is making an effective contribution to boosting the performance capacity of the transport sector, increasing mobility, and at the same time contributing to climate protection.

The production, use, and in the medium or long term even export of biofuels, open up new economic, social and ecological opportunities for poor population groups in developing countries. These new chances are being systematically identified by the German government, which then also supports partner countries in their efforts to realise the new strategies.

VII.2.8. Adjustment measures

The concrete results of climate change for people and the natural environmental cannot yet be predicted with certainty, in spite of the fact that progress in regional climate models is making forecasts increasingly reliable. It is, however, quite clear that it is the countries with the lowest greenhouse gas emissions, i.e. the developing countries, which will suffer most from the results of climate change. This makes anthropogenic climate change a matter of North-South justice. If the average temperature on Earth increases, causing sea levels to rise and making extreme weather events (storms, floods, droughts) more frequent and of a greater magnitude, millions of people living in coastal areas seem set to lose their land, climate-related bad harvests will become more frequent, the areas where tropical fruit and non-heat-resistant strains are grown will be jeopardised, and the vectors carrying malaria and other tropical diseases could multiply and spread rapidly.

The natural disasters of recent years (Central America, the Indian sub-continent, Mozambique and Madagascar) and the subsequent wiping out of years of development work, clearly illustrate how vulnerable people and nature are, and show the extent to which developing countries can be hit by the impacts of climate change. United Nations estimates put the cost of climate change at USD 300 billion a year worldwide, with catastrophic consequences in developing countries in particular.

In future, it will no longer be enough to concentrate efforts on reducing greenhouse gas emissions and preserving and extending CO_2 sinks alone; more and more importance will also be attached to efforts to strengthen the adaptability of individuals and nature on the ground, thus minimising the negative impacts of climate change. For the worst hit countries of Africa, Central America and Asia in particular, and for the smaller island states this issue is of crucial importance.

Although the discussion of suitable measures for adjusting to climate change is still in its infancy (the extent, timing and local impacts of climate change cannot yet be foreseen), the German government is working within the framework of bilateral cooperation to help partner countries prepare, for instance by jointly elaborating proposed adjustment strategies for developing countries and conducting academic research on which policies can subsequently be based.

To this end too, the BMZ Climate Protection Programme for Developing Countries has initiated a number of pilot projects that are intended to help integrate adjustment goals in development cooperation in the long term. These include, for instance, cooperation arrangements with the ongoing Indo-German Bilateral Watershed Management Project in India (Rajastan), and with a programme to promote the improved utilisation of natural resources in Benin, projects aiming to improve disaster preparedness (Mozambique, Nicaragua) and a separate bilateral project to help Tunisia adjust to climate change.

Adjustment measures in developing countries, which are particularly hard hit by climate change, are to be financed through the existing GEF trust fund, and three new climate funds operating under the umbrella of the GEF. In particular the implementation of selected measures on the basis of the National Adaptation Programmes of Action (NAPAs) through the Least Developed Country Fund, to which Germany has contributed USD 15 million, offers an opportunity in the coming years to compile important lessons learned and thus achieve long-term integration.

The utilisation of some of the revenues of the CDM within the scope of the Kyoto Protocol Adaptation Fund, which will soon be starting up now that the Kyoto Protocol has come into force, is an innovative source of funding for adjustment measures.

Another measure to pave the way for the implementation of adjustment measures and to provide training to help partners solve problems independently is the strengthening of institutional and individual capacities in developing countries. With its *capacity building* measures, the German government attempts to help the countries affected identify the problems facing them. The institutions are strengthened such that adjustment problems are incorporated into the development-policy planning process, and policies once adopted can be better translated into practice (e.g. land use planning and agricultural programmes). The spectrum of measures that can be adopted to adjust to climate change is very wide, and goes well beyond the construction of protective infrastructure (e.g. embankments and dykes). It comprises, for instance, forward-looking settlement planning in protected locations, appropriate crops such as salt-tolerant and drought-resistant varieties, food security measures including food storing and trade, the introduction of sustainable irrigation methods, provision of information for the local population on potential risks and practicable early warning systems, the removal of migration barriers for flora and fauna, improving or reorganising the health sector, and small-scale afforestation or agroforestry measures. Activities of this sort aim to reinforce the ability of the local population to adapt, and can build on existing vulnerability and risks.

Organisation, information and preparatory measures help reduce the impact of damages at a relatively low cost. This increases the chances that cost-effective adjustment measures will actually be taken, especially in poor countries. For this reason it is important that the adjustment made necessary by climate change be taken into account when planning projects in the above areas, in order not to jeopardise the sustainability of the projects. Ongoing and planned bilateral pilot projects too serve this aim.

German government support measures with a direct link to adjustment to climate change have focussed to date on the fields of desertification, preservation of biodiversity and integrated coastal protection (conservation of intact ecosystems in coastal areas such as mangrove forests or coral reefs). However, activities in the fields of health, regional planning and rural development also have a positive influence on the ability of developing countries to adapt.

Alongside its regular programmes, the German government is making available food aid and emergency aid within the scope of its emergency aid and disaster relief. In 2003 EUR 124.04 million were earmarked for this purpose, and in 2004 EUR 135 million. To this must be added the many million euros of donations for developing countries channelled through non-governmental organisations. Special attention is accorded to achieving the sustainable improvement of national and local disaster preparedness and protection in particularly hard hit areas. With emergency aid and disaster relief funds the first steps are thus taken towards creating sustainable protective mechanisms. Additional climate-related risks will in future have to be taken increasingly into account.

VII.3. Multilateral cooperation

Alongside bilateral cooperation, the German government makes important financial and substantive contributions to climate protection in development countries at multilateral level, in particular through the Global Environment Facility (GEF). The German government is working to have climate protection taken more into account within the scope of the multilateral development cooperation of the European Union, the European Investment Bank (EIB), the World Bank, regional development banks, the UNDP, etc. In the supervisory bodies of these organisations, the German government is working to have the objectives of the Framework Convention on Climate Change respected in promotion programmes.

The inputs of the German government to multilateral facilitates within the framework of official development assistance and the EU totalled EUR 2,100.3 million in 1999 (of which EUR 1 million was accounted for by the EU), EUR 2,542.8 million in 2000, EUR 2,385.2 million in 2001, EUR 2,118.6 million in 2002 and EUR 2,411.3 million in 2003. At present it is not, however, possible to put a figure on the contributions made by the international organisations which relate to the goals of the Framework Convention on Climate Change.

The Global Environment Facility (GEF) is the financing mechanism of the Framework Convention on Climate Change. It complements existing bilateral and multilateral development cooperation instruments. The assumption of additional costs of measures with global benefits offers parties to the convention (and to other international agreements including the Montreal Protocol on Substances that Deplete the Ozone Layer, the Convention on Biological Diversity, the Convention on Persistent Organic Pollutants, and the Convention to Combat Desertification), the chance to meet shared but differentiated responsibilities effectively. The GEF also finances measures to protect international waters, combat desertification and protect forests. The organisational and decision-making structure of the GEF, which involves to an equal extent the interests of recipient and donor countries, is an important step towards realising the environmental and development partnership to stabilise the global ecosystem initiated at the 1992 UN Conference on Environment and Development in Rio de Janeiro.

In the field of climate protection, the GEF finances measures to help developing countries meet their commitments under the convention (in particular reporting commitments): greenhouse gas inventories, and developing strategies to reduce emissions and adjust to climate change. The lion's share of the climate portfolio, however, goes to concrete measures to reduce emissions of greenhouse gases and measures to bind carbon dioxide (forest protection). The GEF has a worldwide leading role in the introduction of new climate protection technologies and in overcoming market barriers, in particular with respect to the promotion of renewable energies, which accounts for more than half of the GEF's climate protection portfolio.

Table VII - 1 New and additional funds within the scope of the financing mechanism of the Framework Convention on Climate Change

Year	German contribution in €
1999	49,748,700
2000	49,748,700
2000	49,748,700
2001	49,748,700
2003	73,416,561
2003	73,416,561
2004	73,416,561

Source: BMZ

Since 1991 the GEF has provided about USD 1.74 billion for climate protection projects, which is equivalent to 37 percent of all GEF pledges. GEF funds are complemented by funds from other sources totalling some USD 9.29 billion, most of which comes from other public donors, although a share is contributed by private businesses and non-government organisations. The German government contributes around 11 percent to the replenishment of the GEF fund, in its capacity as third largest donor to the financing mechanism of the Framework Convention on Climate Change. At the third replenishment of the GEF (up to 2006) this translated as a sum of USD 263.67 million (EUR 283.36 million).

VII.4. Technology transfer programmes

The success of technology transfer efforts depends on numerous factors. One of the most important of these is putting in place framework conditions which aim to ensure that private businesses can operate in a clearly regulated market in which incentives make innovations attractive, in the environmental sector as in others.

Development cooperation can contribute here in the form of economic and sectoral policy advisory services. It can also support pilot projects which introduce new technologies and help achieve a critical mass as regards demand, making new technologies profitable. Targeted capacity building and networking projects can also be promoted in the technology transfer area. The German government is active in these three fields, although below we will go into only the latter option in more detail.

Within the framework of bilateral technical cooperation, technology transfer is promoted in particular through the German Appropriate Technology Exchange Programme (GATE) at the Deutsche Gesellschaft für Technische Zusammenarbeit GmbH (GTZ).

GATE aims to strengthen the technological competence of industry, non-governmental organisations and other involved groups, and to promote technologies which make optimum use of existing resources and are in line with the ecological and socio-economic requirements of partner countries. The programme offers comprehensive advisory services, helping partners adapt and disseminate technologies. Support is provided for the provision and exchange of technological know-how by regional partners, the testing of new innovative technologies and the improvement of information services.

Focal areas include renewable energies, recycling, sewage and solid waste processing, and resource-appropriate agriculture. An information unit for appropriate technologies is available and documentation and publications are produced. GATE maintains cooperation links with numerous organisations in Latin America and Asia and works with regional networks in Africa.

Table VII - 2 Bilateral financial and technical cooperation relating to the objectives of the convention

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Beitrag des BMZ im Jahr 2000 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
A.C.S.A.D.								1,5339
Ägypten	16,7704			3,8347			1,5339	9,2033
Albanien								13,2936
Algerien				1,0226				5,1129
Amerika na (nur EL)	1,2271	1,3294				1,2782		
Armenien	5,1129							2,5565
Asien na (nur EL)		1,0226	3,0678					
Äthiopien	1,0226		0,9203	1,2271				1,5339
Bangladesch	14,8275					5,1129		
Benin		6,3911	4,6016	0,7669		1,5339		6,4934
Bolivien			2,5565	2,5565				1,0226
Bosnien-Herzegowina						2,5565		
Brasilien	7,6694		18,9178			3,4768		
Chile			1,0226					
China (VR)	25,0533	46,0163	5,1129					
Cote d'Ivoire			4,2437	2,6332				
Ecuador	1,5339		3,0678	1,0226				
Gambia			4,7039					
Georgien	17,8952							3,5790
Guinea			6,7286					12,7823
Honduras						2,8121		
Indien				22,2412				10,7371
Indonesien			5,1129	1,0226				3,0678
Jamaika	3,5790							
Jemen	1,0226						0,5113	12,2710
Jordanien				1,2782				17,8952
Kambodscha		7,6694						
Kamerun		12,5267	9,4589					3,0678
Kongo, Demokratische Republik			2,5565					
Konventionsvorhaben			2,5565					
Madagaskar			7,6694					
Malaysia			1,5339					

Beitrag des BMZ im Jahr 2000 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Marokko	15,3388		1,5339	9,2033				17,8952
Mauretanien				3,7938	2,3008			
Moldau				1,5339		3,5790		
Mongolei	14,3162		0,5113	0,5113		2,3519		
Mosambik	5,1129	7,6694						0,7669
Namibia		6,1355		0,5522		2,0452		
Nepal	14,8275	1,0226	1,0226					
Nicaragua			6,6468					3,0678
Niger			2,3008					
Palästinensische Gebiete						10,2258	0,4090	18,6622
Paraguay			4,0903					
Peru			6,4423	0,4090				13,2936
Pilot-/Sektorvorhaben	3,0166	0,7066	0,6136	3,1649		1,0226	0,2137	1,6361
Ruanda								1,2782
SADC			3,5790		1,5339			0,7669
Sambia								6,3400
Senegal			4,4482					7,6694
Simbabwe			0,7669					
Südafrika	10,2258		1,0226	1,0226		1,0226		
Tansania			3,5790	1,2782				21,2186
Timor-Leste								0,6136
Tschad			0,5113	0,8692				3,8347
Türkei								25,5646
Vietnam		0,5113	13,8049					17,1283
Summe je Förderbereich	**158,5516**	**91,0008**	**134,7050**	**59,9439**	**3,8347**	**37,0175**	**2,6679**	**243,8862**

Table VII - 3 Bilateral financial and technical cooperation relating to the objectives of the convention – 2001

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Beitrag des BMZ im Jahr 2001 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Afrika na (nur EL)			1,5339	4,7550		1,0226		
Ägypten	20,4517			28,6323				1,0226
Albanien	3,5790		2,5565					9,2033
Algerien								8,6920
Amerika na (nur EL)	1,0226	0,3323	9,2033					2,0452
Argentinien			1,5339					
Armenien						6,1355		10,2258
ASEAN			5,1129					
Aserbaidschan				1,1248				15,8500
Asien na (nur EL)			3,3541			1,5339		
Äthiopien		14,1178	1,0226			1,5339		1,0737
Bangladesch	20,4517							
Benin			4,7806					
Bolivien			0,5113	7,6694		5,1129		16,7704
Bosnien-Herzegowin						5,1129		
Brasilien	7,1581		22,4968			2,5565		
Bulgarien		2,0452						1,5339
Burkina Faso				5,2663				6,6468
Chile							8,8965	
China (VR)	5,1129	25,5646	28,3767	3,0678				17,8952
Dominikanische Republik	2,0452		3,9881					
Ecuador	4,8573		5,1129					
El Salvador						0,7669		
Eritrea								5,1129
Gambia			0,4346					
Ghana		12,7823		2,9655				11,5041
Indien	18,6622	2,3008						2,5565
Indonesien	1,5339							
Jemen								6,6468
Jordanien								26,5872
Kambodscha	2,5565	5,1129						
Kap Verde					0,6647			
Kenia	3,0678			11,2996				12,2710

Beitrag des BMZ im Jahr 2001 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Kirgisistan			0,7669					
Kolumbien			6,6468					
Kroatien								7,6694
Madagaskar			4,3460	1,5339				1,0226
Malawi		5,1129			0,4602			5,6242
Mali		2,5565		2,0452				18,1509
Mazedonien		10,2258	1,5339				6,6920	6,6468
Mekong River Commission			7,4137					1,5339
Mexiko	1,5339		2,0452				4,0903	
Mongolei	4,0903							
Mosambik	4,4482	11,2484						
Namibia		5,1129	2,0452	5,1129				3,5790
Nepal	1,5339							
Pakistan	11,2484							
Palästinensische Gebiete							1,2782	26,0759
Peru			5,1129					
Philippinen			0,3579	1,0226		4,0903		2,0452
Pilot-/Sektorvorhaben	3,5790	0,7669		5,8287	1,2782	2,1474		4,0903
Ruanda								2,1474
SADC	1,7895							
Senegal	2,9041		0,1636					
Serbien/Montenegro	18,9178							19,9404
Sri Lanka		0,2556	0,2556		1,2782			0,2556
Syrien								0,7669
Tansania	1,5339							
Thailand			1,0226			4,6016	2,0452	
Tunesien	3,0678						1,5339	7,1581
Türkei								6,6468
Uganda	3,0678		4,0903					18,9178
Usbekistan		7,6694		3,4768				
Vietnam			1,2782					1,0226
Summe je Förderbereich	**148,2133**	**105,2044**	**127,0969**	**83,8007**	**3,6813**	**34,6145**	**26,5360**	**288,9310**

Table VII - 4 Bilateral financial and technical cooperation relating to the objectives of the convention - 2002

Beitrag des BMZ im Jahr 2002 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Afghanistan		0,5000				0,5000		2,5000
Ägypten				42,5000			2,2500	1,5000
Albanien			7,5000					5,0000
Algerien								0,3780
Amerika na (nur EL)						1,0000		1,5000
Aserbaidschan								10,0000
Asien na (nur EL)	2,0000		1,5000	0,9000				
Äthiopien	0,7670	13,3900	3,0000	14,2900				1,3500
Bangladesch	7,5000							
Benin			7,5220	2,9380		1,5000		11,5000
Bolivien		0,1054						
Bosnien-Herzegowin:								6,0000
Brasilien	1,0000		21,0000					
Bulgarien		0,2500	0,6000	0,1000		0,5000		
Chile	5,0450		1,5000				1,0000	
China (VR)	13,5000	13,0000	10,5000					21,0000
CILSS			2,5000					
Costa Rica		0,2000						
Cote d'Ivoire			4,5000	2,5000				1,5000
Ecuador	3,0000		1,5000	0,3000				5,0000
Eritrea								11,7170
ESCWA								0,2500
Georgien	8,0000					1,0740		1,0000
Guatemala								1,6000
Honduras			6,2500			2,7500		
Indien	36,5000		7,0000	2,8000			0,7000	
Indonesien		15,0000	1,8000	1,0000				
Jemen						4,2000		19,5000
Jordanien				3,0000				30,0000
Kamerun		8,0000	2,5000	1,5000				
Kenia	3,0000							
Kirgisistan				1,0000				
Kolumbien			5,0000					

Beitrag des BMZ im Jahr 2002 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Kongo, Demokratische Republik			0,5000					
Konventionsvorhaben			3,0000					
Kroatien								7,0000
Laos		2,5000	1,2500					
Madagaskar			2,5000					
Marokko	30,0000		4,5000					22,7500
Mauretanien			7,7500		3,0000			
Mazedonien				1,0000				
Mekong River Commission			3,5000					
Mongolei	10,2000							
Nepal	13,7500							
Nicaragua			2,0000			1,0000		8,0000
Niger	1,0000							
Pakistan	15,0000							
Palästinensische Gebiete				0,5000				25,2500
Paraguay							4,5000	
Peru			13,3000	0,3410				12,7000
Philippinen			0,3233					
Pilot-/Sektorvorhaben	4,2500		1,7500	3,0000		2,3500		1,5000
Rumänien	0,2500			0,8500		1,0000	1,0000	0,3000
SADC			2,2500					1,5000
Sambia		4,4000		1,0000				8,9000
Senegal	6,7780	6,0000	1,2780					
Serbien/Montenegro	22,0000	2,5000				4,0000	0,5000	16,5000
Südafrika			2,0000	2,0000				
Syrien								19,0000
Timor-Leste		1,3000						4,7000
Tschad		0,1374		3,7000				
Tunesien								4,6000
Türkei						2,5000		
Uganda		0,5727						

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Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Ukraine				5,0000				
Usbekistan		1,6000		1,0000				2,0000
Vietnam			2,0000	1,7500				26,0000
Zentralasien na (nur EL)				3,5500				
Summe je Förderbereich	**183,5400**	**69,4554**	**132,0733**	**96,5190**	**3,0000**	**22,3740**	**9,9500**	**291,9950**

Table VII - 5 Bilateral financial and technical cooperation relating to the objectives of the convention - 2003

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Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Afghanistan	5,5000					1,0000		8,5000
Ägypten	25,5000			16,0000				
Albanien	1,5000			0,7500				10,5000
Algerien								4,9000
Amerika na (nur EL)				1,1000				
Armenien	4,7000		2,5000			0,5000		7,0000
Aserbaidschan	0,5000		2,8500					
Bangladesch	5,0000							
Benin		3,2000						
Bolivien			10,2000	7,0000				14,3000
Bosnien-Herzegowin								8,0000
Brasilien	3,9500		19,2000					5,0000
Bulgarien		0,2500	0,3000	0,5000		0,2000		
Burkina Faso				10,6000				8,8000
Burundi								1,5000
Chile							5,8000	
China (VR)	7,5000		7,5000	7,0000				9,0000
Dominikanische Republik			1,8000					
EAC						1,5000		
El Salvador								1,0000
Eritrea								4,0000
Georgien	1,3000		1,6500					
Ghana			7,5000	7,0000				5,0000
Guatemala						2,0000		
Indien	7,2710		4,3000	1,2000			1,5000	23,2290
Indonesien		32,1000						
Irak								3,0000
Jemen							2,5000	19,7000
Jordanien								12,5000
Kambodscha	4,5000	7,0000				2,7000		
Kamerun			2,0000					
Kirgisistan	4,0000			0,6000				
Kolumbien			3,5000					

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Beitrag des BMZ im Jahr 2003 zum Klima-Nationalbericht

Summe der bilateralen Finanziellen und Technischen Zusammenarbeit i.e.S. (Angaben in Mio. €)

Empfängerland	Maßnahmen zur Minderung der TGH-Emissionen							
	1.Energie-erzeugung und Ver-sorgung	2.Trans-port	3.Forst-wirtschaft und Tropen-wald	4.Land-wirtschaft	5.Fische-reiwesen	6.Indus-trie	7.Abfall-wirtschaft- und ent-sorgung	8.Wasser-versorgung und Ab-wasser ohne Abfall-wirtschaft- und ent-sorgung
Kroatien						1,5000		4,5000
Lesotho				4,7450				
Libanon								6,0000
Madagaskar			14,2500					
Mali	3,7037			19,0000				12,0000
Marokko	4,5000							
Mazedonien						0,5000		
Mexiko			1,0000					
Mosambik		5,0000						
Naher und Mittlerer Osten na (nur EL)						1,0000		
Namibia		11,8500		4,0500		1,6000		
Nepal	8,0000							
Pakistan	20,0000							
Palästinensische Gebiete							1,0000	10,1000
Philippinen				1,5000				5,5000
Pilot-/Sektorvorhaben	2,0000			1,8000		2,7500	1,5000	1,0500
Rumänien	0,9000	1,0000		1,5000				
SADC			4,8000		1,0000	1,5000		1,0000
Sambia		3,0000						2,0000
Serbien/Montenegro	22,5000					14,0000	0,7000	13,8000
Sri Lanka	12,3000					2,8000		
Syrien								16,0000
Tansania			6,4000					40,1000
Timor-Leste		5,0000						
Tunesien						2,5000	7,0000	6,5000
Usbekistan		13,0000		1,0000				
Vietnam			14,5000			5,5000		5,5000
Zentralasien na (nur EL)				2,0000				
Summe je Förderbereich	**145,1247**	**81,4000**	**104,2500**	**87,3450**	**1,0000**	**41,5500**	**20,0000**	**269,9790**

VII.5. The projects

VII.5.1. Wind energy projects

If wind is to be used to a greater extent to generate power, potential investors/operators must be fully informed about the output options and the economic viability of the most recent generation of wind power plants delivering power to the national grid. Project planners, power utilities and other operators, as well as the plant manufacturers, must be granted access to national and international funding through attractive financing agreements. Technical discussions between financing institutes and potential operators of wind farms regarding terms of loans, including risk minimisation, warranty claims, contracts with power purchasers etc., are an important precondition in this context. The production of business plans and variations of the parameters contained therein make possible a precise analysis of the factors which determine which wind power projects will be profitable and can be financed (at least in part) on the market. The dialogue and research project also advises decision-makers from the field of energy politics and regulatory authorities, who are responsible for shaping the political and economic environment for the utilisation of wind power. Technical aspects of wind power utilisation are dealt with in special technical seminars; the basics are taught in introductory courses held at various universities, while more in-depth courses in Germany pass on the focused knowledge that has been assimilated there in the use of wind energy.

Table VII - 6 Utilisation of wind power

Project title: Contribution to sustainable energy supply through increased utilisation of wind energy in Brazil, Argentina, the People's Republic of China and selected African states.			
Project objective: Planners from consulting engineering offices, energy utilities and operator companies are enabled to play a responsible part in planning wind farm projects on a megawatt scale, from technical and economic vantage points. They are able to evaluate financing concepts and collaborate on realising the wind farms. Businesses in Argentina, Brazil and the People's Republic of China are enabled to maintain and repair the plant installed, to produce components and build and erect wind power plants under license. Project partners in Brazil and Argentina are also able to improve the preconditions for the future mobile and stationary use of fuel cells, whereby the electricity used in electrolysis to obtain hydrogen will come solely from wind or hydro-power. Investigations will also be conducted into the economic use of hydrogen as a transportable storage medium.			
Recipient countries: Brazil, Argentina, PR China, African states	**Sector:** Energy	**Funding:** Four individual projects with a total volume of EUR 2,238,000	**Term:** Ongoing since 2002

Project details: In China, InWEnt has also identified the further upgrading needs to step up economic cooperation with businesses operating in the wind energy sector. In future, InWEnt will be working with its project partner, the NPU (Northwestern Polytechnical University in Xi'an), the GTZ and its Chinese partners to set up the wind energy centre in Beijing. InWEnt will be providing capacity building services. InWEnt supported the founding of the African Wind Energy Association (AfriWEA) and the World Wind Energy Conference in Cape Town, and is currently running a one-year training programme in Germany for young wind energy experts from African states. The twenty participants come from Algeria, Burkina Faso, Egypt, Ethiopia, Kenya, Mali, Namibia, Nigeria, the Republic of South Africa and Uganda.
Principal adviser: Klaus Knecht InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482110
Influence on greenhouse gas emissions: Not quantifiable

VII.5.2. Climate protection and development through a sustainable energy supply

Market analyses identify goods and services, which can be produced at competitive prices. From the sale of these goods, the costs of the energy required to produce them (on the basis of renewable energies) can be covered. This creates jobs and generates income in rural communities on an exemplary basis, and makes a contribution to reducing rural poverty. InWEnt trains interdisciplinary teams which advise producers on production, selection and financing of the energy services/ systems needed, and on marketing the products.

Table VII - 7 Climate protection and development in MERCOSUR through sustainable energy supplies

Project title: Climate protection and development in MERCOSUR through sustainable energy supplies
Project objective: Technical and economic solutions to incorporating large-scale central renewable energy systems in the transmission and distribution grids are in use. By producing marketable goods and services on the basis of renewable energies, jobs are created and income generated in rural areas. Energy efficiency measures and the utilisation of renewable energies in urban buildings reduce emissions liable to damage the environment and the climate. Improved framework conditions help achieve this objective.

Recipient countries: Brazil, Argentina	Sector: Energy	Funding: EUR 720,000.00	Term: 2005 – 2008
Project details: Concepts to reduce the rate of increase in the use of energy in towns and cities have been elaborated. Architects, construction planners, city planners, energy experts and local decision-makers are learning about concepts for climate-appropriate neighbourhood development and energy efficient construction in tropical cities, and are using these. The implementation of the newly adopted law on selling electricity to the national grid (PROINFA) is to be further improved through expert discussions, and the government, network operators and utilities are to be advised on the clarification of detailed technical and economic questions, as are investors and operators of wind farms.			
Principal adviser: Klaus Knecht InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482110			
Influence on greenhouse gas emissions: Not quantifiable			

VII.5.3. Training and upgrading interdisciplinary teams of advisers

The project partners are enabled, with the help of capacity building measures, to devise and implement training courses both for interdisciplinary teams of advisers and for the operators of the renewable energy systems. These interdisciplinary adviser teams then conduct market analyses along with potential producers, in order to identify goods and services which can be produced at competitive prices, and from the sale of which the costs of the energy needed to produce them (on the basis of renewable energies) can be covered. In this way, jobs can be created and income generated in rural communities on an exemplary basis, and a contribution made to reducing rural poverty. The interdisciplinary adviser teams advise producers on the production and marketing of products and on the selection and financing of appropriate energy services and systems.

Table VII - 8 Integrated Southern Africa Business Advisory – INSABA

Project title: Integrated Southern Africa Business Advisory – INSABA			
Project objective: In the four partner countries, pilot regions are being selected and interdisciplinary advisory teams trained. These can advise micro and family businesses on the production of marketable goods and services, produced using renewable energies. This generates a targeted demand for renewable energy systems. At the same time, small businesspeople who design and sell renewable energy systems (supply side) are to be enabled to meet this demand in an appropriate way.			
Recipient countries: RSA, Namibia, Botswana, Zambia	**Sector:** Energy	**Funding:** EUR 237,367.00 EU-COOPENER EUR 216,530.00 BMZ	**Term:** 2005 – 2007
Principal adviser: Klaus Knecht InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482110			
Influence on greenhouse gas emissions: Not quantifiable			

VII.5.4. The environment and environmental conflicts in Algeria

Through dialogue and training measures, as well as expert discussions, high-ranking decision-makers from the environmental administration (e.g. environmental directors), staff members of state environmental institutions and state-owned businesses, representatives of civil society, researchers, journalists and media representatives were introduced to the basics of conflict theory and transformation, and acquainted with modern methods of peaceful conflict management. Their ability to articulate problems in the environmental sector, to perceive positions, interests and needs of the parties to the conflict, to facilitate in the process of reconciling legitimate interests and avoiding differences of opinion degenerating into violence was fostered. They learned how to use communication and facilitation techniques, what the preconditions are for successful mediation, and what mediation can bring. They came to recognise the advantages for the process of conflict resolution of involving all participants.
The use of the new methods and instruments was also discussed with reference to resolving climate-relevant conflicts and realising and implementing measures to reduce emissions of CO_2. The contact officer at CRASC is an expert for CDM projects in Algeria.

Journalists writing about environmental problems publicised the conflict management and mediation approach through their newspaper articles. They learned how an objective and comprehensive report, which clearly outlines the problems involved and the respective interests of the parties to the conflict, can help defuse the conflict, and achieve a peaceful solution using objective arguments.

Table VII - 9 The environment and environmental conflicts in Algeria

Project title: Strengthening the conflict management capacities of Algerian leaders in the environmental sector			
Project objective: Algerian leaders were to be convinced of the value of participatory and communicative conflict resolution strategies to enable them to make a contribution to resolving environmental conflicts peacefully. With the help of capacity building services, the Algerian partner organisation CRAS was built up as a coordination unit for conflict management. Media representatives and journalists learned to report objectively on environmental conflicts and to describe the interests of all stakeholders involved in the conflict in an objective fashion.			
Recipient countries: Algeria	**Sector:** Environment	**Funding:** EUR 309,631.32 BMZ EUR 17,500.00 GTZ/GATE	**Term:** 2002, 2003, 2004
Principal adviser: Klaus Knecht InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482110			

VII.5.5. CDM and JI projects to reduce CO_2 emissions

Businessmen and women and potential investors from Germany and the respective partner country are exploring the options for common economically and technically feasible CDM projects. It is ascertained where highly efficient energy technologies such as procedures to ensure the complete combustion of coal or decentralised combined heat/power/refrigeration plants and wind farms not only reduce the burden on the global climate but also, by including CERs (emission reduction certificates issued by CDM projects) are also economically attractive (i.e. a win-win option). Their understanding of the framework conditions, expectations and interests of potential project partners and their understanding of the regulations applying to CDM projects is being consistently expanded. (cf. www.klima-workshop.de).

The discussion also includes the interest, for instance, of the Chinese side in finding purchasers of CERs and the issue of switching these CERs for certificates of the EU emissions trading system (AAUs), i.e. linking project-related flexible mechanisms of the Kyoto Protocol with the EU's emissions trading system (linking directive).

The CDM and legislation governing the sale of power to the national grid are often seen as being mutually obstructive. Given the fact that to date few CDM projects have been realised in the field of renewable energies, a question now being asked is how these two instruments can best complement one another, or how the legislation must be worded in order to lay the foundations for the realisation of CDM projects in the field of renewable energies.

Table VII - 10 CDM and JI projects to reduce CO_2 emissions

Project title: Designing CDM and JI projects to reduce CO_2 emissions			
Project objective: The series of workshops serves firstly to foster an exchange of information among members of the negotiating delegations at climate conferences, in particular among representatives of industry and potential investors from Germany and the respective partner country, with a view to planning and realising CDM projects. In this way, the foundations can be laid for a know-how transfer in the field of energy-efficient technologies and renewable energies, and for joint ventures to realise CDM projects.			
Recipient countries: Brazil, China, RSA	**Sector:** Energy	**Funding:** EUR 200,000	**Term:** 2004– 2006
Principal adviser: Klaus Knecht InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482110			
Influence on greenhouse gas emissions: Not quantifiable			

VII.5.6. Environmental management taking special account of efficient use of energy

The utilisation of natural resources and raw materials in the Cuban economy was moulded for three decades by the directives and models of the Council for Mutual Economic Assistance (COMECON). It was not until the 1990s, under the pressure of the economic crisis, energy shortages and the economic opening up of the country, that Cuba began to take a fresh look at the use of raw materials and fuels. After the UNCED conference in Rio de Janeiro, topics such as climate protection, environmental management and efficient use of energy were presented and discussed in the Cuban media. The development of concepts for action, however, remained limited to isolated examples. The introduction of environmental management and the efficient use of energy are nevertheless central challenges that must be mastered by Cuba if it is to become internationally competitive. In order to achieve effective impetus to further the introduction of environmental management and the efficient use of energy, topics and sectors were selected which bring together factors of macroeconomic relevance that have a high profile in Cuban public opinion:

- By introducing environmental management in industries and service businesses concentrated around the port of Havana, a contribution was made to the urgently needed rehabilitation of the Bay;
- Energy advisers were trained for the most important traditional sector of the Cuban economy (sugar), and the dynamic new tourism sector; they are able to identify high potentials to save energy and to pass on their knowledge to decision-makers, leaders and technicians.

Table VII - 11 Environmental management in Cuban industry taking special account of the rational use of energy (RUE)

Project title: Environmental management in Cuban industry taking special account of efficient use of energy in the sugar industry and the hotel sector			
Project objective: The project pursues two main objectives: Strengthening the environmental management capacities of administrative, economic and technical leaders responsible for the rehabilitation process in Havana Bay, taking special account of energy management. Training qualified Cuban experts as energy advisers who are able to develop and realise concepts and appropriate solutions to save energy, ensure the efficient use of energy, utilise renewable energies and improve energy productivity in the sugar industry and the hotel sector.			
Recipient country/region: Cuba	**Sector:** Environmental management, energy	**Funding:** **EUR 944,824**	**Term:** 2000-2003
Principal adviser: Werner Uka InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482104			
Influence on greenhouse gas emissions: Not quantifiable			

VII.5.7. Energy and the environment in the energy sector

Since Independence in 1947, India's power generation capacity has expanded enormously, rising from 1,362 MW at Independence to an installed capacity of 96,000 MW in the year 2000. Against the background of the country's massive economic growth, and its rapidly expanding population, power generation capacities can be expected to continue expanding rapidly. There are plans to install an additional 40,000 MW or so of capacity by 2010. The lack of efficiency in the electricity sector, both in terms of power generation and the high losses sustained during transmission and distribution, coupled with an urgent need to modernise existing coal-fired power stations, are the greatest challenges facing the Indian electricity industry today.

Two training programmes with theoretical programme sections and practical training placements lasting one year, which address middle managers of coal-fired power stations were held, focusing on improving the technical expertise and boosting the managerial skills of participants. Conservation issues and the need to use renewable energies as well as the use of specific climate protection instruments (CDM) were an integral part of these training courses.
To complement this, several technical events were organised jointly with the India Energy Forum (IEF) for the Indian energy community. They looked at energy efficiency, renewable energies, and climate change and the Kyoto Mechanism.

Participants were enabled:

- To enhance environmental awareness inside their own companies and within their own spheres of influence
- To increase the reliability, availability and quality of energy supplies
- To introduce technical and organisational innovations in their own companies and institutions
- To take into account pollution in the power plant and to incorporate the costs of environmental protection measures (direct and external) when planning energy systems
- To raise efficiency in the use of energy (in particular the use of electricity) through improved demand side management (DSM), the use of energy-saving technologies/ substitution of fuels and regular preventive maintenance work
- To support decision-makers in resolving problems (economic assessment of investments, least-cost planning).

Table VII - 12 Energy and the environment in the Indian energy sector

Project title: Energy and the environment in the Indian energy sector
Project objective: Middle managers of Indian power utilities, most of whom worked in coal-fired power stations, were given a knowledge of the most modern, resource-appropriate power station technologies, which can also reduce emissions, of possible options for recycling waste products, and the use of renewable energy sources.

Recipient country/ region: India	Sector: Energy	Funding: EUR 1,252,486	Term: 2002-2004
Principal adviser: Werner Uka InWEnt gGmbH Lützowufer 6-9 D-10785 Berlin Tel.: ++49-(0)30-25482104			
Influence on greenhouse gas emissions: Positive, but not quantifiable, reduction through more efficient use of fuels. Similarly structured precursor programmes led to savings of over EUR 9 million in 2002 in the state of Punjab alone, when staff of three power stations applied the new knowledge they had acquired in Germany.			

VII.5.8. Innovative energy supply strategies for rural areas of Africa

In rural parts of Africa that are far from the national grids, electricity has to date as a rule been generated by diesel generators, with only a simple regulatory mechanism. Efficiency or environmental considerations have hitherto played practically no part in the use of these generators.

For the successful long-term operation of hybrid plants using vegetable oil (biofuels), experts in the fields of agriculture and renewable energies are needed: there is also a severe shortage of technicians able to maintain and service the generators to be operated using vegetable oil. However, experience gained in Mali in the 1990s by the GTZ project using Lister-Petter generators was positive. These units have proved their worth in developing countries for many years now, and had to be modified only slightly for the planned use as hybrid units.

As regards the cultivation and utilisation of oil plants, (e.g. jatropha or physic nut), initial experience has been gained in Mali, where these nuts are used to produce soap. The idea of using them to produce plant oil, however, is totally new. The knowledge required to extract, store and process oil therefore still has to be transferred to all three countries.

So as to ensure and enhance the sustainability of the planned projects, the political decision-making level was also involved, since they had hitherto been unable to really assess the utilisation of renewable energy sources.

Table VII - 13 Innovative energy supply strategies for Africa

Project title: Innovative energy supply strategies for rural areas of Africa			
Project objective: The project aimed to demonstrate the technical feasibility, economic soundness and social suitability of innovative hybrid village power plants in practice, and to enable multipliers to train the local personnel needed to produce and operate plants of this sort. To help ensure the maximum distribution of plants of this sort, political decision-makers in the respective partner countries were sensitised to the strategic importance of hybrid plants of this sort.			
Recipient countries: Mali, Ghana, Tanzania	**Sector:** Energy	**Funding:** EUR 1,114,000	**Term:** 2003– 2005
Principal adviser: Michael Funcke-Bartz InWEnt gGmbH Weyerstr. 79-83 D-50674 Cologne Tel.: ++49-(0)221-2098 161			
Influence on greenhouse gas emissions: Not quantifiable			

VII.5.9. Project-financed construction of a wind farm close to Qingdao, China

An established European wind plant manufacturer with a large market share in China has, for the first time, realised a project financing arrangement with a Chinese partner business in the wind power sector in China; this is the third project of its sort anywhere. The salt pans in which the wind farm is to be set up are only some 57 km from the city centre of Qingdao, close to the small community of Jimo. The land has been reclaimed from the sea and lies immediately behind an embankment at sea level. The usable area measures some 26 km^2. To date the salt pans have been used exclusively to produce salt. There are practically no settlements or other land use forms in the vicinity of the salt pans.

The project is of vital importance for China's future. The endeavours to replace the large number of coal-fired power stations and the pollution they cause at least in part with clean methods of power generation is being put into practice. The project will help overcome capacity shortfall in the local electricity network. The town of Qingdao can raise its share of clean energy and thus help achieve the goal of reducing emissions in Chinese towns and cities. Within the scope of setting up and operating the plants (in particular in the field of technical management) a know-how transfer can be ensured, passing on new expertise to the Chinese partners.

Moreover, the private-sector financing of a sound power generation project in the field of renewable energies paves the way for the nationwide distribution of wind technology, now well-established in Europe, on the Chinese market.

Table VII - 14 Project-financed construction of a wind farm in China

<table>
<tr><td colspan="4">Project title:
P-3103 – QHW - Qingdao Huawei Windpower Co. Ltd</td></tr>
<tr><td colspan="4">Project objective:
The power generated by the wind farm will be fed into the grid of Shandong Province, China. The total capacity of the wind farm will be 16.35 MW. The project company is based in the town of Qingdao in Shandong Province on the East Coast of China.</td></tr>
<tr><td>Recipient country/region:
China</td><td>Sector:
Wind power</td><td>Funding:
DEG funds (commercial loan)</td><td>Term:
8 years including 1 free year</td></tr>
<tr><td colspan="4">Principal adviser:
DEG – Deutsche Investitions- und Entwicklungsgesellschaft mbH, Mr. Vitinius, Head of the Infrastructure Division, Belvederestr. 40, 50933 Cologne, Germany, Tel. ++ 49 (0)221-4986-1144</td></tr>
<tr><td colspan="4">Influence on greenhouse gas emissions:
A consulting firm working on behalf of the DEG has calculated a baseline on the basis of the local energy mix for quantifying the CO_2 savings attributable to the wind farm once it comes on line. This also takes into account CO_2 generated by the construction of the wind farm, in particular that resulting from the use of steel and concrete. The study concludes that the wind farm will result in an annual reduction of some 25,000 tonnes CO_2 per annum – up to the end of the first commitment period covered by the Kyoto Protocol (the end of 2012) the wind farm would thus prevent emissions of some 239,000 tonnes CO_2.</td></tr>
</table>

VIII. Research and systematic observation

In Germany research aimed at sustainability, including research in the field of “global change”, is funded largely by financial assistance from the Federal Ministry of Education and Research (BMBF) and the German Research Association (Deutsche Forschungsgemeinschaft – DFG). Assistance by the Federal Ministry of Education and Research takes the form of project assistance or – with co-financing by one or more *Laender* – of institutional assistance in the Helmholtz Association of German Research Centres (HGF) or through suitable forms of finance in establishments of the Max-Planck-Gesellschaft (MPG), the Fraunhofer-Gesellschaft (FhG), and the Leibniz Association (WGL), which are financed in accordance with the “Blue List” model. Individual research establishments and projects are also financed by other federal ministries, among them the Federal Environment Ministry via the Federal Environmental Agency (UBA), and the Federal Ministry of Transport, Building and

Urban Affairs via the German Weather Service (DWD). The *Laender* – to some extent in cooperation with the federal level – also support research in this field.

In view of the bewildering multitude and variety of relevant factors, the scientific quest for sustainable paths for global change makes it necessary to overcome barriers between scientific disciplines, as the Federal Government's "Advisory Council on Global Environmental Change" (WBGU), set up in 1992, seeks to do. The Advisory Council regularly presents recommendations on action and research to the Federal Government. The Advisory Council's annual expert reports to date have focused on a variety of topics, including soils [1994], fresh water [1997], environmental risks [1998], biosphere [1999], global environmental policy [2000] and global energy policy [2003]). These reports repeatedly draw attention to the complexity of global interactions and the resulting challenge for research. In special expert reports on CO_2 reduction targets [1995] and climate protection objectives [1997], the Kyoto Protocol [1998] and climate protection strategies looking beyond Kyoto [2003], the Advisory Council has also examined the topic of climate change more closely.

Research into global change rests on four thematic cornerstones: the following interlinked project assistance measures established by the Federal Research Ministry in 1999 and 2000

- "Global changes in the hydrological cycle" (GLOWA);
- "Biodiversity and global change" (BIOLOG);
- "Atmospheric research 2000" (AFO 2000);
- "German climate research programme" (DEKLIM).

The German climate research programme (DEKLIM), which was started in 2001 and designed to run for 5 years, follows on from earlier financial assistance measures by the Federal Ministry of Education and Research (BMBF): the assistance measure "Climate system research" (1987-1994), sectoral assistance measures for research into climate impacts (1990-2000), and the assistance measure "Applied climate and atmospheric research" (1997-2000). To supplement these measures, DEKLIM – like GLOWA, BIOLOG and AFO 2000 – pursues a more integrated, interdisciplinary and international approach and at the same time seeks to cultivate the rising generation of scientists. DEKLIM focuses on the following key areas:

- Palaeoclimate: "proxy data" (ice cores, corals, marine sediments, tree rings) can help to reconstruct past climate variations and also extreme events such as periods of drought. Model studies are conducted hand in hand with the investigation of proxy data and thus open up a new dimension of palaeoclimate research in DEKLIM.
- Climate variability and predictability: understanding present and past climate variability and the geoprocesses responsible for it is a major precondition for developing efficient climate models and hence for model-based predictions of future climate trends (and possible abrupt climate changes).
- Regional process studies in the Baltic Sea region: contribution to the final measuring and analysis phase of the "Baltic Sea Experiment" (BALTEX) which is an integral part of the "Global Water and Energy Cycle Experiment" (GEWEX) of the World Climate Research Programme (WCRP).

- Climate impact research: investigating the interactions of climate change with natural and socio-economic systems improves the scientific knowledge base for specific measures.

The Federal Ministry of Education and Research promotes the integration of German global change research in international and European programmes and makes it possible for the scientists involved to participate and play an active part in coordination meetings at national level and in the organisation of international cooperation. The institutions assisted include:

- the international secretariats of the IHDP, the IGBP core project BAHC and the established European regional project BALTEX in the WCRP experiment GEWEX;
- one national coordination unit each for contacts with the IPCC and the international programmes (WCRP, IGBP, IHDP, DIVERSITAS).

The German IPCC coordination unit set up by the Federal Education and Environment Ministries supports the inclusion of the results of German climate research in the IPCC process, as most recently in the preparation of the Fourth Assessment Report (AR4). More than 30 German climate researchers work for the IPCC in the various author and management bodies.

The priority research topics pursued in the past decade with assistance from the Federal Ministry of Education and Research focused on improving our understanding of the climate system, developing environmental policy instruments, and cultivating the rising generation of scientists.

The result of this research work and its funding to date is an impressive wealth of background knowledge for politics, industry and society that is sufficient for putting the existing findings into practice. The necessary transition from knowledge to action – not only in the field of climate protection – implies a paradigm change in policy on financial assistance for research. This is in line with an over-arching development of the Research Ministry assistance programmes. Aware of the strategic importance of education and research for sustainable development, the Federal Ministry of Education and Research has continuously developed its assistance on this front into a systematically oriented innovation strategy based on the principles of inter-generation responsibility (precautions based on reliable forecasts), integration (interlinking of ecological, economic and social objectives) and participation (strengthening the individual responsibility of the relevant actors). Through interdisciplinary and transdisciplinary research the Federal Ministry of Education and Research links technological advances with organisational and social processes and promotes transfer to the education systems.

The BMBF framework programme "Research for sustainability" which was approved by the Federal Cabinet in 2004 and which implements the research assistance policy aspects of the Federal Government's national sustainability strategy approved by the Federal Cabinet in April 2002, takes even greater account than in the past of the economic and global perspectives of sustainability and regards them as a driving force for innovations in government, industry and society. The framework programme has four fields of action:

- concepts for sustainability in industry and business (e.g. climate protection strategies)
- sustainable use concepts for regions (rural/urban/sensitive regions)
- concepts for sustainable use of natural resources (e.g. water)
- societal action aimed at sustainability (e.g. lifestyles, product use)

The non-university research institutionally financed or co-financed by the Federal Government (HGF, MPG, FhG, WGL) is to be more closely integrated in this concept; these institutions are to be encouraged to cooperate with universities. For example, the project-financed activities in the fields of action mentioned above are to be complemented by the institutionally financed, programme-oriented research of the HGF. A number of Helmholtz centres contribute their expertise to the relevant HGF research field "Earth and environment":

- the Alfred Wegener Institute for Polar and Marine Research (Alfred-Wegener-Institut für Polar- und Meeresforschung – AWI)
- the German Aerospace Centre (Deutsches Zentrum für Luft- und Raumfahrt – DLR)
- the Jülich Research Centre (Forschungszentrum Jülich – FZJ)
- the Karlsruhe Research Centre (Forschungszentrum Karlsruhe – FZK)
- the Biotechnology Research Association (Gesellschaft für Biotechnologische Forschung – GBF)
- the Potsdam Georesearch Centre (GeoForschungsZentrum Potsdam – GFZ)
- the research centre GKSS-Forschungszentrum Geesthacht (GKSS)
- the GSF Research Centre for Environment and Health (GSF-Forschungszentrum für Umwelt und Gesundheit – GSF)
- the Leipzig-Halle Environmental Research Centre (Umweltforschungszentrum Leipzig-Halle – UFZ).

The HGF research field "Earth and environment" is made up of six programmes which are more or less closely related to climate change:

- Geosystem: The changing Earth (coordination: GFZ)
- Atmosphere and climate (coordination: FZK)
- Marine, coastal and polar systems (coordination: AWI [coast: GKSS])
- Biogeosystems: Dynamic change and adjustment (coordination: FZJ)
- Sustainable use of landscapes (coordination: UFZ)
- Sustainable development and technology (coordination: FZK)

The HGF programme "Atmosphere and climate" comprises investigations into the complex interactions in the atmosphere and the processes of interchange with other geo-compartments; the relevant tasks include organising large-scale field experiments (including planning and operation of the scientific infrastructure), operating atmospheric simulation chambers and research aircraft, and planning and performing satellite experiments. The HGF programme Geosystem: "The changing Earth", in its climate-related parts, contributes to our understanding of climate variability and climate-relevant substance cycles; the tasks include explaining and modelling relevant geoprocesses, carrying out status and trend monitoring (including palaeoclimatology), and making use of large-scale scientific infrastructure for global observation (on the basis of international cooperation). The HGF programme

“Marine, coastal and polar systems” includes studies of the influence of the oceans on climate and of the impact of climate change on coastal regions. The HGF programme “Sustainable use of landscapes” is concerned among other things with the topic of “consequences of climate change for land use”.

The assistance measure “Research aimed at climate protection and protection against the impacts of climate change”, which is run by the Federal Ministry of Education and Research and is part of the action field “Sustainability concepts for industry and business” under the framework programme “Research for sustainability”, explores options for climate protection through emission reduction (mitigation) and for adjusting to climate trends (adaptation), and takes account of educational aspects (for details see Chapter VIII.4). It pursues a multidimensional and integration-oriented policy approach that links economic, ecological and social aspects of climate change.

The aim here is to dovetail public research with industrial development; the potential clientele in business, society and politics was involved in the process of identifying scientific topics and setting priorities. The financial assistance includes industry and other potential clients in society, to cater for the need for demand-oriented research and development projects. It also contributes to the establishment of networks between all areas of research and development and to improving the flow of information between industry, science and society.

The activities under the framework programme are linked with the programme-oriented research of HGF, especially the programme fields “Earth and environment”, “Energy” and “Key technologies”, in a way that enables the HGF to contribute infrastructure services and long-term or large-scale studies in particular.

The many and various research activities outlined above are described below in more detail, as examples on a cross-sectional basis for the subject areas “Climate system and variation” (Chapter VIII.1), “Modelling and forecasting” (Chapter VIII.2), “Climate impacts” (Chapter VIII.3) and “Options for action” (Chapter VIII.4).

In addition, a detailed account of “Systematic climate observation in Germany” can be found in the annex to this report (Annex II). This contains descriptions of a broad spectrum of observation and monitoring systems on which information is available. Although incomplete in certain areas, it provides what is currently the most complete overview of climate observation systems in Germany.

VIII.1. Climate system and variability

The “Geotechnologies” programme initiative launched jointly by the Federal Ministry of Education and Research and the DFG in 1999 made important contributions to our understanding of the Earth as a system, and especially of the climate system. The 13 key topics defined in the programme include a number that are closely related to climate change, e.g. “Observation of the Earth system from space”, “Global climate change – causes and effects”, “Gas hydrates: energy sources and climate factor” and “Information systems in Earth management”.

Understanding natural climate variability is an important precondition for being able to forecast future climate trends (having regard to anthropogenic influences) with adequate quality. The importance of this topic is clearly demonstrated by the working title: “Climate development – from understanding variability to making forecasts” of the German climate research programme DEKLIM with its focus topic “Climate variability and forecastability”.

Investigating the causes of climate variability calls for analysis of directly measured or indirectly derived observations of both the present climate and climatic conditions in the past, and also further improvements in the modelling of coupled systems (especially ocean and atmosphere, but also biosphere, land and ice surface).

Under the DEKLIM focus topic “Climate variability and forecastability” assistance is given for research relating to the relevant WCRP core project CLIVAR, which – through additional contributions in the DEKLIM focus “Palaeoclimatology” – is modelled on the IGBP programme PAGES. The work is based on findings from the joint project “Natural climatic variations during historical times” (KIHZ), which was assisted with institutional funds (strategy fund) from the HGF and project funds from the Federal Ministry of Education and Research to include universities and WGL establishments. With the aim of achieving a consistent description of the space-time patterns of past climatic situations, the focus here is on using and networking bioscience and geoscience data from various archives, and also on drawing up a synthetic global time scale and developing transfer functions for deriving climate variables.

These projects are closely dovetailed with palaeoclimatological projects that are closely connected with climate modelling. The main focus is on the issues agreed in the context of the CLIVAR-PAGES initiative, and on projects that also make significant contributions to our understanding of natural climatic variability with a view to the forecastability of future climate developments, especially those that are responsible for variability on time scales ranging from seasons through years and decades to a few centuries.

Institutionally assisted research in this field is now carried on primarily in the HGF programme “Geosystem: The changing Earth”, section “Climatic variability and human habitat” (AWI, GFZ).

VIII.1.1. Hydrological cycle

The global hydrological cycle is a major component of the climate system. When answering questions about the availability, quality and distribution of water in different climate zones, it is necessary to have a detailed knowledge of the causes and consequences of global changes in the hydrological cycle in order to be able to develop a sustainable and viable system for managing ecosystems and communities.

It was for this purpose that in 2000 the Federal Ministry of Education and Research launched the 8-year assistance measure GLOWA, the aim of which is to develop integrated strategies for sustainable and forward-looking management of water and bodies of water on a regional scale, having regard to ecosystem relationships and socio-economic framework conditions. In it, the core issues and detailed parameters of global changes in the hydrological cycle are to be determined and investigated on an interdisciplinary basis for various river basin districts in case studies of varying complexity with regard to water availability and the quality and distribution of the water resources. Here there are numerous connections with DEKLIM.

Taking account of different climatic zones as necessary, a number of river basin districts are investigated in sub-programmes under GLOWA (Draâ [Morocco] and Ouémé [Benin], and Volta, Danube, Elbe and Jordan). The following core topics are of central scientific importance here:

- natural and anthropogenic climate and precipitation variability and its impact on the hydrological cycle,
- interactions between hydrological cycle, biosphere and land use, and impacts on land use change,
- water availability and use conflicts: population development, urbanisation, migration and industrialisation, and the associated changes in demands on water availability and quality; interactions between water (availability, quality and distribution) and human health.

Work on the spectrum of tasks in the GLOWA assistance measure takes the form of integration-oriented and interdisciplinary networked projects. The above mentioned projects are currently in the second of three 3-year assistance phases.

The WCRP experiment GEWEX on the global water and energy cycles also includes regional process studies, including the established international project BALTEX (see above). Central topics here are the influence of large-scale climatic anomalies on climate variability in the Baltic region, influence of the variability of heterogeneous land surfaces and of the Baltic Sea and its annual ice cover on the water and energy balance in the Baltic region, development of an integrated model system for registering the interactions between the components: atmosphere, Baltic Sea, land surface, lakes and hydrology. Particularly relevant from a methodological point of view are new data assimilation techniques and model validations using measurements from the operational measuring network, measuring campaigns and remote sensing.

VIII.1.2. Atmosphere

Despite national reduction efforts, pollutant emissions in the industrialised regions of the middle latitudes remain at a high level and in some cases are continuing to rise. The rapidly growing emission rates in developing and threshold countries are making an increasing contribution to atmospheric pollution. Changes in trace gas concentrations in the troposphere not only have a direct influence on the well-being of people and ecosystems in the heavily polluted regions, but also have an impact on the regional and global climate.

Following numerous precursor programmes, the Research Ministry's assistance programme "Atmospheric Research 2000" [AFO 2000], which was launched in 1999 and designed to last five years, placed financial assistance for German atmospheric research on a new footing. Instead of the previous isolated treatment of specific issues – mainly separated into geographical compartments – it brought together the activities of the four key areas described in an integrated system approach. AFO 2000 pursues three main goals of research policy:

- improving our understanding of the atmosphere as a system
- developing and providing instruments for environmental policy
- cultivating the rising generation of scientists in the field of atmospheric research.

The research work is organised in the following four integrated or interdisciplinary groups of topics:

- Interactions between Earth's surface and atmosphere: analysis of energy and substance cycles in the atmosphere with the Earth's surface as source or sink for these parameters.
- Chemistry, dynamics, radiation and their interactions: investigation of the reciprocal influences of the various layers of the atmosphere – mesosphere, stratosphere and troposphere – and their reciprocal impacts on dynamic, physical and chemical processes.
- Multi-phase processes: studies on aerosols (solid and liquid phase particles) and cloud systems and on polar stratospheric clouds.
- Analysis of atmospheric system: models and data: synoptic analysis of observation data (especially from satellites) and results of complex numerical model calculations.

AFO 2000 is closely connected with the Research Ministry's assistance measure DEKLIM, especially the focus topic "Climatic variability". Institutionally assisted research into trace substance cycles is conducted at, for example, the Max Planck Institute for Biogeochemistry in Jena and the Max Planck Institute for Chemistry in Mainz.

VIII.1.3. Agricultural and forestry emissions and sinks

Agricultural activities are not only affected by climate change, but also contribute directly to the emission of greenhouse gases, especially CH_4 and N_2O, and hence to climate change. In addition, emissions of NH_3 indirectly affect the heat and substance balance of the Earth's atmosphere: NH_3 emissions result in the formation of secondary aerosols, which may have a significant influence on the radiation balance. They contribute to the eutrophication of natural and near-natural ecosystems and to indirect emissions of N_2O. Mineralisation of organic components is promoted in natural soils by nitrogen inputs from the air and in agricultural soils by cultivation and fertilisation, resulting in CO_2 emissions which, unlike other CO_2 emissions by agriculture, do not have a neutral impact on the accounts. On the other hand, fixation of organic carbon in soils or forests (sink) is also possible.

The Research Ministry's financial assistance for climate protection research in the fields of agriculture and forestry seeks to fill existing gaps in our knowledge about the processes by which greenhouse gases (including CH_4) are formed in the agricultural sector and the potential for using forests (afforestation) as temporary CO_2 sinks. On this basis the aim is to provide new action concepts for sustainable agriculture and forestry and, by developing new technologies, to promote energy efficiency in the associated value added chains, for example.

In-depth studies of possible impacts of climate change on forests and forestry in Germany and on the operational options were made under the joint project "Forests and forestry in Germany and global change” (1997-2001), which was assisted by the Research Ministry. The Federal Ministry of Education and Research also provided early assistance for pilot projects on the impacts on agriculture.

VIII.1.4. Marine and polar research

Since the ocean directly influences the Earth’s heat balance and substance balance, the principal objective of climate research related marine and polar research is further clarification of the role of the ocean and the polar regions in the global climate system. The polar regions and certain regions of the oceans are key regions for global climate events. Polar ice and sediments are climate archives from which it is possible to read details of past climate fluctuations. It is a known fact that climate changes influence ocean current systems and the mass balance of the polar ice caps. They may also lead to fundamental changes in the flows of heat and climate-influencing gases.

Germany participates in the relevant core projects of the WCRP (especially: ACSYS, WOCE, CLIVAR) and the IGBP (especially: JGOFS, PAGES). The main focus is on investigating global circulation and heat transport, the global hydrological balance and the global carbon cycle including associated gases. However, the role of the world’s oceans in the Earth’s climate system cannot be understood without including the ocean deeps. To be able to quantify, model and forecast the transportation of substances and energy in the depths of the oceans, the Federal Ministry of Education and Research has developed and implemented a concept in conjunction with scientists.

Sediments and ice deposits are being investigated in key areas in the context of PAGES, ODP (Ocean Drilling Programme) and EPICA (European Project for Ice Coring in Antarctica). These investigations yield palaeoclimatological findings about the development of the climate and of biochemical substance cycles in the course of the Earth’s history. These findings forms building blocks for use in models and forecasts of future changes in the coupled ocean-atmosphere system. Close thematic connections exist here with the DEKLIM focus topic: “Climate variability and forecastability”.

Institutionally assisted research in this field is principally carried on in the HGF programme “Marine, coastal and polar systems”, sub-programme “Ocean and global climate” (involving mainly AWI, GKSS).

VIII.1.5. Observation systems

There is a considerable need for observation with regard to the present status and development of the climate system and its subsystems, and also with regard to the status of systems and structures which are either natural or used by humans and are affected by climate changes or by global change in general.

Many of the observation systems mentioned below can be classified in terms of content and/or organisation as belonging to the fields of both research (primarily: Chapter VIII.1 to Chapter VIII.4) and systematic observation (Annex II), which makes it difficult to differentiate between them and inevitably means that their contents overlap.

German institutions such as the German Weather Service (DWD) and the Alfred Wegner Institute (AWI) play a considerable role in international measuring networks for observing the atmosphere (GCOS), the seas (Global GOOS) and land surfaces (GTOS).

Suitable measuring instruments for field measuring campaigns have been developed and used under German environmental research assistance measures. This applies to both in situ measurements and remote sensing. The measuring platforms available include balloons, aircraft and research vessels (e.g. “Polarstern”).

A new dimension of aircraft-based atmospheric research is to be opened up with the research aircraft HALO (High Altitude and Long Range Research Aircraft). Starting in 2008, HALO will climb to the lower stratosphere, allowing German and international scientists to conduct investigations of hitherto unparalleled quality. With a maximum altitude of over 15 kilometres, a range of more than 8,000 kilometres and a payload of three tonnes, HALO is to provide access to the altitude range of ten to fifteen kilometres, which is of special importance for chemical process and the climate. The key research areas of HALO include investigations into the formation of precipitation, which is of importance for the climate and the development of extreme weather events, including transportation of moisture and cloud water, self-cleaning processes in the atmosphere, and the chemical and dynamic processes in the transitional region between troposphere and stratosphere. Thus the planned key research areas permit a deeper insight into possible climate changes and extreme weather events, and are therefore of great importance not only from a scientific, but also from a political point of view.

Germany’s activities in the field of satellite-assisted observation of the Earth are very diverse. For example, Germany plays a major role in the missions of the European remote sensing satellite ERS-1, which are used for environmental observation of the Earth, and in the work of analysing the data obtained. Germany also plays a substantial part in the POEM-1 programme decided by the European Space Agency (ESA) council meeting in Munich in 1991. The programme consists of the environmental satellite ENVISAT-1 and the operational meteorological satellite METOP-1.

The main aim of the ENVISAT mission is to make a significant contribution to studying the environment, especially in the fields of atmospheric chemistry and ocean/ice. Moreover, thanks to instruments operating in the radar range, it will also permit observation of the Earth’s surface unhindered by clouds and darkness. ENVISAT carries ten different scientific instruments on board, including the “Scanning Imaging Absorption Spectrometer for Atmospheric Cartography” (SCIAMACHY), which will make a major contribution to exploration of the atmosphere. SCIAMACHY has been made available to ESA jointly by Germany, the Netherlands and Belgium.

Together with SCIAMACHY, the two instruments MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) and MERIS (Medium-Resolution Imaging Spectrometer) constitute an ENVISAT payload package that is optimised for the goals of the ATMOS programme. MIPAS is a horizontal-sounding passive Michelson interferometer for studying atmospheric trace gases. It operates in the mid infrared range. Within ATMOS, financial assistance was given for the establishment of a ground segment for scientific analysis and an extensive parallel scientific study on the development of the MIPAS sensor. The instrument MERIS, a medium spectral resolution wide-angle imaging spectrometer, will be used for ocean and land sensing in the visible and near-infrared spectrum. Under the ATMOS project, special data products have been developed for MERIS which will greatly enlarge the quality and range of possible applications of the data supplied by ESA.

The German activities in preparation for the ENVISAT mission were embedded in the ATMOS programme started in 1989. The aim of this programme was to provide high-quality satellite data for investigating global change. Following the start of ENVISAT and the completion of the test and calibration phase (commissioning phase) the ATMOS programme has finally come to an end. To ensure use of the data, the Federal Ministry of Education and Research has started to change its assistance in this field away from preparation for use and towards scientific use of the data products of ENVISAT. This has already been catered for in the criteria for the Ministry's key assistance areas AFO 2000 and DEKLIM. Since its launch on 31.03.2002, the data from the European environmental satellite ENVISAT have been an important basis for the German climate research programme DEKLIM.

In the field of operational observation, Germany with its share in the METEOSAT programme is making a major contribution to a satellite system that guarantees long-term availability of Earth observation data until the year 2012, which is an important basis for registering climate changes. The German Weather Service (DWD), by establishing a control facility for using data from the operational meteorological satellites for climate monitoring purposes (Satellite Application Facility [SAF]), is seeking to make an important contribution to the field of monitoring essential components of the climate system by means of satellite remote sensing.

The European Organisation for the exploitation of Meteorological Satellites (EUMETSAT), with its EUMETSAT Polar System (EPS), will contribute to the global system of polar orbit satellites. The focus of the mission is on long-term continuity of operational global weather and climate monitoring. Germany bears rather more than 25 percent of the cost of EPS. The necessary development work and supplementary activities are being carried out under a programme called METOP-1, which is also supported by ESA and EUMETSAT.

An important role in the provision of ecological data is played by a systematic general ecological environment observation system which is being established primarily in German UNESCO biosphere reserves in cooperation between the federal and regional authorities. This is principally concerned with

- harmonising and amalgamating suitable federal and regional observation systems
- establishing a network of permanent observation areas for monitoring the most important ecosystems
- bringing the data together in a single information system.

VIII.1.6. Data and information management

In view of the vast amounts of data produced by research and systematic observation in the field of global climate change, there is a need for an information management system that permits

- user-appropriate preparation of the data
- ongoing control of data quality
- safe archiving of data stocks and
- convenient access to the data.

A variety of information systems exist in Germany that assist the interested user in the search for data, with the aid of data catalogues and meta-databases, and in some cases permit direct access via the Internet. Coordination and harmonisation of the structure of environmental information systems is the task of a joint federal/regional working group (BLAK UIS).

The German Remote Sensing Data Centre (DFD) of the DLR is concerned with the storage, management and analysis of satellite remote sensing data. The “Intelligent Satellite Data Information System” (ISIS) is available to help data users.

The Central Climatic and Environmental Data Information System (ZUDIS) at the Karlsruhe Research Centre (FZK) provides information about all the climate-relevant data collections and databases which have been compiled in Germany under measurement and observation programmes and are available in Germany.

To improve the provision of climate-relevant data, the DKRZ is lead-managing the establishment of a networked system of the databases existing in Germany and an information system involving all authorities, scientific institutions and major research facilities that possess climate-relevant data. This is also a contribution to the G7-ENRM project (Environmental and Natural Resources Management). The German Weather Service (DWD) offers a climate information service (KLIS) in the Internet.

The Federal Institute for Navigation and Hydrography (BSH) collects the oceanographic data obtained by German institutions at the German Oceanographic Data Centre. Palaeoclimate databases are run by the AWI (with the information system PANGAEA, which integrates among other things the palaeoclimate database PKDB of the University of Hohenheim) and by the GFZ.

The environmental planning and information system (UMPLIS) of the Federal Environmental Agency (UBA) stores important data on environmental protection, including emission data for climate-relevant substances. The environmental research catalogue (UFOKAT) provides an overview of research projects in Germany that relate to the environment. A central database at the Federal Environmental Agency also stores UV-B data together with data from the Federal Agency for Radiological Protection and from the *Laender*.

Other examples of information systems that provide data on the condition of the environment in Germany are the landscape information system LANIS of the Federal Nature Conservation Agency, the Centre for Agricultural Documentation and Information (ZADI) and the various information systems of the *Laender*.

At the GSF Research Centre for Environment and Health an environmental research information system (UFIS) is being established that embraces the existing models and data from projects in the field of environmental research which have hitherto been assisted by the Federal Ministry of Education and Research, with the aim of defining overall principles for model formation and data acquisition.

In connection with international activities, the following data and information systems exist in Germany:

In addition to the national climatological archive, the German Weather Service (DWD) collects, prepares, validates and archives the international data disseminated by the GTS under the WWW programme of the WMO. Together with the Japanese Meteorological Agency (JMA), the German Weather Service also runs a centre for monitoring the availability and quality of the climate data from the stations belonging to the GCOS Surface Network (GSN) (precipitation handled by DWD and temperature by JMA). With external support in the field of atmospheric physics, the Federal Environmental Agency is setting up one of three centres worldwide for safeguarding and controlling data quality as part of the Global Atmosphere Watch (GAW).

Under the WCRP, international data centres have been set up in Germany for relevant data on the global hydrological cycle (both important components of the GCOS):

- at the German Weather Service (DWD): the Global Precipitation Climatology Centre (GPCC)
- at the Federal Institute of Hydrology (BfG): the Global Runoff Data Centre (GRDC)

Central archives of the data collected worldwide have been established among other things for marine research at the Leibniz Institute for Marine Research (IfM-GEOMAR) as part of the IGBP core project JGOFS, and for palaeontological data at the AWI. Under the WCRP core project WOCE, data assimilations (dynamic interpolation of data using global models) are performed at a special study centre (SAC) at the Max Planck Institute of Meteorology (MPI-Met) and in conjunction with the BSH.

VIII.2. Modelling and forecasting

Information about climate development, both short term and longer term, is of great relevance to society. Since climate modelling is currently the only instrument for attempting to forecast the future climate, improving the information value of climate modelling results is of central importance. Modelling methods are therefore one of the focus topics in DEKLIM.

Climate forecasting is based on complex numerical climate models that represent the global atmospheric and oceanic circulation as accurately as possible. For such models the German Climate Computer Centre (DKRZ), founded in 1987 and funded by the Federal Ministry of Education and Research, offers computer capacity to other German research establishments. The completion of the new NEC-SX6 mainframe computer system, also financed by the Research Ministry, serves this purpose for climate modelling. The DKRZ coordinates the European Climate Computing Network (ECCN), a network of Europe's major climate computer centres, including the Hadley Centre and Météo France. The DKRZ and Hadley Centre jointly coordinate the execution of model calculations for the IPCC.

The German Climate Computer Centre (DKRZ) performs climate simulations, e.g. with the ECHAM model which was developed jointly with the Hamburg Max Planck Institute for Meteorology and used among other things for the inventory analyses of the IPCC. Simulations with coupled ocean-atmosphere circulation models permit investigations into climate variability and into the detection of the climate "signal" amid the "noise" of climate variability. The focus continues to be on the question of the anthropogenic "fingerprint" in the climate records since the beginning of the industrial revolution.

Further methodological development of existing model hierarchies is based here on specific applications, especially those from other DEKLIM focus topics. The existing experimental data (from data networks, measuring campaigns, palaeoclimatology, remote sensing) are used for model validation; conversely, models are used in the reconstruction and interpretation of present and past climatic conditions.

VIII.3. Climate impacts

The Potsdam Institute for Climate Impact Research (PIK; member of WGL), founded in 1992, studies the impact of climate on natural systems and addresses socio-economic aspects and also – on this basis – provides policy advice (including supplying substantive material for the WBGU). The PIK's core topics include:

- Non-linear dynamics of the ecosphere
- Critical thresholds and extreme events
- Mitigation and biosphere management
- Global actors in the transition to sustainability
- Regional simulators
- Vulnerability and development.

The PIK is involved in numerous international cooperation programmes and cooperates closely with the British Tyndall Centre for Climate Change Research.

VIII.3.1. Ecosystems

The biosphere was included in the early assistance for climate research in Germany, both as regards the impacts of climate change and in connection with modelling the global carbon cycle. Initially these investigations were highly aggregated and empirical (e.g. statistical models for net primary production of biomes).

Reliable information about how the biosphere reacts to climate change in the long term presupposes studies of ecosystems. Terrestrial ecosystem research is concerned with investigating the structure, function and dynamics of representative ecosystems such as forests, river and lake landscapes, agricultural landscapes and urban industrial landscapes; marine ecosystems are investigated in the context of marine research (see below).

Ecosystem research provides important information, on the one hand about the sensitivity of important ecosystems to climate change, and on the other hand about the possibility of sustainable use or design of these ecosystems, especially with regard to the problems of global change. By integrating knowledge acquired in various disciplines, the aim is to identify potential risks at an early stage.

Project assistance for research into climate impacts on ecosystems is provided, among other things, under the German climate research programme DEKLIM. Institutional assistance for ecosystem research relating to climate effects is provided in the HGF assistance sector "Earth and environment", among other things in the HGF programmes "Biogeosystems: dynamic change and adjustment" and "Marine, coastal and polar systems". Apart from the HGF, the German ecosystem research institutions that are concerned with climate change include:

- Bayreuth Institute for Terrestrial Ecosystem Research
  (Bayreuther Institut für terrestrische Ökosystemforschung – BITÖK)
- Forest Ecosystem Research Centre in Göttingen
  (Forschungszentrum Waldökosysteme in Göttingen – FZW)
- Agro-ecosystem Research Network in Munich
  (Forschungsverbund Agrarökosysteme in München – FAM)
- Ecosystem Research Project Centre in Kiel
  (Projektzentrum Ökosystemforschung in Kiel – ÖZK)
- Centre for Agricultural Landscapes and Land Use Research
  (Zentrum für Agrarlandschafts- und Landnutzungsforschung – ZALF).

At an international level, German ecosystem research is integrated in the UNESCO programme "Man and the Biosphere" (MAB) and in IGBP core projects (e.g. GCTE).

VIII.3.2. Agriculture and forestry

The synthesis of findings on the Research Ministry's key assistance area "Future-oriented forestry management" (1998-2004) is devoted among other things to modelling and upscaling climate-relevant key processes in forest soils in connection with forest conversion measures. Here entirely new methodological approaches have recently been developed which permit precise characterisation of such processes, e.g. direct quantification of N_2 losses from forest soils as a result of denitrification.

The Research Ministry's key assistance areas "Integrated Environmental Protection in the Timber Industry" (1998-2005) and "Sustainable Forestry Management" (2004-2008) tap innovative technological potential in the development and use of wood materials and optimise and further develop regional, supra-regional and global value-added chains in the forestry-timber sector. The assistance helps to achieve the objectives of the "Wood Charter", to strengthen the use of wood as a raw material in Germany and hence to exploit associated CO_2 sink capacities.
One example of the ministry's key assistance area "Integrated Environmental Protection in the Timber Industry" (since 1998) is a research network project for the development and testing of a technology designed to replace conventional cell digestion in sugar manufacture by a treatment process using electrical pulses. The newly developed electroporation technology yields large energy savings by avoiding thermal cell digestion and reducing the energy needed for evaporation of the juice.

VIII.3.3. Coastal regions

Coastal regions are usually regions of particularly intensive use and at the same time they are often of outstanding importance for the functioning of the global ecosystem. In this context, German climate research focuses above all on German and European coastal regions. Central research tasks are:

- Representing recent and past changes in coastal climate and its influence on climate-sensitive systems, such as ecosystems, land and sea use, water quality, tourism.
- Working out scenarios for possible future developments.
- Describing the sensitivity of selected coastal regions – with regard to security in the face of geo-risks, above all storm surges, and the functioning of coastal ecosystems.
- Drawing up appropriate strategies for adjusting to changed conditions and risks.

The project network “Climate change and preventive risk and coastal protection management on the German North Sea coast” (KRIM), which is assisted under DEKLIM and follows on from precursor research in the same field funded by the Federal Ministry of Education and Research, makes a comprehensive and interdisciplinary investigation of the impacts of climate changes in coastal regions on the basis of eight different representative sections of the coast in the Weser-Jade region. The investigations centre round the consequences (with regard to vulnerability and adaptability) of an accelerated rise in sea level and much more severe individual extreme events (storm surges) for the natural and social structures in the area studied. The results are brought together in a decision support system that is also intended for use as a tool for public debate about dealing with the consequences of climate change.

The GKSS coordinates the research into climate impacts on German coastal regions that receives institutional assistance in individual programmes under the HGF programme “Marine, coastal and polar research”. The topics include analysis of past changes, deduction of scenarios, and the climate sensitivity of coastal ecosystems. The Baltic Sea aspect is handled primarily by the Baltic Sea Research Institute in Warnemünde (IOW).

At the German Climate Computer Centre (DKRZ) up-to-date high-resolution IPCC scenarios are run as community computations and made available to specialist circles in suitably adapted form for subsequent evaluation in relation to coastal problems. German researchers are involved in EU projects (RP6) in which scenarios of possible climate futures of European coasts are generated using global and regional climate models (calculated in follow-up models of storm surges, currents and wave motion).

VIII.4. Options for action

VIII.4.1. Research into climate protection through emission reduction (mitigation) and into adjustment to climate trends (adaptation)

DEKLIM is also investigating the interactions between climate change and natural and social systems in connection with selected topics, with the aim of providing networked knowledge about the causes and effects of climate change as a basis for orientation and action. To this end it was necessary to establish a close connection between classic climate and climate impact research and social economics. Necessary methodological steps in this process included integrated modelling of the various systems in question with the incorporation of socio-economic models, and taking account of expert knowledge that could not be expressed in mathematical form. GLOWA also contains action-oriented approaches.

As a result of past research into climate change, climate impacts and the identification of action options, a great wealth of knowledge for orientation and action already exists for politics, industry and society. Following the logic of the framework programme “Research for sustainability” approved by the Federal Government in mid 2004, it is now necessary to put this knowledge into practice. This is the purpose served by the assistance programme “Research for climate protection and protection against climate impacts”, which was established by the Federal Ministry of Education and Research in 2004 and pursues a dual approach with two complementary focus topics:

- avoiding or minimising long-term climate consequences that are due to human activities and are harmful to society and the environment
- adjusting to climate change and to extreme weather events.

The assistance measure is agreed with all other federal ministries concerned with topics of climate protection relevance, including the Federal Ministry of Economics (“classic” energy sources), Federal Ministry of the Environment (renewable energy sources [except biomass]), Federal Ministry of Food, Agriculture and Consumer Protection (energy from biofuels) and Federal Ministry of Transport, Building and Urban Affairs (transport, building). Its key areas include innovations that can be implemented in the short term (above all, changes in processes and/or products in various sectors of the economy), but also necessary research with a long lead time, and the development of climate protection strategies and relevant services. The assistance measure is explicitly concerned – in addition to the hoped-for innovations – to communicate the model of sustainability in industry and society, and to disseminate such approaches through education, training and public relations work (for details see Chapter IX). One approach to this will be a competition entitled “Designing regional climate change for a viable future”, which is to show by means of examples how global problems can be tackled locally.

VIII.4.1.1. Mitigation

In the context of the Kyoto Protocol and the burden sharing within the EU, Germany has promised emission reductions on a large scale by 2008/2012 and embodied these targets in its National Climate Protection Programme. Further reductions in greenhouse gas emissions above and beyond this will – in view of the problems facing industry and society as a result of climate change – remain an ongoing environmental and innovation policy task to be pursued systematically in the long term.

Since the mid 1990s German industry as a whole has given several voluntary undertakings to make efforts of its own to contribute to the Federal Government's climate protection targets; individual branches of industry (chemicals, steel, cement) have subsequently given undertakings of their own going beyond these promises.

Particularly in connection with the emissions trading scheme which started in February 2005, German industry will have to make considerable expenditure on achieving the medium-term national reduction target. It may be that the scientific and technological potential existing today is not sufficient for future reduction targets, which could be much higher. There is therefore a need to start work now on developing new technological approaches to more climate-friendly processes and products for the future.

This is the starting point for the focus topic "Mitigation" with a subsidiary approach, i.e. with state assistance for entrepreneurial initiative. This assistance concept is based on a situation review in selected branches of industry (e.g. chemicals, steel, cement) and has indicated a great potential of innovative approaches to climate protection.

VIII.4.1.2. Adaptation

Extreme weather events, especially windstorms or the floods in the Oder and Elbe basins, have cause great loss or damage to the environment, industry and society in recent years. This has called for substantial expenditure on remediation measures by the state and society, measures for which there was a widespread lack of the necessary knowledge on which to base actions and plans. The issue of adaptation is increasingly being taken up by various actors in the fields of industry, politics and society. The activities stimulated by the financial assistance measure are intended to respond to this need for guidance and action, because:

- Even today, the greater part of the economy is already directly or indirectly dependent on climate and weather.
- Climate and weather are constantly changing, and changes can be expected in the future as well. They cannot be avoided, even if the climate protection targets of the EU and the Federal Government are met.
- Statistically speaking, extreme events that have a particularly great damage potential do not occur with constant frequency.
- Implementing appropriate strategies for adaptation to climate trends and extreme weather conditions is considered to offer new opportunities for German industry, partly because of the country's marked export orientation.

The measure will pursue developments that permit effective adaptation to climate trends and extreme weather situations. This will take place in R&D projects aimed at specific technologies, products, services or strategies, and in theme-oriented or regional cooperation networks. This assistance concept is based on a situation review in selected branches of industry (e.g. building, tourism, finance) and has indicated a great potential of innovative approaches for adapting to climate impacts.

VIII.4.2. Integrated environmental protection, sustainable management

Within the field of action “Concepts for sustainability in industry and business” of the new framework programme “Research for sustainability”, contributions to climate protection can be made not only by the topic “Climate protection strategies”, but also – at least indirectly – by other topics (“Need sectors and associated value-added chains”, “Production systems close to raw materials”, “Key technologies for system change”, “Successful business models in a sustainable market economy”).

This also applies to the key assistance area “Business-oriented sustainability; integrated environmental technology” which was embodied in the now expired 1997 framework programme “Research for the environment”. Unlike curative “end-of-pipe” environmental technology, research for integrated environmental protection places an early focus on the production process, product design and product use, and as cross-sectional topics the business instruments for sustainable management and the framework conditions for innovations.

Preventive integrated environmental protection is often more effective and comprehensive than curative measures. In addition to technical aspects it takes account of the legal and social framework conditions and the demand side, in the interests of business-oriented sustainability. The technology-oriented part of assistance for research into sustainable management is keyed to optimising integrated environmental protection in production processes and products and to closing cycles in the sense that it seeks from the start to

- avoid product-induced and production-induced emissions (flue gases, waste, wastewater) and
- minimise inputs of raw materials and energy into the production, use and disposal of products.

In this connection it is also worth mentioning the assistance measures provided largely in parallel and in the same context for cross-sectional aspects of sustainable management:

- “Framework conditions for innovation and business instruments for sustainable management”: with regard to means of exerting political influence
- “Business instruments for sustainable management”: with regard to means of integrating the “sustainability” model in enterprises
- “Possibilities and limits of new product use strategies”: with regard to means of influencing the demand side.

As a whole, the key assistance area “Business-oriented sustainability; integrated environmental technology” made contributions to sustainability and also, to some extent, directly to climate protection. The same can be expected of the assistance measure “Innovations as a key to sustainability”, which was launched in mid 2004 and forms part of the action field “Concepts for sustainability in industry and business” under the framework programme “Research for sustainability”. Compared with the key assistance area “Business-oriented sustainability; integrated environmental technology”, this takes an approach that is not confined to individual value-added chains and places greater emphasis on socio-economic aspects.

VIII.4.3. Socio-ecological research

As well as the assistance measure “Research for climate protection and protection against climate impacts”, which focuses primarily on socio-economic issues, the assistance measure “Socio-ecological research”, which is likewise part of the framework programme “Research for sustainability”, also makes contributions in the field of climate protection/action options.

The principal aim of the key assistance measure “Socio-ecological research” is to draw up, in cooperation with actors from various sections of society, action strategies and options for implementing the National Sustainability Strategy. It deals with problems that arise in the relationships between human beings and their natural and social environments. The opportunities for shaping these relationships are examined from a cross-disciplinary perspective. Special importance is attached here to ensuring that findings on the social dimensions of sustainability, i.e. the values, interests and freedom of action of actors involved, are treated in the same as scientific findings. The topic of climate protection is taken up in different ways by 20 research alliances which are aggregated in four projects or topic clusters described in more detail below:

- Political and economic instruments
    - Emissions trading schemes as transformation processes: Assessment of the market-based instrument “emissions trading” in relation to the associated sustainability potential, with a view to feeding the results into the ongoing process of designing emissions trading schemes;
    - Global governance and climate change: investigation (using multi-tier analysis) of climate policy at global, national, regional, local and individual level;
- Societal learning and sustainability: analysis of the design of participatory learning processes in the development of science and organisation (including participatory methods in product development) taking climate protection as an example, in various fields of needs;
- Energy consumption/substance streams and mobility styles: establishment (on the basis of a standardised survey of 2000 persons in three major German cities) of a generalisable target group model (mobility types).

VIII.4.4. Energy research and energy technology

The largest share of CO_2 emissions in Germany arises from the conversion and consumption of energy. As a contribution to reducing these emissions it is therefore logical on the one hand to make the energy supply technologies already available more efficient and more cost-effective, and on the other hand to make new technical options available at an early stage and exploit further technology potentials. Providing assistance for energy research is in line with the Federal Government’s overall energy policy objective of phasing in a viable energy supply system without nuclear energy that is able to operate without subsidies in the long term. The principal concern of the German energy research programme is to reconcile long-term security of energy supplies with solutions to the problems of environmental and climate protection.

VIII.4.4.1. Basic research

Under its initiative “Networks for basic research into renewable energies and efficient use of energy”, the Federal Ministry of Education and Research provides assistance among other things for projects designed to make results and methods of basic scientific research usable for future developments in the field of “Efficient use of energy”. In addition the Research Ministry, as part of its institutional assistance, supports the Helmholtz institutions, whose research work in the “Efficient energy conversion” programme focuses on important contributions to power plant technology, fuel cell development and superconduction.

VIII.4.4.2. Nuclear fusion research

The aim of fusion research is to show that large-scale electricity generation is fundamentally possible from a technical point of view on the basis of controlled nuclear fusion in a fusion reactor. The key areas of research into fusion energy are in the fields of plasma physics (maintaining a burning plasma), developing and adapting typical components (e.g. large superconducting magnets, powerful high-frequency generators (gyrotrons), systems for maintaining plasma purity (diagnosis)), and making materials available that withstand the stresses in fusion reactors (ion and neutron bombardment) for a sufficiently long time and display low tritium absorption and activation properties. The ambitious research objectives can only be achieved in long-term international cooperation and by bundling resources. The international efforts (EU, China, Russia, Japan, South Korea, USA) are aimed at implementing the ITER project. ITER seeks to demonstrate for the first time the technical feasibility of a fusion reactor, with a burning plasma and an energy gain by a factor of 10. Fusion research in Germany is concentrated at three centres: The Max Planck Institute for Plasma Physics (IPP), the Karlsruhe Research Centre (FZK) and the Jülich Research Centre (FZJ). Germany’s fusion research is integrated into the European fusion programme and is partially financed by EURATOM. Currently the biggest project in German fusion research is the large new stellerator Wendelstein 7-X in Greifswald, which is expected to be completed in 2010.

VIII.4.5. Mobility research

The research programme “Mobility and transport” clearly focuses transport research on the goal of sustainability. The transport sector continues to be one of the main causes of CO_2 emissions. As a result of the continued growth in transport volume, traffic-induced CO_2 emissions have increased by a further 15 percent since the start of the 1990s. All forecasts indicate that this trend will continue beyond the year 2010. Bearing in mind that the transport sector is an extremely important economic factor, it is abundantly clear that this is a key area where it is essential to succeed in reconciling environmental and economic considerations on a long-term basis.

The research field “Sustainable solutions through innovative transport technologies” forms the basis for research activities aimed at reducing ozone precursor substances, particulates, CO_2, other greenhouse gases and noise. One aim is to conserve natural regions and landscapes and improve the quality of life in urban agglomerations. The key areas are the development of alternative vehicle and drive concepts, research into pollutant formation as a basis for optimising combustion processes within engines, active safety and assistance systems, and noise reduction at source. In the optimisation of conventional vehicles, energy savings are also to be achieved by means of technology transfer from projects in the Research Ministry's materials research programme. A major new assistance area in this field is the model vision "Traffic management 2010".

"Indirect reduction" of emissions is also promoted in other research fields by means of traffic avoidance, reorganisation, or information and education.

The aim of the key area "Traffic control systems of the future – innovative traffic design in dynamic networks" is to use telematics applications to optimise road, rail, air and water traffic and network it on a cross-carrier basis. The idea is that in future it should be possible to select the optimum carrier in the passenger and goods transport sectors, with the aim of reducing travelling times and conserving resources.

In view of the growing volume of goods traffic on the roads, the research field "More efficient transport systems for a dynamic economy" is above all looking for new solutions for shifting more goods to rail and water transport. Another goal is to respond to the increasing environmental burdens caused by road freight traffic by improving vehicle utilisation and optimising route planning and operational logistics. The key area "Optimised transport in closed cycle and waste management" reveals substantial potential for relieving the road traffic burdens.

The action field "Rail and bus for faster, more convenient and more environmentally friendly travel" seeks to increase the efficiency and attractiveness of local public transport by means of operational and organisational innovations and new carrier and interchange technologies, and thereby promote environmentally acceptable transport that is free from hold-ups. "Understanding mobility better" promotes among other things research activities in the field of leisure and holiday traffic, which accounts for some 50 percent of the volume of traffic (in passenger kilometres) in motorised personal traffic. The aim is also to find new forms of leisure traffic.

In the context of promoting traffic-reducing structures and finding substitutes for physical traffic, efforts are to be made to dovetail uses such as living, working, leisure and shopping. Support for strategies that avoid traffic and reduce traffic inputs is aimed at the causes that generate traffic, and can make an important contribution to climate protection. This point is forms a programme interface with the research programme "Building and living".

IX. Education, training and public relations

IX.1. Overall policy on education, training and public relations

IX.1.1. Climate protection as a topic in education for sustainable development

With a view to implementing the 21-percent reduction in greenhouse gas emissions by 2008-2012 compared with 1990 which was promised at European and international level, the National Climate Protection Programme of 18 October 2000 was reviewed and updated in 2005. Since the emissions trading scheme covers a large proportion of the CO_2 emissions by the Industry and Energy sectors, the Federal Government's efforts in the National Climate Protection Programme 2005 are focused in particular on the Household and Transport sectors.

In the 1990s, environmental education in Germany responded to the demands of international environmental policy by upgrading to education for sustainable development. Thanks to this further development at the conceptual level, education now caters even better for such complex issues as climate change. This calls not only for scientific and technical expertise, but also for an understanding of economic and social mechanisms and – not least – a capacity to incorporate the dimension of intra- and inter-generation equity in solutions to problems.

Many concepts, projects and teaching materials that have been created in the context of education for sustainable development and are continuing to be developed are repeatedly proving to have a bearing on the issue of climate protection through a wide variety of thematic approaches, above all the topic of renewable energy sources. Education for sustainable development is a contribution to recognising climate protection as a central topic for the future, understanding the globally interlinked mechanisms and learning what action and design options exist, with the aim of using them in the various consumer roles or as an economic actor in businesses and administrative authorities.

In the context of implementing Article 6 of the Framework Convention on Climate Change, the national focal point for climate education was established at the Federal Environment Ministry (climate-education@bmu.bund.de). This primarily serves as a platform for public and private actors in the field of education. Through intensive exchange of information and ideas it can facilitate greater use of synergies. The focal point is intended to bring about better networking of the many different governmental and non-governmental actors in the formal and informal education sectors and the various associated educational activities within the federal system. The national focal point sees its mission as improving the visibility of the diverse educational activities in the field of climate protection as an important component of sustainable development, and thereby creating a basis for further development.

Chapter IX of this report provides a first overview of selected activities in this field in Germany, with the initial focus on the federal level. In Germany the federal system and the many governmental and non-governmental actors in formal and informal areas of education mean that it is always difficult to achieve a complete survey. The national focal point will continue to update the inventory of the numerous climate education activities at federal, regional and local level and at the level of non-governmental actors as well.

IX.1.2. Public relations work by the Federal Environmental Agency

IX.1.2.1. Website

In recent years there has been an increasing focus on the climate issue in media-based public relations work. An Internet portal on climate protection which reflects important scientific and political aspects has been created and designed.

The Internet portal (http://www.umweltbundesamt.de/klimaschutz/index.htm) contains a broad spectrum of information, some examples of which are mentioned below:

- Numerous brochures provide information about the latest international scientific findings and the current position of climate policy. With their compact descriptions and comprehensible treatment of the topics they offer good basic material for informing and educating the general public.
- A discussion platform in which various recurring arguments put forward by sceptics are taken up and discussed by experts from specialised branches of climatology. This discussion platform is particularly suitable for readers interested in climate protection, who will find answers here to frequently asked questions.
- Accounts of various up-to-date research findings, also including special visual presentation.
- A linked project on "Protecting climate" gave rise to an additional Internet portal (http://www.klimaschuetzen.de), which presents knowledge about climate protection issues in clear and graphic form primarily for the target group of young adults aged about 20-30, but also for other interested persons. Moreover, a cinema commercial on climate protection was produced, inserted in the portal, and shown in numerous cinemas in 2003/2004.

IX.1.2.2. Assistance for associations

In connection with assistance for associations, a variety of projects have been implemented within the sphere of responsibility of the Federal Environment Ministry. A number of these are specifically mentioned below in view of their special public impact:

The competition "Energy Saving Community" was run for the first time between January and April 2005 by Deutsche Umwelthilfe (DUH), and is for all cities, administrative districts and municipalities in Germany. The communities' successes in saving energy themselves and in activities aimed at their citizens are assessed on the basis of a questionnaire. The Federal Environment Minister is the patron and awards the prizes. In addition, the best examples are presented at six regional events – to encourage others to follow them. Local authorities can make a considerable contribution to climate protection, as they are often able to take action where national policies are too remote from the actors: by working on changes in behaviour and on energy-efficient solutions that require a particular infrastructure. But local authorities frequently fail to play this role, partly because they do not regard their own small contribution as worthwhile in the face of the global challenge. Studies are used to prepare information in such a way that it can be used directly. For example, a study for the city of Munich showed how CO_2 emissions could be reduced by 50 percent if the city had the political will to carry it through. The "Energy Saving Community" competition also creates a nationwide incentive to take action.

The campaign "Intelligently mobile – the fit way to work" was run during European Mobility Week. The climate alliance "Klima-Bündnis / Alianza del Clima e.V." – a network of European cities and at the same time coordinator of the German cities participating in "European Mobility Week" – focused on environmentally acceptable and cost-effective design of business mobility. In this project, local authorities and business enterprises developed approaches and models for staff traffic, business trips and delivery traffic. The central concern of the campaign was to make a concerted effort that would raise business awareness of the benefits of company traffic planning and prompt as many businesses as possible to take concrete action.

In the nearly 42,000 schools in Germany it would be possible to save a total of EUR 180 million a year in energy costs – mainly through changes in habits. The “Fifty/Fifty PLUS” project by Klima-Bündnis / Alianza del Clima aims to make a contribution to this. The fifty/fifty principle means that each of the schools taking part is free to take 50 percent of the energy costs saved by conscious user behaviour and spend the money as it thinks fit. Thus pupils, teachers and caretakers are called upon to save heat, electricity, water and waste by means of easily implemented energy-saving measures. The Fifty/Fifty PLUS project makes it easier to join the model. It offers coaching for schools in the form of visits by the project team or promoter training courses, and also an electronic newsletter and a website.

For many years now the German Protestant Kirchentag (Church Congress) has been making great efforts to minimise the environmental burdens caused by this major event, which is held every two years. For the Thirtieth German Protestant Kirchentag 2005 in Hanover the Kirchentag decided to make Energy and Climate a focus topic. The aim was as far as possible to draw the attention of all participants and helpers to the energy issue and to encourage them to save energy. At the Kirchentag “Climate Market”, initiatives and associations in the field of energy and climate protection presented themselves and provided information about their work. As part of the Kirchentag’s climate protection campaign they showed people how to save energy, avoid emissions and use renewable energy sources. Furthermore, the electricity used at the exhibition grounds throughout the Kirchentag in Hanover was from “green” sources. Power consumption was reduced by means of constructional measures at the central office and energy-saving behaviour on the part of the staff in the offices.

Under the “Climate Network” project run by the nature conservation association “Naturfreunde Deutschlands e.V.”, energy-saving measures are being implemented in its hostels. A network of regional actors was set up for this purpose. The network draws its strength from mutual exchange of information. All information in the fields of transport, energy saving, use of renewable energies, energy-saving remediation and typical regional food and drink is collected, edited and made freely available to all. The intention is to reproduce and disseminate the wealth of experience accumulated by the association’s members in the field of climate protection. In the project period up to the beginning of 2007 the aim is to continue developing the communication and competence network of the association’s establishments and the groups themselves. Climate protection is made tangible for the guests, for example in the form of a solar energy system and accompanying information or a power consumption diagram.

IX.1.2.3. Education projects for sustainable development

In addition various education projects for sustainable development have been implemented, e.g. projects aimed at improving environmental awareness or environmental communication. These criteria also form an important basis for active climate protection – as a parameter of sustainable development.

An overview can be found in the Federal Government’s current report on education for sustainable development (Bundestag publication 15_6012).

IX.1.3. *Educational measures as a cross-sectional task for research*

The framework programme “Research for sustainability”, an important contribution to which is made by the Research Ministry’s assistance measure “Research for climate protection and protection against climate impacts” introduced in 2004 (see Chapter VIII), integrates educational measures as a cross-sectional task for research, in order to

- make models for sustainable activities, e.g. in the climate protection sector, both visible and plausible,
- practise integration-oriented, forward-looking thinking in complex contexts,
- communicate basic decision aids, models for problem solving, management rules and quality objectives for sustainable development,
- illustrate the innovation potential of the sustainability concept, and
- thereby promote people’s readiness to play an active part in furthering the model of sustainable development in their everyday life, at work and in society.

To facilitate the integration of educational measures as a cross-sectional task for research, assistance is given for accompanying processes that make it possible to reach target groups in industry and society, education and training and thereby to implement the measures.

In addition to research and development work on further reduction of greenhouse gas emissions and measures to adapt to climate trends and extreme weather situations, therefore, the assistance measure “Research for climate protection and protection against climate impacts” also explicitly includes plans for projects that address the problem of communicating climate change in educational research and practical teaching. In this connection assistance is to be given for measures in the field of school and non-school education, initial and further vocational training, university and academic further education, knowledge transfer, and general information and public relations work.

To explain current progress on research into climate protection and present fundamental findings on climate change to a broad public, the Federal Government, as in the current German climate research programme (DEKLIM), also publishes brochures. The following are a few examples:

- “Research for climate protection: progress and prospects” (BMBF, 2002)
- “The challenge of climate change” (“Herausforderung Klimawandel” – BMBF, 2003)
- “Research for climate protection and protection against climate impacts” (“Forschung für den Klimaschutz und Schutz vor Klimawirkungen” – BMBF, 2004)

The conference on research into global change and its implementation, which was held Berlin in July 2003 under the title “From knowledge to action?”, should also be seen in this context.

To make it possible to provide up-to-date and target group oriented education, sociological research is regarded as an important basis and frame of reference for educational work. Regular sociological surveys, e.g. on environmental awareness or readiness to play an active role, scientific monitoring of educational projects and concept or feasibility studies on new educational ideas are firm components of educational activities for sustainable development that also benefit educational work on climate protection.

IX.2. Education in schools and training programmes

IX.2.1. School education

IX.2.1.1. Transfer 21

On the basis of the model programme described above, work is currently in progress on transferring the results to a broad practical level under the BLK programme "Transfer 21". The goal of this concept is, within a four-year period, to integrate 10 percent of the schools in the 14 *Laender* taking part. Special emphasis is placed here on the development and qualification of support systems, the inclusion of primary and all-day schools, and the integration of teacher training.

The transfer concept makes dissemination the responsibility of the individual *Laender*, but provides for federal support for this task. Transfer is to include not only the products of the programme, but also the process knowledge of the actors. Existing structures are to be used as a basis (school networks, support and guidance structures), with the aim of expanding them and improving their quality.

IX.2.1.2. Scientific literacy – the example of climate protection

The educational material on climate protection at www.bmu.de/bildungsservice, some of which is also available in English, is likewise based on the results of this model programme for the design of teaching on sustainability issues. Sustainable development must be supported by targeted educational work, and at the same time topics like climate protection that are discussed in the context of sustainable development offer excellent starting points for general education. Climate protection is a vivid and topical example that is particularly suitable for promoting and demanding not only technical and scientific, but also social problem-solving competence (scientific literacy). Scientific literacy in 15-year-olds is tested in the OECD's programme for international student assessment (PISA). This educational material on climate protection combines two approaches: on the one hand it consists of high-quality, scientifically up-to-date and service-oriented educational material for climate protection, and on the other it also provides examples, encouragement and suggestions on how to make use of climate protection as a sustainable development topic for general education.

IX.2.1.3. "The changing climate – stimulating environmental education"

Through this brochure ("Klima im Wandel – Impulse der Umweltbildung") the Bavarian regional government provides multipliers with an overview of facts and trends, consequences and action options in the field of climate protection. The brochure is designed to give readers a rapid overall picture. The brochure includes a CD-ROM with slide templates, enabling the material to be used directly for presentation purposes.

IX.2.1.4. “Climate change – the right picture of the Earth”

This presentation at the regional horticultural shows in North Rhine/Westphalia in 2001 and 2003 used satellite pictures and background information on development history to illustrate the consequences of anthropogenic activities in the past 2000 to 3000 years. The aim of the project was to present climate change in an easily understood form and indicate practical ways in which everyone can make an active contribution to climate protection by modifying their habits.

IX.2.1.5. Climate expedition

This project, which also uses satellite images, addresses children and young persons aged between about 11 and 19. With the aid of specific examples it demonstrates the complex relationships between local activities and global climate impacts. It provides a basis on which students can develop and discuss possible solutions. “Climate expedition” is a project run by the environmental and development organisation Germanwatch, and is supported by the government of North Rhine/Westphalia.

IX.2.1.6. Media database “H_2O knowledge”

The media database “H_2O Knowledge” (www.umweltbundesamt.de/uba-datenbanken/H2O-Wissen.html) was created for the Federal Environmental Agency in 2002 as part of the environmental research plan 2002. In addition to focus topics taken straight from the field of water conservation, it addresses topical issues such as “Floods” or “Water conservation and climate protection”. It provides teachers and other multipliers in environmental education with an important aid to compiling suitable teaching material from the wealth of information available. The media database contains more than 300 entries, selection from which is possible with the aid of a sophisticated but easy-to-use search interface. Apart from the usual search by title and author, it is also possible to search by age of child, subject taught and key topics. This considerably simplifies the task of preparing teaching units and project days.

IX.2.2. Vocational training

Vocational training has a special role to play on the road to more climate protection as a component of sustainable development. This is quite possibly the last time in their life that young people are being prepared by systematic learning in vocational training establishments for their roles as actors in the fields of production, logistics and administration in the working world, and ultimately as consumers in the private sphere.

Against this background the Federal Government initiated and financed an extensive series of conferences for actors. These worked out, on both an occupation-specific and an over-arching basis, the competences needed to qualify young persons to practise sustainable management. This is an important contribution to climate protection.

These fundamental findings are currently being tested in a series of model tests with scientific back-up, using concrete examples.

Another important ongoing task is the integration of suitable content in the training regulations as the basis for in-house vocational training. In new and reclassified occupations, sustainable development and climate protection are already standard content.

IX.2.2.1. Model experiment "LE.NE – Learning about sustainable energy technologies in the craft trades"

The model test "LE.NE" addresses the reclassified or reorganised occupations in the sanitary, heating and air-conditioning trades and integrates sustainable energy technologies. In the process of developing training concepts and redesigning learning processes, the relevant parties from the craft trades and vocational schools are brought together with the local further education authorities with the aim of arriving at practicable and sustainable action models for personnel in the craft trades of tomorrow. This system-oriented innovation concept is at the same time intended to draw the attention of small craft businesses in particular to the opportunities that lie in the use of renewable energy sources and responsible use of energy, and above all in company commitment to products and services of sustainable design on the market.

IX.2.2.2. Model experiment "Renewable raw materials – strategies for modernising rural areas with viable qualification concepts for the future"

The model experiment "Renewable raw materials...", which is developing and testing a qualification concept for the use of renewable raw materials (biogas systems, bio building products, bio insulating materials), has just got under way. It is embedded in regional activities, and is expected to significantly stimulate and generate initial impacts on climate protection even in the development phase.

The results of the model experiments will be made available to the public.

IX.3. Public relations work and campaigns

IX.3.1. Climate protection campaign

The order to run a campaign on climate protection in the household and small consumer sectors was placed with the Federal Environment Ministry as part of the National Climate Protection Programme of 18 October 2000. The campaign focuses in particular on making a contribution to exploiting the considerable CO_2 reduction potential that exists in the buildings sector. An evaluation shows that increasing energy efficiency in space heating for living accommodation currently yields the best climate protection results per euro invested. By means of automated guidance from the Internet, a kind of free remote diagnosis, households are given practical information on what measures, e.g. to buildings, do most to reduce energy consumption in their specific case, and what financial assistance they can expect to receive from the state. The campaign also draws attention to other ways and means of saving energy in households, e.g. lighting, standby operation of information and communication systems, and in the field of mobility.

The climate protection campaign is thus an important instrument for meeting the binding international commitment to reduce greenhouse gas emissions in Germany in the period 2008 - 2012 by 21 percent compared with 1990. This campaign by the

Federal Environment Ministry also promotes education, training and public awareness relating to climate change and countermeasures in the context of Article 6 of the Framework Convention on Climate Change. The aim is to include all relevant actors in the campaign.

IX.3.2. Atmosfair – climate-aware air travel

Every flight by an aircraft gives rise to greenhouse gases, the quantity and impact of which depend on the distance travelled, aircraft type, utilisation and altitude. Since not everyone is willing or able to refrain from travelling by air, an opportunity is provided for those concerned about the consequences of their actions to fly on a climate-aware basis: "Atmosfair". Atmosfair calculates the climate impacts of a flight, and the passenger makes a voluntary payment for the greenhouse gases he causes. The money is invested in solar energy, hydro power, biomass or energy-saving projects in developing countries under the Clean Development Mechanism. Of course this does not undo the impact of the flight on the climate. But in the long term these investments can reduce greenhouse gases elsewhere that have a similar impact to airline flights. Projects are currently being financed in Brazil and India.

Atmosfair is a joint initiative by the "forum anders reisen" ("forum for alternative travel") and the environmental and development organisation "Germanwatch". It is supported by the Federal Government, and its first patrons were former Federal Environment Minister Jürgen Trittin and UNEP Director Klaus Töpfer.

IX.3.3. Film "The Day after Tomorrow" – science or fiction?

When the film "The Day after Tomorrow" came to German cinemas the Federal Government made information available that was tailored specifically to the film. The aim was to prevent possible disquiet about the subject matter of the film. The information provided indicated which scenes in the film were invented purely for the purpose of entertainment and which scenarios were based on climate change consequences that scientists regarded as possible. As an additional service, educational material was also developed to help parents and teachers to discuss the impressions created by the film – whether seen at first hand or based on hearsay – with children and juveniles. One important principle in the development of this material was that it should not be necessary to see the film in the cinema to be able to profit from using the material.

IX.3.4. Keep Cool

"Keep Cool – Setzen Sie das Klima aufs Spiel" ("Keep Cool – Gamble with the climate") is a board game developed by two staff members of the Potsdam Institute for Climate Impact Research (PIK). The aim is to ensure that all global actors with their various interests and objectives work together to enable the global climate to recover and prevent "climate collapse" taking place. This idea underwent further development for the educational material on climate protection so that it could also be used for larger groups such as school classes. The instructions for the role game are also available in English from www.bmu.de/bildungsservice.

IX.3.5. Climate relay – promoting participation in decision processes

From 10 May to 1 June 2004 the "Klima-Bündnis", a global alliance of more than 1200 cities, ran the "Climate Relay 2004" with assistance from the Federal Government. The destination was "renewables2004" in Bonn. In the course of these 23 days some 15,000 active participants carried the baton over a distance of around 4,000 kilometres, passing through the capitals of all 16 German *Laender*. All environmentally friendly means of transport were permitted: the participants covered the ground on foot, by bicycle, on horseback, recumbent bicycle, rowing boat, solar car – the motto was: above all climate friendly.

The baton contained the climate relay declaration signed by all German *Laender*, a four-volume book of messages containing 130 declarations, wishes and suggestions on climate protection from local authorities, non-governmental organisations and individuals. These four volumes document impressive examples of how local authorities, NGOs and individuals are already making use of their opportunities to influence and design decision processes.

IX.4. Participation in international activities

Education is an important precondition for effective climate protection, and for making it possible for society as a whole to be prepared to actively support and enforce a policy of switching to sustainable management in all areas. This is why we need people in all walks of life who are willing and able to shape our society in the present and for the future. The Federal Government will make every effort to ensure that the model of sustainable development is integrated in standard practice in all areas of education – in kindergartens, schools, vocational training, university education and further education. This will establish a good basis for climate protection.

In the immediate future the framework providing the structure for many activities will be the UN Decade "Education for sustainable development". The educational policy signals for this were set in 2004. In April 2004 the federal ministries agreed to entrust the Federal Ministry of Education and Research with lead managing the Decade within the Federal Government.

In Germany the German UNESCO Commission – like UNESCO within the system of the United Nations – has taken over a coordinating function and for this purpose it is supported and funded by the Federal Ministry of Education and Research. As a mediating organisation for foreign cultural policy, the German UNESCO Commission has the task of advising the Federal Government, parliament, *Laender* and civil society on UNESCO matters and helping to implement the UNESCO programme in Germany. With the support of the Federal Ministry of Education and Research, a secretariat and a working unit have been set up for the UN Decade in Germany.

A national committee set up by the German UNESCO Commission brings together experts from scientific, cultural and media circles, representatives of the Bundestag, the Federal Government and the conference of *Laender* education ministers, and also personalities who publicly champion the idea of sustainability. The first meeting of this committee was held on 27 May 2004. The German UNESCO Commission established the national committee as an advisory and controlling body for the duration of the Decade.

The Round Table brings together members of the “Alliance for learning sustainability” who are working on the implementation of the UN Decade in Germany. It represents organisations, institutions and projects in all sectors of education that make significant contributions to designing the Decade. In preparation for the Decade, the Round Table met for the first time on 2 November 2004 in Berlin. This body has the task of interlinking individual activities and measures in the various sectors of education on a cross-sectoral basis, promoting national and international cooperation, and identifying areas and issues where there is a need to step up activities.

Ahead of the UN Decade, the German Bundestag passed a unanimous resolution on 1 July 2004 calling for the preparation of a national action plan “Education for sustainable development”, which was to become part of the national sustainability strategy. The national committee’s first assignment was to draw up the national action plan by the end of 2004 and agree it with the members of the Round Table in a consultation process. The action plan was officially presented at the kick-off event for the Decade, held on the premises of the public television channel ZDF in Mainz on 13 January 2005.

The principal aim of the action plan for the UN Decade is to ensure that the idea of sustainable development is firmly established in all sectors of education in Germany. This will allow Germany to make major strides in the direction of sustainability in the coming ten years – and beyond. This true in the national interest, but also for Germany as a country with special international responsibility. Four strategic objectives – partly based on the analysis of the latest “Report by the Federal Government on Education for Sustainable Development” – are being pursued to achieve this over-arching goal:

- Further develop the concept and bundle activities, and broadly spread good practices
- Networking of stakeholders in education for sustainable development
- Improvement of public awareness of education for sustainable development
- Strengthening of international cooperation

In the next ten years, these four strategic objectives will serve as requirements for strengthening and further developing education for sustainable development in Germany. The Federal Government will make further contributions to the national action plan. Among other things it is planned, as a measure under the national action plan on climate protection, to make an inventory that registers the progress made on implementing Article 6 of the Framework Convention on Climate Change at local, regional and federal level, and assesses the need for further action.

Since the beginning of the decade in 2005, suitable projects and initiatives in Germany that are in line with the objective of education for sustainable development have been recognised by the national committee as official initiatives for the “Alliance for learning sustainability”. The aim is to make the UN Decade “Education for sustainable development” visible throughout Germany and to create a map on which one can trace the nationwide spread of education for sustainable development with the aid of the project locations. At the same time as the official international kick-off event for the Decade in New York on 1 March 2005, the first awards for Decade projects were presented on the occasion of UNESCO Day at the Didacta fair in Stuttgart, which was devoted to the topic of “Education for sustainable development”.

X. Appendix I

X.1. The GCOS standards

X.1.1. Best practices for GSN stations ("Manual on Observations" 2.10.3.19)

- In the event of significant changes in sensor devices or station location, members should provide for a sufficiently long period of overlap (at least one, but preferably two years) with dual operation of old and new systems to enable comparisons to be made and the identification of inhomogeneities and other measurement characteristics.
- CLIMAT data should be provided in an accurate and timely manner. CLIMAT reports should be transmitted by the fifth day of the month, but not later than the eighth day of the month.
- Rigorous quality control should be exercised on the measurements and their message encoding. CLIMAT reports require quality control of the measurements themselves and their message encoding to ensure accurate transmission to national, regional and world centres for further use. Quality control checks should be made on site and at a central location in order to detect equipment faults at the earliest stage possible. The "Guide to Instruments and Methods of Observation" (WMO No. 8) provides the appropriate recommendations.
- The site layout should follow the recommended form ("Guide on the Global Observing System" WMO No. 488).
- The sites and instruments should be inspected regularly and maintained in accordance with WMO recommended practices ("Guide to Instruments and Methods of Observation", WMO, No. 8). As part of the maintenance, the necessary calibration practices should be traceable to the standards provided by the Guide.
- A national plan should be developed to archive daily data and metadata pertaining to each climate station. Metadata should include data concerning a station's establishment, subsequent maintenance, and changes in exposure, instrumentation and staff. The data and metadata should be archived both in the original form and in digital format.
- Detailed metadata and historical climate data for each GSN station should be provided to the GSN Data Centre. Both data and metadata should be up to date.

X.1.2. Best practices for GUAN stations ("Manual on Observations" 2.10.4.9)

- Long-term continuity should be provided for each GUAN station. This requires the provision of the necessary resources, including well-trained staff, and keeping changes of location to a minimum.
- Changes of bias caused by changes in instrumentation should be evaluated on the basis of a sufficient overlapping period of observation (perhaps as much as one year) or by making use of the results of instrument comparisons made at designated test sites.
- Soundings should preferably be made twice a day and should reach as high as possible, noting the GCOS requirements for ascents up to a height of 5 hPa. Because climate data are needed in the stratosphere to monitor changes in the circulation, composition and chemistry of the atmosphere, every effort should be

made to maintain soundings regularly up to as high a level as possible, noting the above GCOS requirement.
- CLIMAT TEMP data should be provided in an accurate and timely manner. CLIMAT TEMP reports should be transmitted by the fifth day of the month, but not later than the eighth day of the month.
- Rigorous quality control should be exercised at each GUAN site. Periodic calibration, validation and maintenance of the equipment should be carried out to maintain the quality of the observations.
- Basic checks should be made before each sounding to ensure accurate data. Checks should also be made during and at the end of every sounding to ensure that any errors or incomplete soundings are corrected before transmission.
- Back-up radiosondes should be released in cases of failure in order to maintain the record from the GUAN station.

Detailed metadata should be provided. The batch identifier on the radiosondes should be logged for each flight, so that faulty batches can be identified and the data amended or eliminated from the climate records if necessary. Up-to-date records of metadata in a standard format should be provided to the GUAN Data Centre so that shifts in the data will not be mistaken for climate change. The metadata should include detailed information about the station such as location, elevation, operating instruments and their changes over time. Changes to operating and correction procedures should also be recorded. Both the corrected and uncorrected upper-air observations should be archived. Climate change studies require extremely high stability with regard to systematic errors of the radiosonde measurements.

X.1.3. Karl's principles

- The impact of new systems or changes to existing systems should be assessed prior to implementation.
- A suitable period of overlap for new and old observing systems is required.
- The details and history of calibration, validation, changes in data processing algorithms and assessments of data homogeneity should be treated with the same care as the data themselves.
- The ability to assess the quality and homogeneity of extreme data, including high-resolution data and descriptive information, on a routine basis should be assured.
- Climate monitoring products and assessments, such as IPCC assessments, should be integrated into national, regional and global observing priorities.
- Operation of historically uninterrupted stations and observing systems should be maintained.
- High priority for additional observations should be focused on data-poor regions that are particularly sensitive to change.
- Long-term requirements should be specified to network operators and designers and instrument engineers at the outset of system design and implementation.
- The conversion of research observation systems to long-term operations in a carefully planned manner should be promoted.
- Data management systems that facilitate access, use and interpretation of data should be included as essential elements.

These principles were adopted in Decision 5/CP.5 at the Fifth Conference of the Parties to the Framework Convention on Climate Change[102]. Supplemented by principles for the operation of satellite systems, these were passed as Resolution 3.2.3/1 at the Fourteenth World Meteorological Congress of the WMO[103].

[102] UNFCCC, 1999: Report of the Conference of the Parties on its fifth Session, held at Bonn from 25 October to 5 November 1999, Addendum Part Two: Action taken by the Conference of the Parties at its fifth Session. FCCC/CP/1999/6/Add.1.

[103] WMO-No. 960, 2003: Fourteenth World Meteorological Congress, Geneva, 5-24 May 2003. Abridged final report with resolutions.

XI. Appendix II

Second Report of the Government of the Federal Republic of Germany on Systematic Climate Observation in Germany as a contribution to Germany's Fourth National Report under the United Nations Framework Convention on Climate Change

XI.1.1. Contributing Institutions

Deutscher Wetterdienst, Umweltbundesamt, Bundesamt für Naturschutz, Bundesamt für Seeschifffahrt und Hydrographie, Bundesanstalt für Gewässerkunde, Deutsche Gesellschaft für Technische Zusammenarbeit GmbH

XI.1.2. Forewort of the President of DWD

The *United Nations Conference on Environment and Development*, held in Rio de Janeiro in 1992, was also responsible for bringing observation and monitoring of the climate with regard to its variability and possible changes, to the attention of the general public. The *Framework Convention on Climate Change* adopted in Rio is a first attempt at recognising the influences on climate caused by mankind and, where necessary, counteracting them. The *Kyoto Protocol*, which recently entered into force, obligates the signatories for the first time to implement concrete measures in this regard.

A fundamental basis of these activities is the continual and comprehensive observation of our environment, which now allows us to make statements on changes and variability in the climate on a global, regional and local scale. Climate observations and studies on climate change are being conducted jointly by numerous states in close cooperation on global and regional levels. Within the *World Climate Programme* of the United Nations, several programmes have been set up, which serve global climate monitoring. Coordinated programmes such as, for example, WMO *Global Observing System* (GOS), *Global Climate Observing System* (GCOS), *Global Ocean Observing System* (GOOS), *Global Terrestrial Observing System* (GTOS), and *Global Atmosphere Watch* (GAW), are devoted to particular parts of the system.

Germany participates actively in a great number of these programmes. A national contribution is thus part of a larger context, where the climate system is to be understood as a complex, interdisciplinary physical-chemical-biological system made up of the atmosphere, the oceans, the biosphere and cryosphere.

Since the *First Report on Systematic Climate Observation* in Germany, three developments in international cooperation should be emphasised which show that political interest in 'Observation of the Earth System' has also increased considerably.

First and foremost is the initiative of the G8 states to formulate a 10-year Implementation Plan for a *Global Earth Observation System of Systems* (GEOSS) by the *Group on Earth Observations* (GEO)[104]. Germany was actively involved in this and coordinated, for example, the work on Section 4.4 'Climate'.

As an amendment to the GEOSS 10-year Implementation Plan, the *United Nations Framework Convention on Climate Change* instigated the 'Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC' (GCOS-IP, for short), which is the climate module of the GEOSS 10-year Implementation Plan.

The regional action and implementation plans are to be seen as the third module. These were also instigated by the *United Nations Framework Convention on Climate Change* in the course of regional GCOS workshops.

This means that there is now a hierarchy of measures to be dealt with. It is the responsibility of the governments, in cooperation with international organisations, to translate these measures into action in the coming years and decades.

This *Second National Report on Systematic Climate Observations in Germany* fulfils a resolution of the *United Nations Framework Convention on Climate Change* (4/CP.8) and is an updated stocktaking of the efforts made by Germany in monitoring the climate system as set down in the First Report.

This Report, like the First National Report, was compiled, in collaboration with experts from relevant institutions, by the Deutscher Wetterdienst (DWD) in its responsibility as coordinator of national GCOS activities.

At this point I would like to thank all those institutions and their staff, who have contributed to the successful completion of this Report. We have listed the names of those, who are known to us, below. However, I am sure that this Report would not have been possible in its comprehensive form without the help of further colleagues, whose names do not appear here.

I also associate this Report with the hope that the core elements of the existing station networks can continue to survive for a long time to enable sustainable studies on the climate to be carried out, in spite of the threat of economy measures. We are endeavouring to close gaps where they exist, so that the following generations will have this valuable historical information at their disposal.

Wolfgang Kusch
President
Deutscher Wetterdienst, Offenbach am Main

XI.1.3. Contributors

Coordinator of the Report:
Stefan Rösner, nationales GCOS-Sekretariat, DWD

Coordinator of the 'Atmosphere' part:
Stefan Rösner, nationaler GCOS Koordinator, DWD

[104] http://earthobservations.org/

Contributors:
Johannes Behrendt, DWD
PD Mag. Dr. Franz H. Berger, DWD
Wolfgang Benesch, DWD
Horst Dier, DWD
Kerstin Dietrich, GTZ
Dr. Dirk Engelbart, DWD
Dr. Wolfgang Fricke, DWD
Dr. Stefan Gilge, DWD
Dr. Gerd-Henning Klein, DLR
Dr. Gert König-Langlo, AWI
Dr. Ulrich Leiterer, DWD
Stefan Rösner, DWD
Dr. Bruno Rudolf, DWD
Klaus-Jürgen Schreiber, DWD
Karla Vietzke, DWD
Reinhard Zöllner, DWD

Coordinator of the 'Ocean' part:
Dr. Klaus Peter Koltermann, BSH

Contributors:
Dr. Eberhard Fahrbach, AWI
Jürgen Fischer, IFM-GEOMAR
Kay Herklotz, BSH
Peter König, BSH
Dr. Klaus Peter Koltermann, BSH
Prof. Dr. Martin Visbeck, IFM-GEOMAR
Prof. Dr. D. Stammer, IfM Hamburg
Reinhard Zöllner, DWD

Coordinator of the 'Terrestrial Observations' part:
Dipl.-Biol. Jutta Stadler, BfN

Contributors:
Dr. Michael Bilo, BfN
Christoph Eichen, BfN
Heinz Engel, BfG
Frank Klingenstein, BfN
Peter Krahe, BfG
Dr. Thomas Maurer, BfG/ GRDC
Rudolf May, BfN
Jutta Stadler, BfN

Coordinator of the 'Space-based Monitoring Programmes' part
Stefan Rösner, DWD

Contributors:
Wolfgang Benesch, DWD
Dr. Gerd-Henning Klein, DLR
Dr. Wolfgang Klein, DLR

XI.1.4. Detailed summary

The *Global Climate Observing System* (GCOS) was set up in 1992 with the objective of making observations and information required to tackle climate-related issues available to all users. GCOS is a system jointly funded by the *World Meteorology Organisation* (WMO), the *Intergovernmental Oceanographic Commission* (IOC) of UNESCO, the *United Nations Environment Programme* (UNEP) and the *International Council for Science* (ICSU). GCOS is intended as a long-term system for climate monitoring which is managed by the users of the provided information. It is intended to help to reveal climate changes and their underlying causes, to facilitate assessments concerning the impacts of climate changes and climate variability and to facilitate research activities aimed at improving the understanding of the climate system and relevant predictions.

In Germany, competences for systematic long-term observation of the various variables describing the climate system are distributed among a number of different Federal Ministries. These are the *Federal Ministry of Transport, Building and Urban Affairs* (BMVBS) and its subordinate authorities *German Meteorological Service* (DWD) and *Federal Maritime and Hydrographic Agency* (BSH) as well as the *Federal Ministry for the Environment, Nature Conservation and Nuclear Safety* (BMU) and its subordinate authorities *Federal Environmental Agency* (UBA) and the *Federal Agency for Nature Conservation* (BfN). Research institutions also play an important role.

Moreover, Germany delivers significant contributions to European satellite observation systems developed and operated by the *European Space Agency* (ESA) and the *European Organisation for the Exploitation of Meteorological Satellites* (EUMETSAT) aiming at the detection of global climate changes.

In fall 1993, a national GCOS Secretariat was established at the DWD in Offenbach to coordinate the cooperation among the institutions involved on a national level in climate observing systems. The BSH operates the German national GOOS Secretariat.

The present report is the *Second Report of the Government of the Federal Republic of Germany on Systematic Climate Observation in Germany* with the view to forming part of *Germany's Fourth National Report under the United Nations Framework Convention on Climate Change*. It contains descriptions of a broad range of observation and monitoring systems insofar as information has been provided. Although the report will be incomplete to some extent, it still represents the most comprehensive overview of climate observing systems in Germany.

For additional information on environmental monitoring systems operated by the Federal Government in general, please refer to the *Federal Environmental Agency* (UBA, 1998).

XI.1.4.1. Atmospheric observations

Meteorological observations have a long tradition in Europe. As early as in 1780 Karl Theo-dor, Prince elector of the Palatinate, founded the Societas Meteorologica Palatina with 39 meteorological stations from the Ural to Greenland to America. State weather services in Germany started collecting climatological data at the end of the century before last, but only since German reunification in 1990 have the data been recorded and processed according to standard guidelines. With the use of automatic stations, the temporal density of measurements was increased considerably.

Germany's contributions to GCOS are manifold: Germany contributes to the GCOS Surface Network (GSN) by operating 4 stations (one of which is in the Antarctic) and, jointly with the Japanese Meteorological Service, a GSN Monitoring Centre (GSNMC) for monitoring the availability and quality of climate data from GSN stations. Another contribution to GCOS is the Global Precipitation Climatology Centre (GPCC) which the DWD operates to regularly provide global analyses of monthly precipitation produced on the basis of all available observations for global climate-monitoring purposes. Two of the stations operated by Germany, one of which is in the Antarctic, contribute to the GCOS Upper Air Network (GUAN). German stations also contribute to the Global Atmosphere Watch (GAW). All stations that are part of the GSN, GUAN, or GAW networks will be in operation until 2010. In addition, there is the Global Runoff Data Centre (GRDC) operated at the Federal Institute of Hydrology (BfG).

Besides these stations, there are a wide variety of other monitoring sites where meteorological and atmospheric parameters are observed, the spatial density of which depends on the type of parameter. The number of stations varies from around 4000 in the network of precipitation stations to only a few stations that measure (climate-relevant) gases. These stations are largely operated by the DWD (meteorological issues) and the Federal Environ-mental Agency (UBA) in the context of atmospheric chemistry, but also by the authorities of the individual Laender, in particular, in the field of precipitation. Any other observational net-works operated by the Laender shall not be discussed in this report. What should not be for-gotten in this context are the meteorological satellite programmes to which the Federal Republic of Germany makes significant financial contributions.

This observation network is complemented by the observatories of Lindenberg and Hohenpeissenberg, which fulfil national and international functions by operating as reference stations for measurements of physical and chemical processes with often more than 50-year-long time series (e.g. series of ozone-measuring, series of temperature-humidity measuring in the upper troposphere).

XI.1.4.2. Oceanographic observations

The monitoring of climatic changes in the marine sphere requires the use of specially co-ordinated systems that monitor both the atmosphere and the ocean. Fluxes of energy and matter at the ocean/atmosphere interface create strong links between the two systems. With the oceans covering the major part of the Earth's surface, their impact on the climate is of great importance. Correct quantification requires a temporally and spatially extensive data-base that also includes the continuously changing climate-relevant parameters. Data collec-tion in the oceans is difficult and must make use of all international cooperation possibilities and imaginable resources. A major part of large-scale studies is carried out within research projects that, in the long run, can hardly be considered as sustainable but constitute an im-portant and indispensable contribution to the systematic study of the deep ocean.

Buoys, both drifting and moored types, provide oceanographic and meteorological data from each sphere and thus also from the ocean/atmosphere interface. This is what the Vol-untary Observing Ships (VOS) programme aims at: mostly commercial ships (around 800 ships in Germany and 6,700 world-wide) take part in the voluntary weather observing net-work and deliver meteorological and oceanographic data.

For over 130 years, the 'Helgoland Reede' station has been taking, on workdays, surface temperatures, salinity values and selected nutrients as well as biological samples. This time series completes the data provided by automatic buoys deployed at the former positions of fire ships.
At present, the vertical sounding of the oceans is mainly carried out on board ships within the Ship of Opportunity Programme (SOOP). Within the SOOP programme, the tempera-tures are recorded down to a depth of approx. 1,100 m. Most of this data is made available in near real-time via the Global Telecommunication System (GTS) to be used for time-critical applications. Special applications use the quality-checked archive version of the data which provides a higher, more precise resolution. Nowadays, profiling floats (ARGO floats) meas-ure the temperatures and salinity of the upper 2,000 m of the oceans on a quasi-operational basis. Just like the SOOP data, the values measured by ARGO floats are also made available world-wide via GTS.
On the other side, marine aerological soundings (ASAP) provide vertical profiles of air pressure, temperature, humidity and wind up to a height of 20 km. Another important element for determining the state of the ocean are the satellite observations, the satellites being the only observing system that is able to provide a temporally and spatially almost seamless data coverage at a global scale.
On top of the operational methods, continual experiments relating to specific issues are being carried out, e.g. on board research ships. The geostrophic transports between the sub-tropical and subpolar gyres in the North Atlantic, for example, are subject to studies con-ducted in close cooperation between various European research institutes. Meteorologists, too, carry out experiments to explore the marine atmospheric boundary layer and large-scale energy transports.
Providing observations and models, a number of research projects that are conducted within the framework of the World Climate Research Programme (WCRP) such as CLIVAR, CliC, GEWEX, SPARC and SOLAS, contribute their share to systematic climate monitoring. The assimilation of oceanographic and remote sensing data has made progress, in Ger-many, however, it is not yet operationally used.
The Federal Maritime and Hydrographic Agency (BSH) has assumed the function of the national secretariat for the Global Ocean Observing System (GOOS) the task of which is the coordination of Germany's contributions to GOOS.

XI.1.4.3. Terrestrial observation systems

The Laender are conducting numerous terrestrial observations but there is no known nationwide consolidation of data. Terrestrial observation systems where a standardised methodology is applied throughout the whole area exist only at a few federal institutions.
The German Meteorological Service (DWD) operates a measuring network comprising more than 280 stations at which the ground temperature is measured in various depths. A further important contribution to climatic change observations are the phenological observations which are also regularly conducted by the DWD at currently about 1420 sites in Germany. For 410 sites there are time series, some of which cover more than 50 years.
Germany also contributes to the developing of the GTN-H with its network of precipitation measuring stations, the DWD’s Global Precipitation Climatology Centre (GPCC) and the BfG’s Global Runoff Data Centre (GRDC).

As regards the change of distribution limits of plants and animals there are almost only single observations. The Federal Agency for Nature Conservation (BfN) hosts databases on the occurrence, distribution and population status of vascular plants (FLORKART: about 4500 species, about 14 million data sets) and butterflies (LEPIDAT). For decades now, the European and global distribution areas of Central European species have been systematically mapped, made available (recently in digital maps), and analysed as regards range shifts, invasions and decline of population, at the Institute for Geobotany of the University of Halle.
Together with the Federal Statistical Office, a methodological concept for an Ecological Area Sampling (Ökologische Flächenstichprobe – ÖFS) was developed. Implementing this concept would provide indications of changes in the distribution of biotopes and species. A decision on implementation of this monitoring method has not yet been taken.
However, it is expected that comparable data on the conservation status of species and habitat types of community interest will be collected Europe-wide with respect to the EU Habitats Directive and Birds Directive.
Changes in the migratory behaviour of migratory animal species are documented by several universities and the Radolfzell bird station.
Still, there is no focal point for the Global Terrestrial Observing System (GTOS) in Germany. This leads to difficulties with the overview on this kind of observational data.

XI.1.4.4. Space-based observations

For the identification and assessment of changes in the climate system, satellites offer the following advantages: they even provide, on a continuous and seamless i.e. an area-coverage basis, data for regions where there are no or only sparse other observation data available; the data relating to various regions come from one and the same observing sys-tem; some information, such as the radiation budget at the top of the atmosphere, can only be determined by means of a satellite system.

Besides national initiatives, most of the European satellite systems are developed and at least partly operated by the European Space Agency (ESA). Of particular relevance for the investigation of the processes within the climate system are the experimental and pre-operational ESA Earth observation programmes. Due to the longevity needed, however, op-erational satellites play a major role in the detection of variations or changes in the climate system. In Europe, the operation of meteorological satellites and the planning of appropriate successor systems is in the responsibility of EUMETSAT with its headquarters in Darmstadt. At present EUMETSAT operates the geostationary Meteosat satellites. Beginning in 2006, EUMETSAT will, in the framework of its Polar System programme (EPS), start launching the first European polar-orbiting meteorological satellites called MetOp. The European MetOp satellites and the US NOAA satellites complement each other to form a part of the jointly or-ganised operational polar satellite programme. In both organisations, EUMETSAT and ESA, Germany is the largest contributor.

The first data transmitted from a Meteosat satellite dates from 1977. This Meteosat system was in operation above Europe, Africa and the Atlantic until the end of 2005 and will remain in operation above the Indian Ocean for even longer. The first satellite of the considerably improved Meteosat Second Generation (MSG) started operation at the beginning of 2004. With a view to guaranteeing the continuity of the availability of MSG data at least until 2019, the construction, launch and operation of altogether 4 MSG satellites were irrevocably con-cluded.

Within the so-called Satellite Application Facilities (SAF) operated by EUMETSAT, the DWD has agreed to function as the lead institution for the tasks of deriving climate-relevant parameters from data transmitted by the MSG and EPS/MetOp satellites and of establishing, operating and further developing the 'SAF on Climate Monitoring'. Under the responsibility of EUMETSAT, the SAFs form a European network of specialised centres for the exploitation of satellite data. The Satellite Application Facility on Climate Monitoring (CM-SAF) is one of presently 8 such competence centres. Early 2005, the CM-SAF started the pre-operational production of climatologies for radiation, clouds and humidity issues on the basis of satellite data.

XI.1.4.5. Coordination of Earth observation activities

In the field of geoinformation there is a wide variety of institutions and organisations involved, but their activities and mutual data exchange are not yet well co-ordinated. Here is an exem-plary selection of some of them: CEOS, IGOS, GCOS, GOOS, GTOS, GMES, ICP IM, ICSU and ICSU WDC, UNFCCC, CLIVAR, CORINE, EMEP. For this reason, as a result of the 2003 G8 Summit in Evian (France), an initiative was launched under the title 'ad hoc Group on Earth Observations (GEO)' for a more efficient coordination of the on-going and future activities in the field of earth observation (in situ and remote sensing), for minimizing the defi-ciencies of observation systems and for securing simple and ample exchange of data. The result of this initiative is the establishment of the Global Earth Observation System of Sys-tems (GEOSS), i.e. a system of earth observation systems which is highly supported by pol-icy and is now supported by over 60 countries. The GEO Secretariat is hosted by WMO at its headquarters in Geneva. On the national level, GEOSS is under the overall responsibility of the Federal Ministry of Transport, Building and Urban Affairs (BMVBS), with the DWD having played a major part in the activities undertaken by GEO to establish GEOSS. GEOSS will, among other things, bring improvements to the national activities in the field of recording the state of our climate system, any changes and their effects.

XI.1.5. General Information on 'Systematic Observation'

XI.1.5.1. National programmes for systematic atmospheric monitoring

XI.1.5.1.1. The legal basis

The Federal Republic of Germany has set forth its obligations to carry out systematic (climate) observations in various national laws (e.g. *Environmental Information Act*, *Act on the German Meteorological Service* (DWD)).

The *German Meteorological Service* (DWD)[105] is the National Meteorological Service of the Federal Republic of Germany. It is legally bound to carry out meteorological observations, i.e. by the Act on the German Meteorological Service (DWD) of 10 September 1998 (Federal Law Gazette I, p. 2871), last amended by Article 5 of the

[105] http://www.dwd.de

Act to Improve Preventive Flood Control of 3 May 2005 (Federal Law Gazette I, p. 1224). The DWD thus fulfils the obligations arising from the Framework Convention on Climate Change in the area of systematic observation of meteorological variables. In fall 1993, a national GCOS Secretariat[106] was set up at the DWD. Since its establishment, this Secretariat has played an active role in developing the GCOS programme and coordinates national GCOS activities. Since August 2001, the national GCOS Secretariat has also been in charge of compiling the *National Report on Systematic Climate Observation*.

Meteorological variables are also measured by other authorities at national or Laender level.

The air monitoring network, which originally had been established by the *German Research Foundation* (DFG) and later, in 1974, was transferred into the newly founded *Federal Environmental Agency* (UBA), had the task of monitoring air quality throughout Germany. To this end, it sampled the air both at clean-air sites and in conurbations. When monitoring responsibilities were taken over by the Laender and, subsequently, the Laender networks were built, the UBA air monitoring network was confined to fulfilling Germany's international obligations to provide measurements and reports, i.e. to measuring the wide-ranging and transboundary background pollution at selected clean-air sites.

Air-quality measurements are carried out in accordance with a range of laws and protocols:

- *UN/ECE Convention on Long-Range Transboundary Air Pollution* (*Geneva Convention on Air Pollution*) and succeeding protocols: SO_2 Protocol, NOx Protocol, VOC Protocol, 2nd Sulphur Protocol, Protocol on Heavy Metals, POP Protocol, Multicomponent Protocol.
- Supporting scientific programmes pertaining to the *Geneva Convention on Air Pollution*:
    - *European Monitoring and Evaluation Programme* (EMEP)
    - *Working group on Effects* and, in particular the *International Cooperative Programme on Integrated Monitoring* (ICP IM) and *International Cooperative Programme on Mapping* (ICP M)
- HELCOM
- OSPARCOM
- GAW (as successor of BAPMon, GO_3OS[107])
- 4th EU daughter directive 2004/107/EC of 15 December 2004

XI.1.5.1.2. National Plans and Organisational Structures

National plans pertaining to meteorological observations are developed and updated by the DWD in accordance with the legal basis. There is no separate national plan for climate monitoring in place.
The DWD is in charge of carrying out meteorological observations on the territory of the Federal Republic of Germany. The DWD is a public institution, with partial legal capacity, under the department of the Federal Ministry of Transport, Building and

[106] http://www.dwd.de/research/klis/internat/gcos/
[107] GO_3OS = Global Ozone (O_3) Observation System

Urban Affairs (BMVBS). Its tasks pertaining to systematic observation, as set forth by the Law on the DWD, i.a. are as follows:

- Short and long-term recording, monitoring and assessing of meteorological proc-esses, and of the structure and composition of the atmosphere
- Recording of the meteorological interactions between the atmosphere and other ar-eas of the environment
- Operating the necessary measuring and observation systems for fulfilling the tasks listed above
- Provision, archiving, and documentation of meteorological data and products.

With a view to continuing and modernising the observing networks, the technical equipment of the stations, their spatial distribution and the measuring programmes were redefined within the large-scale 'Messnetz 2000' project for the future. The results of this project are intended to be fully implemented by the end of 2007. For further information please see Section XI 1.6.4.

In order to fulfil its tasks, the DWD operates a meteorological observing network consisting of various specific station networks, the station density of which depends on the require-ments to be met and meteorological parameters to be measured.

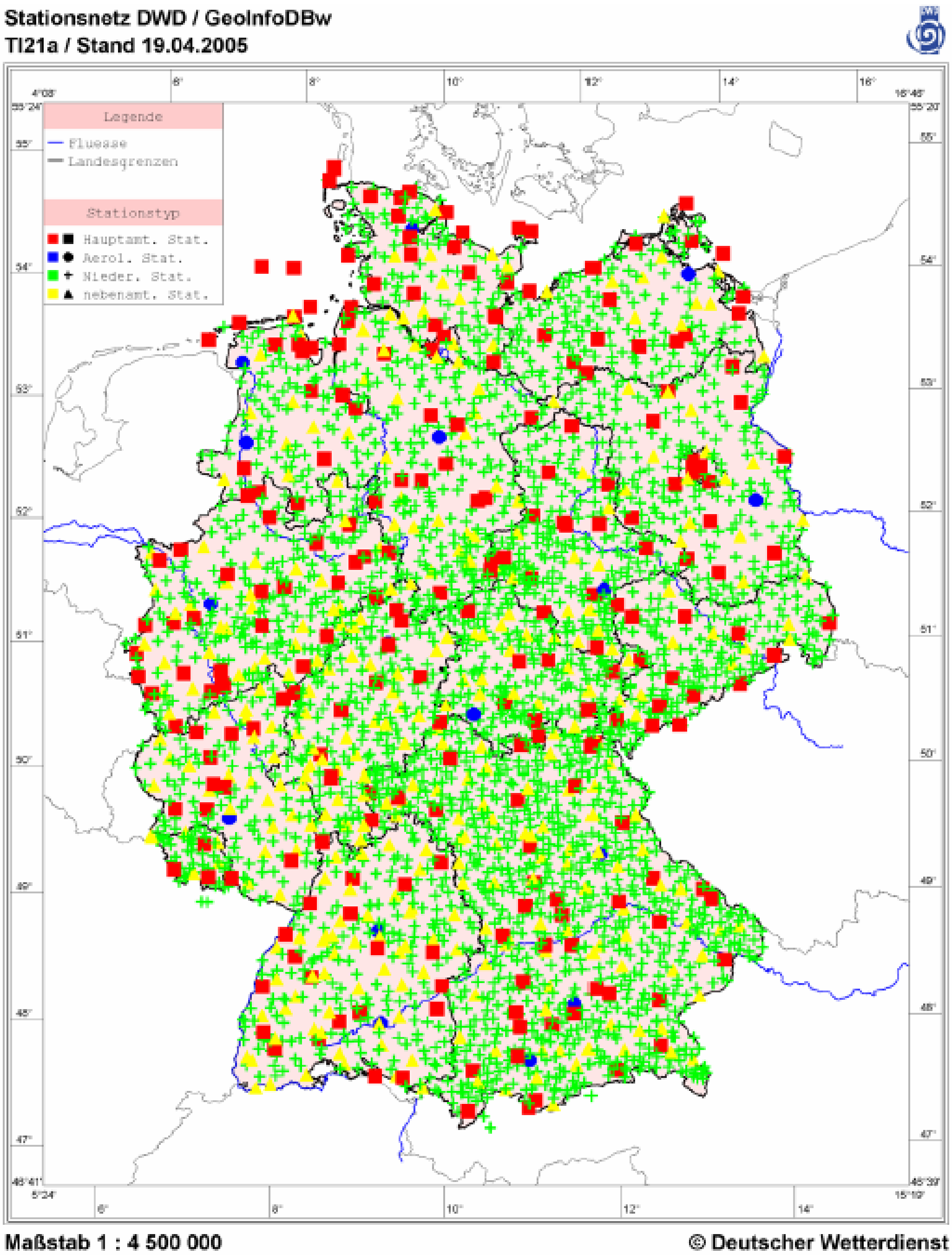
Figure XI - 1 provides an overview of the station density in the various observing networks oper-ated by the DWD. A full list of the stations operated by the DWD is given in table format by the KLIS climate information system of the DWD under 'station information' . For further information, please refer to Section 3.

In some Laender, the station density is further increased by regional observing networks operated by the Laender in question. Besides measuring precipitation, such observing net-works also record air temperature as well as the speed and direction of wind. A more recent development is the increasing number of privately operated observing networks. However, their measuring standards only partly meet the criteria established by the DWD, and their data is normally not made available to the DWD for the purposes of international data ex-change. For this reason, such networks are not discussed in the present report.

The measuring network of the Federal Environmental Agency (UBA) can be subdivided into four task-specific areas:

1. Measurements for EMEP (atmospheric chemistry, substances in precipitation and dust, and meteorological parameters)
2. Measurements for OSPARCOM and HELCOM
3. Solar UVB monitoring (BfS/UBA)
4. Atmospheric chemistry measurement programme in the framework of Global Atmosphere Watch

Fig. XI - 1 **Geographic distribution of the stations within the various networks operated by the DWD**



A map showing all sites of the air monitoring network operated by the UBA is available on the Internet.[108] The number of manned measuring stations including the Zugspitze/Hohenpeissenberg GAW station has been reduced to a total of seven; whereas the number of automatic measuring stations has been reduced to 0. The UVB measuring network consists of 3 UBA-operated sites, situated in Zingst, Langen and Schauinsland. All are associated with the BfS' Neuherberg station.

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[108] http://www.umweltbundesamt.de/uba-info-daten/daten/mbm/mblage.htm

Parts of Zugspitze section of the GAW global station Zugspitze/Hohenpeissenberg as part of the WMO/UNEP programme are still being set up; experimental measurements have already begun. This further enhances the measuring of climate-relevant gases (CO_2 since 1972, CH_4 since 1993). Moreover, two stations now measure N_2O and SF_6 (Zugspitze, Schauinsland).

The radioactivity measurements formerly carried out within the IMIS measuring network were discontinued in 1999. Measuring parameters and sampling: detailed descriptions of the parameters at each station can be found on the Internet[109]. The measuring data is available on request from the Langen branch office of the UBA. Public access to monthly aggregated data is provided on the Internet[110]. Ozone data and forecasts as well as the concentration values of other air pollutants are available on the Internet[111], together with relevant data of the Laender.

The results obtained from the observing network are integrated into the following products:

- UBA Intranet pages
- Monthly reports from the observing network
- Annual report
- Data supplies to international organisations
- German-wide ozone forecasts and description of the current situation
- Scientific analyses and further development of measuring methods.

XI.1.5.1.3. Participation in Remote Sensing Programmes

With regard to observations of the Earth from space, the Federal Republic of Germany is a member of the *European Space Agency* (ESA), as well as EUMETSAT (*European Organisation for the Exploitation of Meteorological Satellites*). ESA is primarily responsible for experimental missions and the development and testing of new satellite missions, EUMETSAT for operational satellite systems for meteorology and relevant Earth observing missions, and for planning the appropriate operational successor systems. Apart from the advantages that satellites offer anyway for recording the status of the climate system, its changes and effects (see Section 'Space-based Observations' in the Detailed Summary), EUMETSAT missions are of particular significance for climate monitoring, because of their long-term continuity guaranteed from the outset. Thus the operation of the first Meteosat Generation covers a period lasting from 1977 up to at least 2005, and MSG (Meteosat Second Generation) is also expected to be in operation for approx. 25 years or longer. At EUMETSAT and ESA first studies have been started on a joint basis for a Meteosat Third Generation (MTG) to cover a period up to about 2030. First considerations have also been given to an EPS successor system. At EUMETSAT the interests of the Federal Republic of Germany are represented by the DWD. In this way it also participates inter alia in the formation of the *Integrated Global Observing Strategy* (IGOS). Germany is one of the main contributors to both EUMETSAT and the ESA

[109] http://www.umweltbundesamt.de/uba-info-daten/daten/mbm/messprogramm.htm
[110] http://www.umweltbundesamt.de/uba-info-daten/daten/mbm/monatsberichte05.htm
[111] http://www.env-it.de/luftdaten/start.fwd

Earth Observing Programme, and carries a great deal of weight in the planning and decisions of these European satellite organisations[112].

In addition to this, in the framework of the German Space Programme[113], Germany is involved in various ESA projects via the German Aerospace Center (DLR) Space Management, and carries out projects of its own within the national programme. At present climate-relevant observing systems such as CRYOSAT, GOCE, SMOS, Aeolus/ADM, SWARM and EarthCare are in the development phase in the ESA *Earth Observation Framework Programme*.[114]. In the national Space Programme the BIRD, CHAMP and GRACE missions are being operated at the moment, as well as the atmosphere sensor SCIAMACHY on ENVISAT. The latter provides the DLR at Oberpfaffenhofen[115] with constantly updated NO_2 total columns. Furthermore, the TerraSAR-X[116] and RapidEye[117] projects are at the development stage. TerraSAR-X covers the Federal need for scientific X-band radar data for use in the fields of ecology, hydrology, geology, oceanography and interferometry, and constitutes at the same time a beginning of the commercialisation of Earth observation. The launch of TerraSAR is scheduled for June 2006. The RapidEye satellite system – consisting of 5 satellites with optical cameras, which for the first time will be in a position to take at least one picture every day of each point on the Earth - is geared to commercial use by agriculture, insurance companies, the food industry, and organisations working in the field of disaster aid. Its launch is planned for the end of 2006.

Within the framework of EUMETSAT's so-called 'Satellite Application Facilities' (SAF), the DWD has taken over the task of acting as lead institution for the derivation of climate-suitable parameters from the new generation of satellites (MSG, EPS_MetOp), and of building up, operating and further developing the 'SAF on Climate Monitoring' in cooperation with other European Meteorological Services. The SAF started operations at the beginning of 2005[118].

The DWD is also involved in validation activities at the EUMETSAT *Satellite Application Facility for ozone monitoring*, which is managed by the Finnish Meteorological Service FMI, and in which the DLR is also actively involved on the national side. The ozone SAF, which, at present, is still in the construction phase and, according to plan, will be in full operation as from 2007, makes important contributions to the routine monitoring of the chemical composition of the atmosphere by using satellite remote sensing data.

XI.1.5.1.4. International Data Exchange and Data Policy

DWD data are exchanged internationally within the framework of the WMO programme. Climatological time series from 44 selected stations of special value are provided worldwide by the DWD via the Internet, free of charge and without restriction of use. The data also include the observations at German sites that go back furthest in time. Excerpts from all other databases can be provided upon request. Use of the data for research purposes and the performance of official duties is permitted free of charge. The conditions for the use of data from EUMETSAT

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112 http://www.eumetsat.int
113 http://www.dlr.de/rd/fachprog/eo
114 see http://www.esa.int/esaEO/
115 http://wdc.dlr.de/data_products/SERVICES/SCIANRT
116 http://www.terrasar.de
117 http://www.rapideye.de
118 http://www.cmsaf.dwd.de

programmes are fixed jointly by the member states. The rules agreed upon provide that all products contributing to climate observation are made available on request for unlimited use.

In 1999 the DWD, acting in cooperation with the Japanese Meteorological Service, began setting up the *GCOS Surface Network Monitoring Centres* (GSNMC) with the goal of improving the availability and quality of climate data provided by the GSN stations. Since the international availability of climate data depends, inter alia*,* on use of error-free transmission formats, reports on detected formal errors are submitted annually. Such errors can hamper, or even preclude the use of the transmitted climate data. Reporting also covers the quality of the transmitted data on monthly precipitation totals and monthly mean temperatures. Data collected by means of this system are transferred once a month to the ICSU *World Data Centre A for Meteorology* (WDC-A) and are thus available via the network of *World Data Centres*.

XI.1.5.1.5. Activities to Support Developing Countries

The *Federal Ministry for Economic Cooperation and Development* (BMZ) is responsible for formulating and implementing the Federal Government's development policy. Its duties concentrate on the following areas:

- Shaping of global framework conditions,
- Development of bilateral and multilateral support strategies,
- Supporting development programmes and projects in the partner countries,
- Supporting cooperation of non-governmental organisations in development policy,
- Monitoring of success and control of the use of resources.

The Federal Government provides a range of different types of development assistance. In addition to technical cooperation, which is implemented mainly by the *Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH*, the spectrum includes financial cooperation (*KfW Banking Group*), and Germany's contributions to international organisations (multilateral cooperation).

The GTZ has been active as a service enterprise in international development cooperation since 1975. GTZ has more than 10,000 staff members in over 120 countries worldwide and is the largest undertaking of its kind in Germany.

The Federal Republic of Germany has been supporting the implementation of the *United Nations Framework Convention on Climate Change* in developing countries since 1993. In a first and second phase, the activities in the framework of the '*Measures to implement the Framework Convention on Climate Change*' project have concentrated on supporting developing countries in collecting national data on greenhouse gas (GHG) emissions and reduction possibilities. In the third phase, the *Clean Development Mechanism* (CDM) was added, and since the fourth phase, the *'Climate Protection Programme for Developing Countries*' has also covered the subject of adaptation to climate change.

The DWD has neither the legal possibilities nor the financial means to take part in technical cooperation. It can, however, cooperate directly with meteorological services in partner countries to convey its knowledge and skills in support of these services, so that they are better able to fulfil their national and international tasks.

EUMETSAT carries out many activities to support and further less developed countries, with the focus on Africa as a continent with special climatic conditions. In this context, the joint and mainly EU-funded PUMA project (*Preparation on the Use of MSG in Africa*) should be mentioned, which offers to each African country the opportunity to receive and use MSG data; or the training activities for countries in, for example, Central and Eastern Europe or Africa, that are organised jointly and in close cooperation with the *World Meteorological Organization* (WMO). The DWD also participates actively in such training programmes. Through EUMETSAT, Germany thus also makes an indirect contribution to assistance granted to developing countries.

Within the GAW programme, the *Federal Environmental Agency* (UBA) is responsible for the *GAW Training and Education Centre* (GAWTEC) and organises the training sessions for measurement engineers from the GAW stations. The training sessions deal with the major climate gases and volatile organic compounds (VOCs). So far, almost 100 trainees from all five continents and around 40 countries have attended the training programmes. The GAWTEC centre is the only training centre of its kind worldwide within the GAW programme.

XI.1.5.1.6. Deficiencies

As a rule, the DWD observes the 10 Climate Monitoring Principles (see end of document).

The reduction of precipitation stations within the responsibility of the DWD (as shown in Table 2) has been partly compensated for through the use of regional precipitation networks of the Laender and through the radar measurements from the DWD radar network (see Section 3).

Stations that deliver climatological relevant data constitute a valuable cultural heritage, which deserves special protection and continuation.

XI.1.5.2. Nationale programmes for systematic ocean monitoring

XI.1.5.2.1. The legal basis

The Federal Republic of Germany is obliged by law to systematically monitor the marine environment. According to the Federal Maritime Responsibilities Act, as amended on 18 September 1998, the Federal Maritime and Hydrographic Agency (BSH) has to monitor changes to the marine environment, support marine shipping and fisheries with scientific re-search and carry out nautical and hydrographic services. The obligation to carry out marine meteorological observations is set forth, inter alia, in the Act on the Deutscher Wetterdienst of 10 September 1998 (Federal Law Gazette I, p. 2871), last amended by Article 5 of the Act to Improve Preventive Flood Control of 3 May 2005 (Federal Law Gazette I, p. 1224), in the International Convention for the Safety of Life at Sea (SOLAS) of 1974 including its corre-sponding amendments and the Protocol of 1978, as well as in numerous international con-ventions relating to the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). The IOC coordinates the contributions from the various countries to the Global Ocean Observing System (GOOS).

Moreover, by participating in GOOS the German Government has integrated monitoring in its international activities, as required, and approved the establishment of the national GOOS Secretariat at the BSH. The national GOOS Secretariat cooperates closely with the German GCOS Secretariat hosted by the German Meteorological Service. Many of the observing sys-tems described in Section 4 'Oceanographic Observations' are part of the German contribu-tion to GOOS.

XI.1.5.2.2. National Plans and Organisational Structures

The MARNET observing network has been developed and set up in the national oceano-graphic sector on the basis of a concept submitted to the Federal Ministry of Transport, Building and Urban Affairs (BMVBS). At present new stations are being set up, in the North and Baltic Seas, to extend this observing network. The 'Nordseeboje III' was moored close to the position of the former 'Forschungsplattform Nordsee' and put into operation. Besides that, 'Arkona Becken' station and the 'FINO1' research platform were included into the observing network (see the station plan in Section 4 'Oceanographic Observations'). No further stations are planned at present. However, it is intended to introduce new measuring methods and to improve the measuring equipment in the interests of obtaining the best possible data quality and data availability. In this context, attempts are being made, within the framework of the European workshop on fixed monitoring networks in the North Sea region (SeaNet), to achieve a relevant consensus of the European countries, in cooperation with the European Association for the Global Ocean Observing System (EuroGOOS). The BSH actively partici-pates in international oceanographic data collection on merchant ships, the Ship of Opportu-nity Programme (SOOP).

As described in Section 2.1.2, the DWD is responsible in Germany for carrying out mete-orological observations and thus also for marine meteorological observations. See the rele-vant section for details on the DWD's tasks and organisational structure.

For the collection of marine meteorological in situ data at near sea surface level, the DWD uses the national fleet of world-wide operating and voluntarily observing merchant ships, re-search and fishing vessels. This network is embedded in the international VOS Scheme, which is coordinated within the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) and in whose establishment, maintenance and evaluation the DWD is substantially involved.

On the European level, the DWD takes part in the EUMETNET Composite Observing Sys-tem (EUCOS). There, it plays a major in the EUCOS Surface Marine Observing Project (E-SURFMAR) which provides and co-ordinates observing ships as well as drifting and moored buoys for meteorological-oceanographic purposes.

The DWD runs marine meteorological observing systems situated along the foreshores of Germany, partly in cooperation with the BSH.

In marine meteorology, it is inevitable to study the marine atmosphere up to high altitudes. For this reason, the DWD has set up a series of mobile semi-automatic upper-air sounding stations on sea vessels and thus it participates in the international Automated Shipboard Aerological Programme (ASAP).

Within the EUCOS, the DWD has assumed the role as the member responsible for the E-ASAP project and provides the project manager. In addition, it contributes by providing a number of containerized sounding units.

From the organisational point of view, the DWD's marine meteorological activities are hosted at the 'Marine Climate Monitoring' and 'Meteorological Harbour Service' units of the DWD.

XI.1.5.2.3. Participation in Remote Sensing Programmes

Section XI.1.5.1.3 reports on the participation of the DWD in remote sensing programmes. These have significance not only for the systematic observation of the atmosphere but also for the observation of the Earth's surface and thus the oceans.

In view of monitoring of the sea surface, the satellites of NOAA, NASA, EUMETSAT and ESA routinely collect data on sea ice and surface temperatures and monitor the environment. Altimetric data, which come from satellite programmes such as ERS1, ERS2, Topex/Poseidon and, recently, Jason, are increasingly used for quasi-operational oceano-graphic applications. For this reason, these programmes must be continued without interruption. Programmatic interests are represented through participation in national preparatory meetings, in the meetings and conferences held by the relevant bodies of ESA and EUMETSAT (see Section XI.1.5.1.3) and in national and international user groups.

The DWD not only runs numerical weather prediction models, but also, in cooperation with the Geesthacht Research Centre (GKSS), sea-wave models that already use wind and wave data at sea surface level taken from ESA and NASA satellite data. The sea-wave models will soon also be using the sea surface heights measured with radar altimeter systems within the optional Jason-2 programme of EUMETSAT to which Germany contributes around 25 %.

XI.1.5.2.4. International Data Exchange and Data Policy

With the view to simplifying, and making more secure the exchange of operational oceano-graphic data, SeaNet carried out the EU-funded SeaNet Data Interface (SNDI project). This project aims at facilitating data exchange within Europe, initially in only 6 countries. SeaNet data policy provides for authorities and research institutions to use data free of charge, whereas commercial use is subject to charges pursuant to the national provisions of the country providing the data. A reduced set of MARNET data is made available world-wide via GTS.

Ultimately, national data policy in the oceanographic field will be oriented to the policy of GOOS, which favours the unrestricted release of observational data.

The data collected within SOOP on national level will be forwarded to the Global Surface Data Centre.

In Germany, international exchange of marine meteorological data lies in the responsibility of the DWD. It takes place on the basis of international agreements and commitments within the framework of the WMO – e.g. within the VOS Scheme via GTS or within the Marine Cli-matological Summaries Scheme (MCSS). Within the MCSS the DWD operates in Hamburg one of the two Global Collecting Centres (GCC). Resolution 40, adopted on the occasion of the 12th WMO Congress, is an important guideline for policies for exchange and dissemina-tion of marine meteorological data.

XI.1.5.2.5. Activities to Support Developing Countries

In actions restricted to specific periods and mostly within or in connection with development projects funded by the Federal Ministry of Education and Research (BMBF) or the EU, the BSH provides scientific / technical consultancy if developing countries show an interest in deploying and purchasing oceanographic observation systems resulting from relevant projects (e.g. China and Indonesia in connection with the MERMAID and CANVAS projects, etc. run by the BMBF). In-depth and more extensive activities require additional resources.

XI.1.5.2.6. Deficiencies

If GOOS and EuroGOOS are to become effective operational instruments aiming at achieving the defined objective, the declarations of intent of the involved countries must be followed by the provision of appropriate funds. The measuring network components already in place are a start. However, in the view of the enormous need for data such components can only be the beginning of a considerably enlarged overall system. Due to the lack of funds, the sustainable operation of the systems in place and their further extension or enlargement cannot be considered secure.

XI.1.5.3. Nationale programmes for systematic terrestial climate-related observations

XI.1.5.3.1. The legal basis

Land use

In 1979, as an action following the Final Act of the *Conference on Security and Co-operation in Europe* (CSCE) in 1975, the *Convention on Long-Range Transboundary Air Pollution*, UN/ECE-CLRTAP, was signed in Geneva by the then 34 member states of the *UN Economic Commission for Europe* (as of 1998, following the political restructuring processes in Europe, a total of 43 of the 53 member states had joined the Convention) and by the European Community. This was the first internationally binding instrument to address the problems of air pollution on a broad basis. 'Besides establishing the general principles for international cooperation to control air pollution, it has created a framework for institutionally combining research and policies' (UN/ ECE 1996, unofficial translation). Implementation is carried out by an Executive Body, which is supported by 3 working groups and the *European Monitoring and Evaluation Programme* (EMEP)[119]. The working groups are supported by special working groups staffed with experts from the member states.

Biota

With the amendment of the *Federal Nature Conservation Act* in March 2002 the legal basis concerning nature conservation-oriented biotic information was established in section 12 of the act. It provides for integrated environmental monitoring to be legally enshrined as a task to be jointly carried out by the Federal Government and the Laender. Monitoring in the field of nature conservation lies within the competence of the Laender. At present no programme or initiative for the design of a joint monitoring has been established on this basis.

[119] http://www.unece.org/env/lrtap/conv/lrtap_o.htm

EU Directive 2001/18/EC provides for the monitoring of releases and the placing on the market of genetically modified organisms. To determine relevant ecological impacts, data on species and their distribution is to be collected. Relevant monitoring concepts are being developed at present. In the course of approval of the release, the content and scope of the monitoring of genetically modified organisms (GMO) is determined in the specific management plan. It is not foreseeable whether such efforts can be expected to produce climate-relevant data. The EU Directive was implemented in German law in June 1990 (Genetic Engineering Act). A complete implementation into German law is expected for midyear 2006.

XI.1.5.3.2. National Plans and Organisational Structures

<u>Land use</u>

The German contribution to the *Working Group on Effects* (UN/ECE-CLRTAP) refers to several components:

- *Federal Environmental Agency* (UBA): *International Cooperative Programme on Modelling and Mapping*
- *Federal Environmental Agency* (UBA): *International Cooperative Programme on Integrated Monitoring of Air Pollution Effects on Ecosystems* (ICP *Integrated Monitoring*)
- *Federal Agricultural Research Centre* (FAL): International Cooperative Programme on Effects of Air Pollution and other Stresses on Crops and Natural Vegetation (*ICP vegetation, formerly ICP Crops*)
- *Federal Environmental Agency* (UBA): *Monitoring of heavy metals in mosses* (*ICP vegetation*)
- *Bavarian National Heritage* (*Bayerisches Landesamt für Denkmalpflege*): *Programme on Effects of Air Pollution on Materials, including Historic and Cultural Monuments* (*ICP Materials*)
- *Federal Ministry of Food, Agriculture and Consumer Protection* (BMELV) / *Federal Research Centre for Forestry and Forest Products* (BfH): *International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests* (ICP Forest)
- *Federal Environmental Agency* (UBA) / *Bavarian Agency for Water Management* (Bayerisches Landesamt für Wasserwirtschaft): *International Cooperative Programme on Assessment and Monitoring of Acidification of Rivers and Lakes* (ICP Waters)

Integrated monitoring begins by assessing the status quo of ecosystems and their changes under the influence of anthropogenic pollutants. For this purpose, concentrations and depositions of air pollutants are determined. In addition, the interactions of substances deposited from the atmosphere with different sub-compartments of the investigated ecosystems are examined – in this context, the soil or groundwater and surface water and biota, for example.

In order to differentiate between ecosystem changes brought about by the impact of anthropogenic air pollutants and those occurring naturally, it is necessary to carry out long-term monitoring of plants and animals (biomonitoring) in direct connection with collection of physical and chemical environmental data (i.e. monitoring and data collection at the same monitoring sites, and at the same times). Such studies are currently being carried out at 50 monitoring sites, located in 27 European and Northern American countries. Sweden is coordinating this programme; the *International Programme Centre* is located in Helsinki, Finnish Environment Institute. An overview of the meta data of all participating countries is available on the Internet[120]. Germany is participating in the programme with the following monitoring sites:

- Location: Bavarian Forest (size: 0.64 km^2), observation started: 1989, until 1992 as pilot programme, since 1992 permanent measuring programme.
- Location: Neuglobsow – Stechlinsee (Brandenburg), observation of air chemistry and climate over the last 30 to 40 years, since 1999 permanent measuring programme.

The monitoring sites have been mapped extensively. The measuring programmes are divided into compulsory programmes and optional programmes. Apart from climate and air chemistry they also include monitoring on soils, leachage and groundwater, surface water in streams and lakes, forest damage and vegetation as well as aquatic indicator species.
The data provided by the German programme is forwarded, in the prescribed formats, to the data centre in Finland. There, joint reports are drawn up. Annual international reports are available on the Internet[121]. Further information is available in the Internet, too[122]. This site also provides further information regarding the manual and links to other cooperative programmes. The GTOS website also has a link to this programme.

Soil
In the context of the implementation of the Federal Soil Protection Act and the Soil Protec-tion Ordinance of 1999 soil examinations are carried out in the area of the UBA air measur-ing network. At 17 measuring and sampling sites, the soil has been mapped for land use. Apart from data on soil chemical and physical properties, soil index data is also collected, for determination of such factors as carbon content, cation exchange capacity, pH values and the organic substance. Such data collection within the UBA air monitoring network forms an integral part of the data collection at the approximately 700 permanent monitoring areas of the Laender. Standards for the relevant methods and study parameters were prepared in connection of implementation of the Federal Soil Protection Act.

Biota
There are no national plans for nature-conservation-oriented integrated environmental monitoring. At the expert level, the competent regional authorities and the Federal Agency for Nature Conservation (BfN) have developed a concept for nature conservation-oriented envi-ronmental monitoring. No decision on implementing this concept has yet been taken. The Laender carry out surveys in keeping with their own relevant plans, and in their respective areas. As a rule, it is not possible to combine such results at the national level, since these surveys differ in their subjects, criteria and intervals. The only combination of observation data from Laender-level and regional projects carried out so far by a federal agency was conducted by the BfN for vascular plants. The database FLORKART currently holds a data set of 14 million observations. It provides nationwide data on species

[120] http://www.environment.fi/default.asp?contentid=17110&lan=en
[121] http://www.environment.fi/default.asp?node=6335&lan=en
[122] http://www.environment.fi/default.asp?contentid=17110&lan=en

distribution, which might serve as a basis for the determination of range shifts. With the Centre for Phytodiver-sity Germany (ZePhyD), there exists a national structure of loosely coordinated centres of competence, which takes responsibility for the continued collection, centralised consolidation and provision of data on the population status and distribution of plants in Germany.

XI.1.5.3.3. Participation in Remote Sensing Programmes

The EU *Coordination of Information on the Environment* programme (CORINE) was initiated in 1985 and mainly focuses on:

- Protection of habitats
- Control of air pollution
- Protection of the environment in the Mediterranean.

On the basis of satellite data, an inventory of land cover was drawn up in Germany for the first time in 1990, including both natural land cover and human land uses. This inventory is known as the 'CORINE Land Cover'. The European programme provided for a national survey on the basis of a harmonised 'Technical Guide' and a collection of the data to form a European, harmonised data set.

In 1991 the UBA commissioned the *Federal Statistical Office* to carry out the survey for Germany. After the establishment of the *European Environmental Agency* (EEA) this task was continued in the EEA project *Land Cover – Ecological Monitoring*.

The *European Topic Centre on Land Cover* (ETC/CL) was founded in 1995 as an international coordinating body, within the EEA, in order to coordinate the *LC Ecological Monitoring Project*. *National Reference Centres* (NRC) were established in the member states of the EEA, functioning as national contact points. During the initial survey carried out in Germany the *Federal Statistical Office* functioned as NRC Germany.

Methodology

The internationally binding nomenclature includes a total of 44 land cover classes for Europe and takes account not only of the main categories of the land cover/land use such as artificial areas, agricultural land, forests and water surfaces but also of classes that are substantially significant for nature conservation and landscape protection. 36 classes are relevant for Germany. The scale of the output product was fixed at 1:100.000. The smallest surfaces mapped correspond to 25 hectares (500m x 500m) and linear features, such as rivers and roads, less than 100 m in width are not included. The method is explained in detail in the 'Technical Guide', which is available in German and includes additional information on digitalisation.

EUROSTAT compiled the international surveys within the *Geographical Information System of the European Commission* (GISCO). The data is available upon request at *EEA – ETC CORINE Land Cover*; upon establishment of the new ETCs, from 2001 onwards, it is available from the *ETC Terrestrial Environment*.

Information on *European Topic Centres* (ETC) is available on the Internet[123]

This set of data is to be used for *Ecological Area Sampling*.

[123] http://www.eionet.eu.int/Topic_Areas

XI.1.5.3.4.   International Data Exchange and Data Policy

Soil

Data exchange with the Laender is governed by the Administrative Agreement on Environ-mental Data Exchange, which defines the subject and extent of data (e.g. basic soil data, background values, site parameters). The Federal Agency for Geological Sciences and Natu-ral Resources (BGR) contributes substantially to the establishment of a national information system, since individual special information systems of the BGR (e.g. pedology) make avail-able important information necessary for the work of the Federal Environmental Agency (UBA).

The UBA is currently setting up the Federal Soil Information System. Continuous provision of data from the Laender to the Federal Government is expected to begin in coming years.

Biota

Information is provided to the international level within different international conventions and on the grounds of EU Directives. These include the:

- Habitats Directive
- Bird Directive
- Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA)
- Agreement on the Conservation of Bats in Europe (EUROBATS)
- Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)
- Agreement on the Conservation of Seals in the Wadden Sea
- Ramsar Convention
- Bern Convention
- Helsinki Convention
- Alpine Convention

The Laender provide the information, and the Federal Government partly prepares summa-ries or draws up national reports. There are no standard provisions at the federal level as regards the collection methods or the measuring networks. However, the Habitats Directive and on a more general level the Birds Directive include legally binding provisions. They relate to the type and quality of the required data. The methodology for collecting and consolidating the data have to be completed and standardised by the Laender in cooperation with the Fed-eral Agency for Nature Conservation (BfN).

XI.1.5.3.5.   Deficiencies

Soil

Results of the permanent monitoring areas from the past exhibit a high degree of heteroge-neity, and comparison is therefore only partly possible. In the past, specifications regarding standards for setting aside permanent monitoring areas, for sampling and for analysis were inadequate. As a result, the compatibility of 'historic' data is limited. Ordinances and imple-menting regulations pursuant to the Federal Soil Protection Act (BBodSchG) will accelerate this process of harmonisation of data collection.

Biota

Deficiencies are mainly found in the coordination and standardisation of biotic surveys. For this reason, it is not possible to prepare nationwide overviews. Monitoring of biological diver-sity, as required pursuant to Article 7 of the Convention on Biological Diversity, still remains to be implemented in Germany. Existing Laender surveys focus almost exclusively on pro-tected, endangered and valuable species and habitats. Therefore the information they pro-vide covers only subsets of biological diversity and only a small proportion of the surface of Germany. And yet monitoring of compliance with the overarching sustainability principle, and climate-relevant monitoring, requires information that can support representative conclusions regarding all of Germany's territory.

XI.1.6. Meteorological and Atmospheric Observations

XI.1.6.1. General Information

Meteorological observations have a long tradition in Europe. As early as in 1780 Karl Theodor, Prince elector of the Palatinate, founded the Societas Meteorologica Palatina, which under the direction of its secretary Jakob Hemmer operated 39 meteorological stations from the Ural to Greenland to America. The measurements and observations were made at 07:00, 14:00 and 21:00 o'clock local mean time (the so-called 'Mannheim hours') and were sent to Mannheim by diplomatic bag. State-owned weather services in Germany started col-lecting climatological data at the end of the 19th century, but only since German reunification in 1990 have the data been recorded and processed according to unified standards. With the use of automatic stations, the temporal density of measurements was increased considerably with the result that now thanks to automatic measuring systems, the stations record and store the data in intervals of one to 10 minutes. In addition, for the time being, there still is a great number of secondary climate and precipitation stations, where meteorological parame-ters are recorded once or three times a day by voluntary observers.

Relevant climatological requirements – for example, relative to the networks operated by the German Meteorological Service (DWD) – have always been given careful attention, since both real-time and climate applications benefit from the precision required for climatological purposes. For this reason, the DWD recognises and respects the principles applied to cli-mate monitoring (see Section 7.1.3). Nonetheless, the DWD no longer operates a full-time measuring network for climatological purposes only.

In fall 1993, the DWD established a national GCOS Secretariat. This Secretariat has as-sumed responsibility for coordinating national activities relative to climate monitoring. In co-operation with the Japanese weather service, it also monitors the availability and quality of reports provided by the GSN stations and, to this end, operates a GSN Monitoring Centre (GSNMC). The DWD also participates actively in the GCOS Surface Network (GSN), GCOS Upper Air Network (GUAN) and Global Atmosphere Watch (GAW).

The Global Precipitation Climatology Centre (GPCC), which is also operated by the DWD, represents yet another contribution to GCOS. It is one of the German contributions to inter-national climate-analysis and climate-research activities, and represents a component of the Global Precipitation Climatology Project (GPCP), which is integrated in the Global Energy and Water Cycle Experiment (GEWEX) of the World Climate Research Programme (WCRP).

Other contributions of the DWD to the GEWEX programme, in particular to its sub-programmes Coordinated Enhanced Observation Period (CEOP), Global Water Vapour Pro-ject (GVaP) and GEWEX Atmospheric Boundary Layer Studies (GABLS) are conducted at the Lindenberg Meteorological Observatory – Richard Assmann Observatory (MOL-RAO).

The 'Satellite Application Facility on Climate Monitoring' (CM-SAF), which is operated un-der the lead of the DWD, makes a substantial contribution to climate monitoring by compiling, on the basis of satellite data, times series of climate-relevant parameters.

XI.1.6.2. Contributions to the GCOS networks

Table XI – 1 presents an overview of the German contributions to GCOS.

XI.1.6.2.1. Contributions to the GCOS Surface Network (GSN)

A total of three DWD stations in Germany and one station operated by the Alfred Wegener Institute (AWI) in the Antarctic have been selected for the GCOS Surface Network (GSN):

- Hamburg-Fuhlsbüttel (WMO No. 10147),
- Lindenberg (No. 10393),
- Hohenpeissenberg (No. 10962).
- Neumayer (No. 89002).

Additional stations are available, if necessary, as supplement or to support the GSN at a regional level.

The Hamburg-Fuhlsbüttel station is an aeronautical meteorological office that was estab-lished in 1891 as an observatory. In 1955, it was moved about 270 m to the west, and it is now located on the grounds of Hamburg Airport. In 1995, the station was moved again – this time, about 700 m to the south-west. In that same year, a transition was made to semi-automatic operation, and since then the station has automatically recorded air temperature (at heights of 2 m and 5 cm), ground temperature, humidity, air pressure, wind direction and wind speed, precipitation and sunshine duration.

The Lindenberg Meteorological Observatory - Richard Assmann Observatory (MOL-RAO) was established in 1905 by Richard Assmann, the discoverer of the stratosphere, and it be-gan making measurements in the same year. In each of the years 1956 and 1971, the ob-servation/measurement site was moved by around 200 m. Semi-automatic operation began already in 1992. Like the Hamburg-Fuhlsbüttel station, this station automatically measures air temperature at heights of 2 m and 5 cm, along with ground temperature, humidity, air pressure, wind direction and wind speed, precipitation and sunshine duration. The station is slated to become a National Reference Station. This means that all of its conventional meas-urements and observations will be continued in parallel with automatic data collection.

Measurements at the Hohenpeissenberg Meteorological Observatory began in 1781, within the framework of the Societas Meteorologica Palatina. This station made the transition to semi-automatic operation in 1993. Since then, the station has automatically recorded air temperature at heights of 2 m and 5 cm, along with ground temperature, humidity, air pres-sure, wind direction and wind speed, precipitation and sunshine duration. This station is also slated to become a National Reference Station. This means that all of its conventional meas-urements and observations will be continued in parallel with automatic data collection.

The first 'Georg von Neumayer' station in the Antarctic was established in 1981 on the Ek-stroem Ice Shelf as a research observatory for geophysical, meteorological and air chemistry measurements. The new Neumayer station facility was completed in March 1992, at a loca-tion only ten kilometres from the original site. The snow-covered Neumayer station is located on an ice shelf that is 200 metres thick and almost completely flat.

As far as possible all stations within the DWD and AWI network conform to the principles applied to climate monitoring (Section 7.1.3). The effects of introducing new measuring sys-tems, and of changing existing systems are checked by the DWD via parallel measurements at selected stations.

Protection of the GSN and GUAN stations is guaranteed by virtue of their status as aero-nautical meteorological office in one case and meteorological observatories in the three other cases.

XI.1.6.2.2. Contributions to the GCOS Upper Air Network (GUAN)

One DWD station in Germany and one AWI-operated station in the Antarctic were selected to contribute to the GCOS Upper Air Network (GUAN):

- Lindenberg (10393) and
- Neumayer (89002).

At Lindenberg station, radiosoundings are run at 00, 06, 12, and 18 UTC which include also upper wind measurements. The radiosoundings were first started in 1957 and have been carried out since July 2004 via GPS navigation. In February 2004, Lindenberg has replaced Stuttgart-Schnarrenberg (10739) as the GUAN station for Germany. The MOL-RAO gives a world-wide unique focus to calibrating humidity measuring instruments on a routine basis by means of radiosondes with the aim of achieving highest quality standards for humidity profile measurements from radiosondes (with the accuracy being higher than an uncertainty in the relative humidity of 1 %). Thanks to the synergy between the measurements with high tem-poral resolution (e.g. GEWEX / GVaP water vapour measurements) at the MOL-RAO the radiosoundings assume even more importance as they make cross-calibrations between the existing measuring systems also possible.

XI.1.6.2.3. Contributions to Global Atmosphere Watch (GAW)

Germany contributes to the Global Atmosphere Watch (GAW) with the following stations:

- Global station at the Zugspitze/Hohenpeissenberg,
- Neumayer global station (Antarctic, operated by AWI), and the

- Schauinsland and Neuglobsow regional stations.

The Zugspitze/Hohenpeissenberg GAW station consists of 2 platforms: one in the Zug-spitze environmental research station and one in the Hohenpeissenberg Meteorological Ob-servatory of the DWD.

The Hohenpeissenberg Meteorological Observatory has a long tradition of taking mete-orological and atmospheric chemistry measurements. The beginning of its series of uninter-rupted meteorological observations dates back to 1781. 1967 saw the start of the ozone-measurement programme that has now developed into a vast and extensive programme. In 1994, the installation of the GAW station began, and the Observatory's measurement pro-gramme was considerably expanded. Pursuant to the GAW requirements for global stations, measurements include reactive trace gases, physical and chemical properties of aerosols, substances in precipitation and a range of auxiliary data needed to interpret atmospheric chemistry data.

The global station at the Zugspitze is operated jointly by the Federal Environmental Agency (UBA) and the DWD. The DWD measures here meteorological components, aerosol concentrations and various radionuclides whereas the UBA deals with reactive and climate-relevant trace gases as well as data relating to aerosol and precipitation chemistry. In addi-tion, the UBA operates the two GAW regional stations of Schauinsland and Neuglobsow where also climate-relevant trace gases are measured. The Zugspitze/Hohenpeissenberg global station coordinates its activities and cooperates closely with the observatories at the Hoher Sonnblick in Austria and the Jungfraujoch in Switzerland. Its neighbouring stations are situated in the East in Tibet, in the North at the Arctic Circle, in the West on the Irish Isles and in the South on the Canary Islands. What is unique in the GAW network is the fact that here the concentration measurements are made in the free troposphere above a densely populated and comparatively highly industrialised area.

The Zugspitze/Hohenpeissenberg GAW station largely fulfils the 10 principles of climate monitoring (see Section 7.1.3).

XI.1.6.3. Other networks for monitoring weather and atmospheric composition

In addition to the stations in the global monitoring networks (GAW, GUAN, GSN), the DWD operates a national station network that regularly collects meteorological data in Germany. The data is subjected to quality assurance measures and then archived chronologically in a clima-tological database. Most of these time series begin in the 1940s, although some date back to the 19th and 18th centuries.

Since the mid-1970s, the DWD has regularly stored all meteorological data collected by its station network on electronic media, checked the data for quality and then archived it on a rou-tine basis. Furthermore, the data collected earlier in table form on paper or (since the 1950s) on punch cards, were registered, then archived in a standardised form on magnetic tape and later added to the climate database.

Data gathered by the Meteorological Service of the former German Democratic Republic (GDR), until 1990, has also been similarly processed (even though in some points in quite different ways) and compiled in a suitable data archive, the Standardised Meteorological Data Storage Medium (EMDS). This data archive was integrated into the DWD climate data-base to the greatest possible extent with the work having been completed in 1992. Due to the different ways of data processing used in the old and new Federal Laender before 1990, the data sets differ in form and content.

Since 1997, new climate data has been stored within the DWD database application called MIRAKEL, which is based on a relational database system. The migration of the former data archive to the MIRAKEL database has largely been completed, with the result that the aforementioned climate data is now archived in a relational database system that greatly facili-tates the use of the data.

The entire climate database has been divided into data sets that are defined in terms of the sets of elements and temporal density of the data.

The data sets come from the station network of the DWD (figures as of 2004):

- Approx. 190 synoptic-climatological reporting stations with qualified observers ('meteoro-logical watch offices') and / or with automatic function ('automatic weather stations') in-cluding 17 stations from the Bundeswehr (German Federal Armed Forces);
- Approx. 325 climate stations with comprehensive measuring programmes carried out by non-professionals;
- Approx. 2600 precipitation stations with restricted measuring programmes carried out by non-professionals;
- Approx. 300 stations where ground temperature is measured;
- Additional analyses of the analogue measurements taken at selected stations and the hourly measurements made by automatic equipment (wind, temperature, humidity and sunshine duration);
- Approx. 660 automatic stations for 10-minute data (of which approx. 60 measure only wind parameters and approx. 260 only precipitation);
- 17 upper-air stations (of which 12 carry out the complete measuring programme);

Approx. 100 synoptic reporting stations are also climate stations (synoptic-climatological re-porting stations), and all climate stations are also precipitation stations. The analyse of analogue measurements has now almost completely given way to the calculation of hourly values on the basis of 10-minute data taken by automatic stations.

Information about the observation stations within the DWD observing network is also ad-ministered in the MIRAKEL database and can be retrieved via the Internet. Further details are given in Tables XI-2 and XI-4. Tables XI-3 and XI-5 list the homogenous time series available at the DWD and the AWI.

The DWD also participates in other global measuring networks. Its Lindenberg Meteorological Observatory – Richard Assmann Observatory (MOL-RAO) is part of the BSRN (*Baseline Surface Radiation Network*)[124] and thereby contributes to the global monitoring of atmospheric radiation. Furthermore, the MOL-RAO acts as a regional radiation centre of WMO RA VI with the aim of guaranteeing highest standards of atmospheric radiation measurements in WMO RA VI Europe. The combination of network measurements with simultaneous and continuous quality control guarantees virtually unique facilities for the validation of the results from Numerical Weather Prediction models and the validation of satellite products (such as surface radiation budget) from the CM-SAF.

The MOLRAO actively contributes to several sub-projects of the *Global Energy and Water Cycle Project* (GEWEX) being part of the *World Climate Research Programme*

[124] http://bsrn.ethz.ch/

of WMO. This includes participation in the *Coordinated Enhanced Observation Period* (CEOP), *GEWEX Atmospheric Boundary Layer Studies* (GABLS) and *Global Water Vapor Project* (GVaP) projects. CEOP aims at the design, implementation and operation of the prototype of an integrated global observing network for the components of the energy and water cycle including global numerical weather prediction and climate models, earth-observing satellites and a network of in-situ surface reference stations, and in the use of the complex data sets for the investigation of large-scale processes within the global energy and water cycles. GABLS presently focuses on the representation of the stable atmospheric boundary layer in atmospheric simulation models. For both projects, MOL-RAO provides complex data sets of quality-controlled meteorological data. These are based on the combination of measurements from a variety of in-situ and ground-based remote sensing systems operated at the MOL-RAO. Near-surface profiles of wind, temperature and humidity are measured at the 99m meteorological tower at the Falkenberg boundary layer field site and at a 30m mast situated in a pine forest. The lower part of the atmospheric boundary layer above the tower is monitored with a sodar / RASS system at the Falkenberg site. Radiation, energy fluxes, and precipitation at the land surface / atmosphere interface are measured over different representative types of land use within a 20*20 km^2 area around the MOL-RAO. Area-averaged values of the turbulent energy fluxes have been derived from these measurements using suitable aggregation rules. These area-averaged fluxes are currently validated against path-integrated flux values derived from scintillometer measurements.

An important aim of GVaP is, on a global level, the recording and modelling of water vapour and its spatial and temporal variability. Water vapour is fundamental to the energy and hydrological cycle and its observation with a broad range of measuring instruments at selected references stations form an indispensable part of the project. The assignment of the top level (level 1) is linked to the operational use of radiosondes, microwave radiometer, GPS receiver, Fourier spectrometer and water vapour lidar. These prerequisites will be fully met at the MOL-RAO by 2006. All instruments must be ready to provide information about atmospheric water vapour.

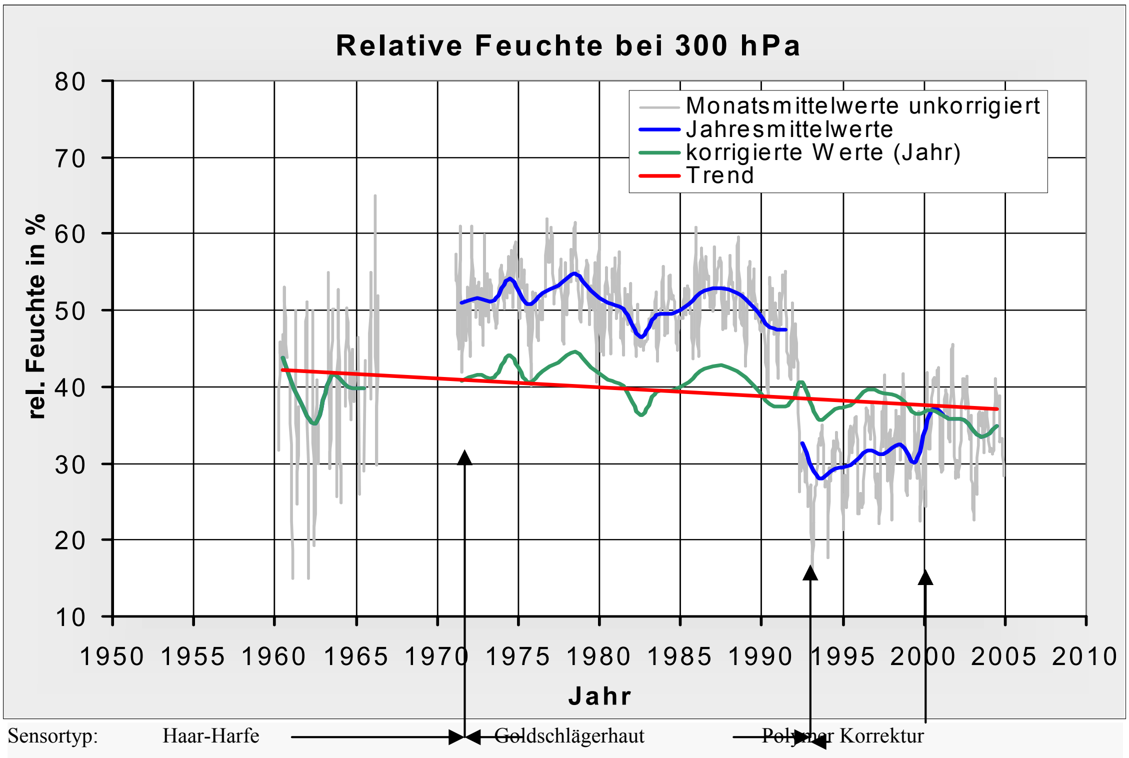
One contribution of substantial importance consists, for example, of ground-based microwave radiometry. The critical advantage of this technology is its capacity for a continuous automatic operation at high temporal resolution in almost any cloud and weather situation (exception: heavy rain).

Fig. XI - 2 **Radiometrics TP/WVP 3000. Microwave profiler at the MOL-RAO for routine calculations of temperature, humidity and liquid water profiles up to a height of 10 km.**

The MOL-RAO started to use a microwave profiler (MWP) (Fig. XI-2) as early as in 1998 and has made all the preparations for its long-term use at the reference site of Lindenberg.
From the multi-channel measurements of atmospheric emission in the ranges of the water vapour line (22 – 30 GHz) and the oxygen band (50 – 60 GHz) it is possible to derive vertical profiles of temperature and water vapour and the rough vertical structure of liquid water con-tent. In this context, complex quality checks are a major prerequisite for the further use in climate applications. Taking advantage of the infrastructure available at the MOL-RAO, ap-propriate procedures have been developed for this purpose which incorporate, for example, the total water vapour content derived from radiosonde, GPS and MWP measurements. The evaluation is done on a monthly basis and guarantees mutual comparability. In connection with the aforementioned measurement methods, Lindenberg GVaP station has the most ex-tensive and coherent observational database worldwide on total water content and corre-sponding vertical distributions at its disposal.

Fig. XI-3 shows the trend of relative humidity in the upper troposphere above Lindenberg.

Fig. XI - 3 Development of relative humidity in the upper troposphere (300 hPa, approx. 9 km) above Lindenberg over the last 45 years and the sensors used for the measuring of humidity



In connection with air temperature, water vapour is the key quantity for relative humidity which, in turn, controls the physical-chemical processes of aerosol and cloud formation and growth. In the end, this is the deciding factor for the absorption, emission and reflection ca-pacities of solar and terrestrial radiation which determine radiation transfer and the energy budget of the atmosphere. Furthermore, water affects the free atmosphere also due to its chemical characteristics and its capacity to 'wash out' the atmosphere. Particular importance must therefore be attached to the exact determination of the humidity content of the atmos-phere in the gas, liquid and solid state.

For the measuring of relative humidity above Lindenberg (and world-wide) different types of sensors were used:

- Hair hygrometer (Haar-Harfe): recording instrument used with kites and balloons, type LANG or FREIBERG, until 1971
- Goldbeater's skin (Goldschlägerhaut): Russian radiosonde types RKS and MARZ, 1971 to 1992
- olymer sensors (Polymer): Finnish radiosondes RS80, RS90, RS92, since 1992

The determination of relative humidity causes a great problem at negative temperatures. The studies carried out by SODEN and LANZANTE (1996) show that there are large sys-tematic differences between the various humidity sensors at temperatures below 0 (compari-son of satellite data with radiosoundings in the upper troposphere).

For this reason and due to the 'break' in the Lindenberg relative humidity series after the change of the measuring instrument, air humidity measurements using operational radioson-des have been improved fundamentally since 1995. With this aim, precision humidity sound-ings have been carried out once a week since 1999 using the Lindenberg reference sensor (FN method, modified RS90 radiosonde, Leiterer et al., 2004). The precision humidity meas-urements using the FN method achieve an accuracy of 1 % of relative humidity in the free atmosphere.
From the comparison of the routine soundings using the RS80 sensor with the precision humidity measurements, it was possible to develop correction methods for RS80-A-Humicap radiosondes.

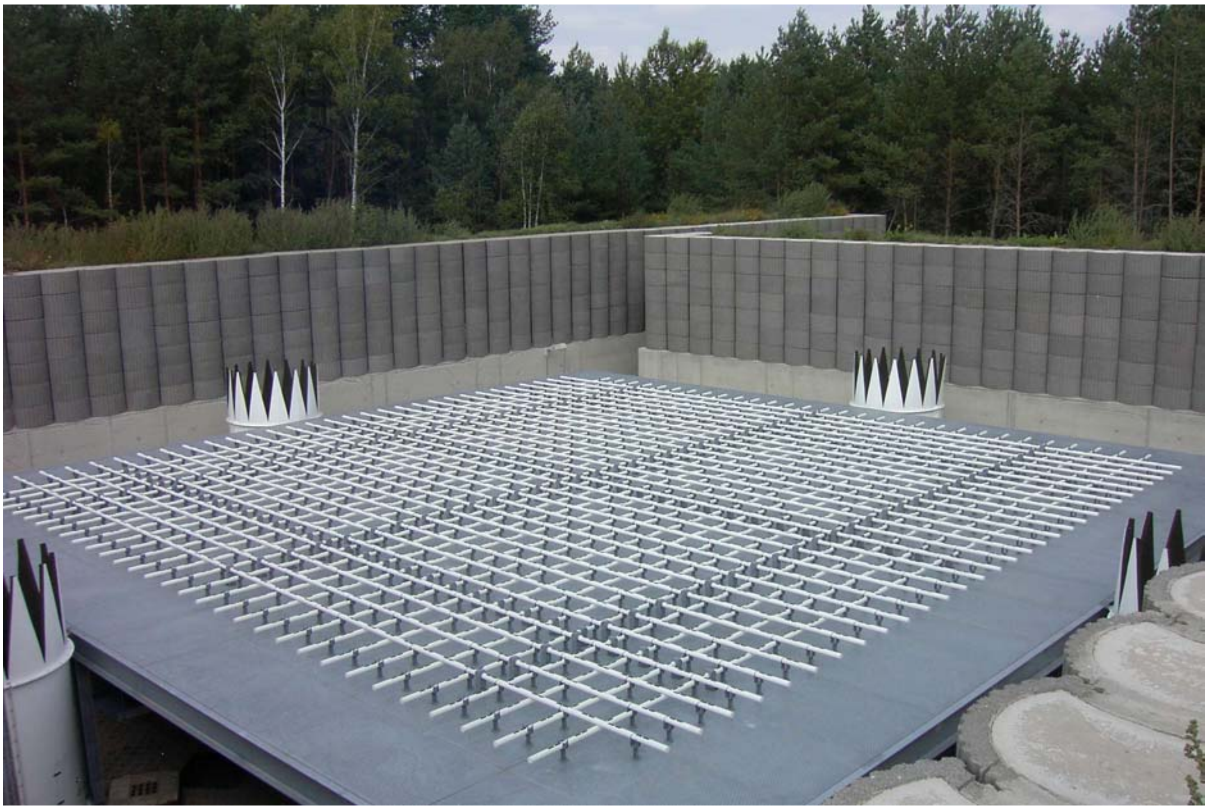
The correction method uses the following additional measures (Leiterer et al., 2004):

- Groundcheck correction for a relative humidity of 100 %
- Correction for inertia (which depends on the humidity gradient and temperature)
- Temperature-related correction
- Selection of relative humidity in case of icing of the humidity sensor

Examining the relative humidity gradient of identical measuring sensors made it possible to correct the past measurements (Leiterer et al., 2004). As a result, it was possible to ho-mogenise the times series of water vapour distribution in the free atmosphere above Linden-berg. Thanks to the calculated corrections, a data quality was achieved which allows clima-tological interpretation of humidity profile measurements. Fig. XI-3 gives the original and the corrected values of relative humidity.

Reliable values for the 300-hPA level have only been available since the nineteen sixties. Before that date, this level was very rarely reached by the humidity measurements. The same applies to the period from 1966 to 1970, when the measurement values from above 400 hPA were not taken into consideration in the evaluations. Fig. XI-3 shows the variation of relative humidity at the main pressure level of 300 hPa. Over the last 45 years there has been a decrease of humidity of approx. 4 % of relative humidity in the upper troposphere above Lindenberg.

Fig. XI - 4 **Antenna field of 'LAP – 16000' tropospheric wind profiler / RASS at Ziegendorf (Mecklenburg-West Pomerania)**



The 'vertical sounders' listed in Table XI-4 are wind-profiler radar systems with radioacoustic sensors (RASS). These systems allow a temporally and vertically highly resoluted monitoring of wind-vector profiles and virtual temperatures at altitudes ranging from about 0.5 km to a maximum of 16 km (wind) and 4 km (virtual temperature), depending on the backscattering ability of the atmosphere. A prototype of this type of installation has been in quasi-operational service since July 1996 at the MOL-RAO. Within the 'Messnetz 2000' project, the DWD has supplemented the operational radio-sounding network with three 482-MHz wind profiler / RASS systems (Ziegendorf in Mecklenburg-West Pomerania (2003), Nordholz in Lower Saxony (2004) and Bayreuth (2005)). Together with the existing measuring equipment at the MOL-RAO, this will allow an operational high-resolution monitoring of vertical wind and temperature distribution at 4 selected locations in Germany. The establishing of this remote sensing network of the DWD was completed by summer 2005.

As shown in Table XI-2 the DWD operates a weather-radar network comprising a total of 16 locations. As of 2004 the RADOLAN[125] project, which is supported by the Working Group of the German Laender on Water Issues (LAWA), started to provide hourly precipitation data with a resolution of 1 km^2 on an operational basis. Currently, a procedure is being developed for routine online calibration of radar precipitation data by means of automatic ground-based precipitation-measuring stations. While raw radar reflectivity data has been available for some locations since 1991, complete coverage of Germany was not given until 2001. Further information can be found on the DWD website.

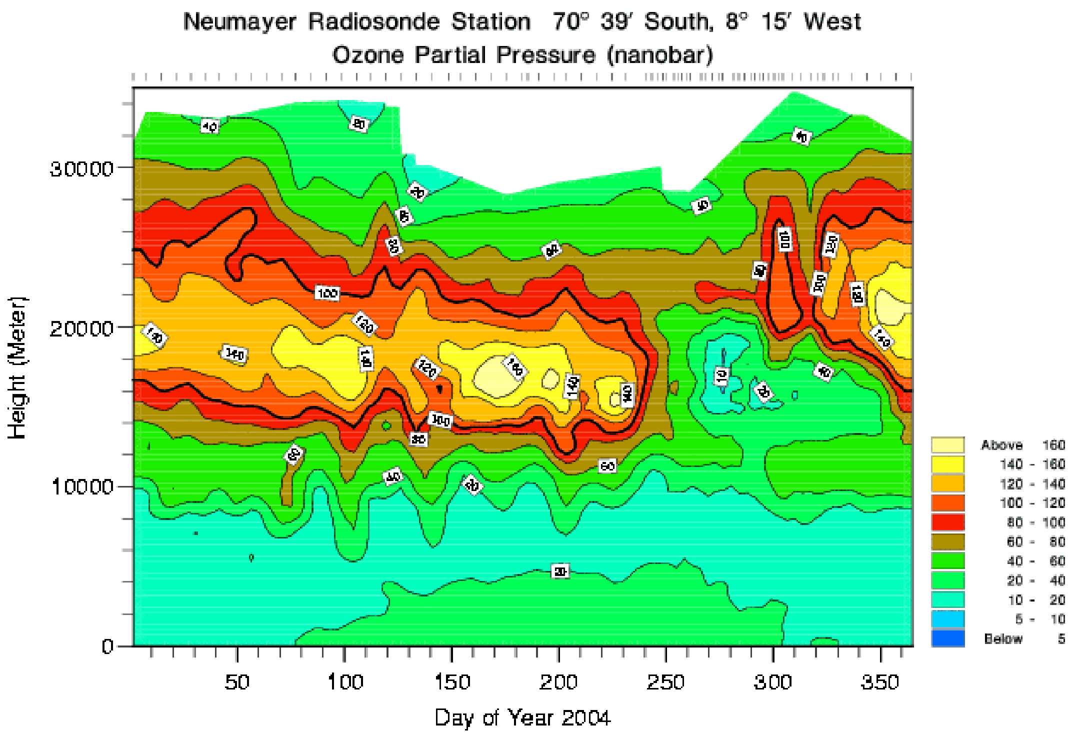
[125] http://www.dwd.de/RADOLAN

In Germany, the Alfred Wegener Institute for Polar and Ocean Research[126] (AWI) also contributes to global monitoring of atmospheric and oceanographic variables. To this end, it operates 2 stations in polar regions: the Koldewey station in Ny Ålesund on Spitsbergen, and the Neumayer station on the Ekstroem Ice Shelf in Atka Bay, in the north-eastern region of the Weddell Sea in the Antarctic. It also operates the 'Polarstern', a research and supply ship that is the most important tool of German polar research (see Section XI.1.7).

The 'Georg von Neumayer' Antarctic station was first established in 1981, on the Ekstroem Ice Shelf, as a scientific observatory for geophysics, meteorology and atmospheric chemistry and as a logistics base for summer expeditions. Georg von Neumayer, after whom the station was named, was an important pioneer of German south-pole research. By the early 1990s, weather stresses from ice movements and snowpacks made it necessary to rebuild the premises of the station. The new Neumayer station facility was completed in March 1992, at a location only ten kilometres from the original site. Once this station has reached the end of its lifetime in 2008, the scientific programmes will be continued in a third station without any interruption.

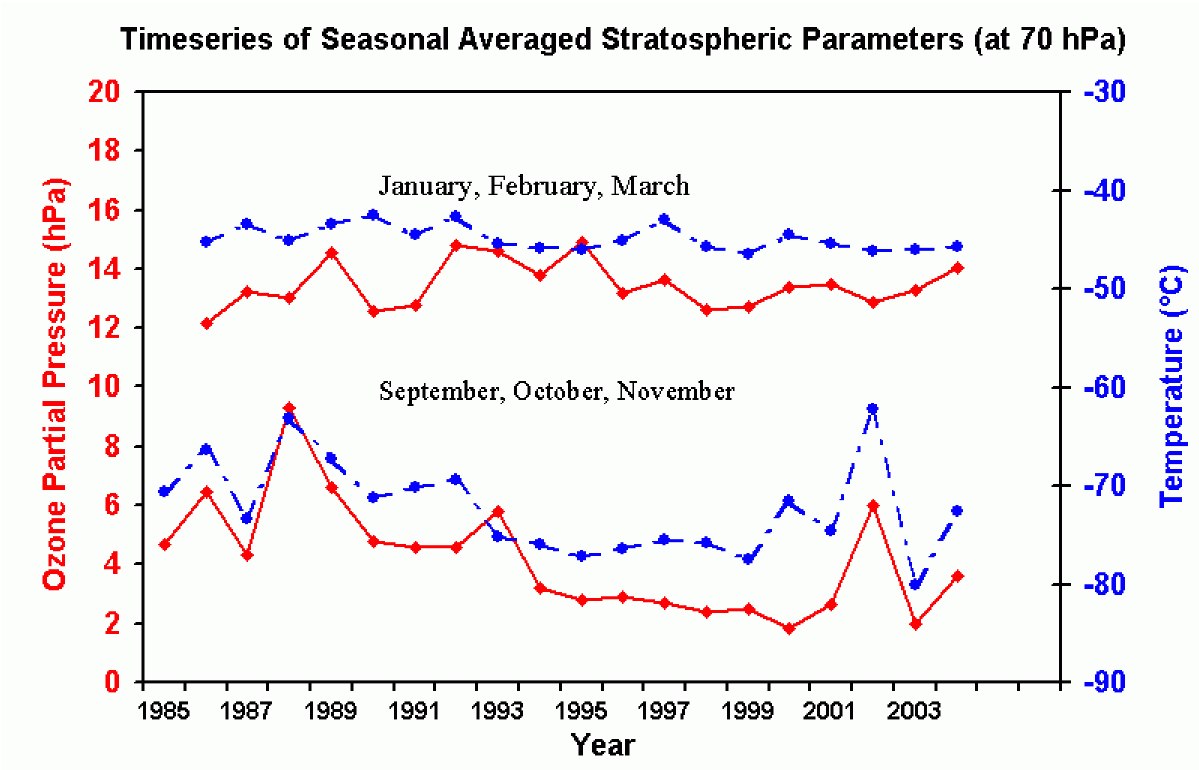
The station's research and measuring programme has been continually expanded, and it now includes measurements of atmospheric ozone (Fig. XI-5). Its atmospheric-chemical measurements are carried out in cooperation with the DWD, the Institute for Environmental Physics at the University of Heidelberg and the University of Mainz[127]. The Neumayer station also contributes to the GUAN and GAW networks.

Fig. XI - 5 Annual variation of ozone concentrations above the Neumayer station



[126] http://www.awi-bremerhaven.de/
[127] http://www.awi-bremerhaven.de/GPH/SPUSO.html

Fig. XI - 6 **Time series of seasonal averaged stratospheric parameters (at 70 hPa)**



Since 1998, scientists of the Alfred Wegener Institute have been working in Ny-Ålesund where in August 1991 the German research station 'Koldewey' was inaugurated. Koldewey provides research facilities for scientists specialised in the areas of biology, chemistry, geophysics and atmospheric physics. Since 1992, the Koldewey station has been part of the *'Network for the Detection of Stratospheric Change'* (NDSC), a global network that studies long-term changes in the stratosphere. It provides important long-term data that are needed to better understand the chemical and physical processes in the stratosphere. The AWI carries out the stratospheric measurement programme in cooperation with the University of Bremen and the Norwegian Institute for Air Research (NILU). The meteorological and aerological data collected by the station is regularly reported to WMO.

All data is validated, post-processed and archived by the *Meteorological Information System of the Alfred Wegener Institute* (MISAWI)[128]. Measurements in Ny-Ålesund are made in close co-operation with the Norwegian Meteorological Service and the *Norsk Polarinstitutt*. Radiation measurements are carried out as part of the BSRN of the WCRP.

Both AWI stations are included in Tables XI-2, XI-4 and XI-6.

[128] http://www.awi-bremerhaven.de/MET/

XI.1.6.4. Reorganisation of the ground-based observing network of the DWD (Messnetz 2000)

The DWD will have completed the reorganisation and modernisation of its ground-based observing network - primary as well as secondary and its aerological network by around 2007.

This will complete the aim of a National Base Observing Network (NABAM) which is jointly operated, on the basis of standard principles and a coordinated network configuration, by the civil National Meteorological Service, i.e. the DWD, and the Meteorological Service of the German Federal Armed Forces, i.e. the Bundeswehr Geoinformation Service, and also in-cludes the voluntary observing stations.

With completion of the reorganisation the following aims will also be achieved:

- Real-time or near real-time availability of high-quality data sets obtained according to standardised methods and their derivative products with high levels of temporal and spa-tial density, for operational and non-operational applications.
- All primary and secondary stations of the civil Meteorological Service plus the stations of the military Meteorological Service (NABAM) will use standardised methods and have the same (or compatible) equipment (IT and measuring systems).
- The NABAM includes voluntary stations for climate, precipitation and wind data. This will considerably increase the spatial density of real-time data.
- All stations will send their high temporal resolution data in real time or near real-time to headquarters. State-of-the-art online transmission procedures will be used – in the in-terest of earlier availability of the data for non-operational applications.
- All NABAM stations will use modern, largely automated data verification procedures, which improves the quality of the climate database.
- The network configurations of the civil and military Meteorological Services will be harmonised.
- Taking account of the latest state of the art, full use will be made of the potential for automation of measurements and visual observations.
- A substantial increase of the economic efficiency of the operated networks will be ob-tained thanks to the automation of substantial elements of data collection and data verifi-cation, as described above, in connection with the legally enforced staff savings.

XI.1.6.5. Basic principles of meterological and atmospheric observations

The German Meteorological Service (DWD) as the national meteorological service of Germany, carries out meteorological observations throughout all of Germany. The legal basis for the activities of the DWD is the Act on the German Meteorological Service (DWD) (DWD-Gesetz).

This law defines the tasks of the DWD as follows:

- the provision of meteorological services for the general public or for individual cus-tomers and users, especially in the fields of traffic, trade and industry, agriculture and forestry, the building industry, public health, water management including pre-ventive flood control, environmental protection, nature conservation and science,

- the meteorological safeguarding of aviation and shipping,
- the issuing of official warnings of weather occurrences that could become a danger for public safety and order, especially concerning the impending danger of floods,
- the short and long-term registration, monitoring, and evaluation of meteorological processes in the atmosphere, its structure and composition,
- the recording of interactions between the atmosphere and other environmental spheres
- the forecasting of the meteorological processes,
- the monitoring of the atmosphere for radioactive trace substances and the forecast of their transport,
- the operation of the necessary measuring and observation systems for fulfilling the duties listed in items 1 to 7, and
- the holding in readiness, archiving and documentation of meteorological data and products.

XI.1.6.6. Data exchange and data policy

Pursuant to its statutory tasks as the national meteorological service of the Federal Re-public of Germany, the German Meteorological Service (DWD) is involved in international cooperation in the field of meteorology and fulfils the obligations resulting therefrom. For ex-ample, it manages the international exchange of the data collected by the above mentioned stations. Station metadata and historical data are transmitted to the responsible data centres.

XI.1.6.7. Quality assurance

In July 2004, the DWD became ISO 9001:2000 certified. The certificate was handed over on 17 August 2004.

The DWD carries out quality-assurance procedures for all measured and observed data. The procedures may differ depending on the variables and data sets concerned.

The tasks of the DWD include the safe storage of collected data for future applications and the provision of access to this data. For this reason, all collected data, along with their descriptive metadata, is stored in a relational database that provides optimal access and en-hances both uses and quality assurance. The database includes indexes that indicate what quality-assurance measures have been carried out. 'Quality bytes' describe the quality status for individual elements.

Describing the quality of data collected prior to the introduction of automatic quality-assurance procedures poses a problem. Although such historical data normally underwent manual quality-assurance procedures, it also needs to be subjected to standardised quality-assurance methods, a task that must still be performed.

Disruptions to measurement series, especially those resulting from changes in measuring and analysis procedures, changes in the surroundings or location of a station, are identified by means of homogeneity tests. Where possible, the measurement series of a station are homogenised to harmonise them with the latest applicable measurement and site conditions.

A great number of the monthly indices of the two long time series of the Hohenpeissen-berg and Hamburg stations have already been homogenised. These include average daily mean temperature, mean daily maximum and minimum temperatures, precipitation total and the numbers of days that exceed certain thresholds (frost days, summer days, days with at least 1 mm precipitation, etc.). Some homogenised time series are already available (Table XI-3). Similar homogenisation is currently carried out for the Lindenberg station.

The DWD has available very long series of observational data from a great number of sta-tions. Among these are the 19 stations listed in Table XI-3 (HOMDAT Data Set). In addition to these stations, which contribute to the GSN, GUAN or GAW networks, other stations have also compiled long series of near-ground and aerological data. These long series of meteoro-logical observations and measurements available to the DWD represent a unique cultural heritage – at least on the national level – and are thus especially valuable and worthy of pro-tection.

Tab. XI - 1 Contribution to global climate observing systems

	GSN	GUAN	GAW	BSRN*
How many stations are under the responsibility of the contracting party?	4	2	4	3
How many of these stations are currently in operation?	4	2	4	3
How many are operated according to the GCOS standards?	4	2	4	3
How many are likely to be in operation in 2010?	4	2	4	3
How many deliver data to international data centres?	4	2	3	3

**Baseline Surface Radiation Network of the WCRP*

Tab. XI - 2 Near-ground atmospheric observation systems for climate (as of 31.12.2004)

Systems	Climate parameters (e.g. temperature, precipitation, other)	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)			Adequate quality assurance? (Please check one box)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/ platforms likely to be operated in 2010
			fully	partly	not suited	30-50y	50-100y	>100y	fully	partly	not suited		
Stations suitable for national climate monitoring	air pressure	191[129,, 130]		X		53	107	7	x			191 (100%)	197
	cloud cover/ cloud elevation, type	553[27,28]		X		184	285	13	X			553 (100%)	500
	humidity	553[27,28]		X		198	290	12	X			553 (100%)	500
	precipitation (liquid)	3143[27,28]		X		1550	2638	104	X			3143 (100%)	2100
	precipitation (solid)			X		190	287	13	X				
	precipitation (radar)	16	X			0	0	0		X		16 (100%)	16
	global radiation (satellite measurement)	grid, METEOSAT resolution	X			0	0	0	X			(100%)	Yes
	global radiation	53	X			11	2	0	X			53 (100%)	140[131]
	diffuse solar radiation	30		X		4	1	0	X			30 (100%)	
	thermal radiation from the atmosphere	11[27,28]		X		0	0	0	X			11 (100%)	11
	sunshine duration	344[27,28]		X		113	163	3	X			344 (100%)	310
	temperature (2 m)	533[27,28]		X		192	304	14	X			553 (100%)	500
	visibility	533[27,28]		X		192	304	14	X			533 (100%)	500
	wind speed and direction	294[27,28]		X		189	291	13	X			294 (100%)	300
Internationally distributed station reports	air pressure	191[27,28]				53	107	7	X				200
	cloud cover/ cloud elevation, type	191[27,28]				53	107	7	X				200
	humidity	191[27,28]				53	107	7	X				200
	precipitation (liquid)	191[27,28]				53	107	7	X				200
	precipitation (solid)												
	global radiation	44[27]				11	2	0	X				25
	diffuse solar radiation	30[27]				4	1	0	X				25
	thermal radiation from the atmosphere	4				0	0	0	X				11
	sunshine duration	172[27,28]				53	107	7	X				200
	temperature (2 m)	191[27,28]				53	107	7	X				200
	visibility	191[27,28]				53	107	7	X				200

129 Including 17 stations of the German Armed Forces (future NABAM stations) and the AWI stations Ny Ålesund and Neumayer.
130 Of these, about 70 stations are only automatic
131 Of these, about 115 stations with SCAPP radiation measuring instrument (Scanning Pyrheliometer-Pyranometer)

Systems	Climate parameters (e.g. temperature, precipitation, other)	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)			Adequate quality assurance? (Please check one box)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/ platforms likely to be operated in 2010
			fully	partly	not suited	30-50y	50-100y	>100y	fully	partly	not suited		
	wind speed and direction	191				10	69	0	X				200
Stations that report CLIMAT		101[27,28, 132]							X				94[30]
Reference Climate Stations (RCS)		3				0	0	3	X				3

Tab. XI - 3 Available homogeneous data sets for near-ground meteorological observations

Name of data set	Climate parameters	Number of stations or grid width and region	Time period	References
HOMDAT	Temperature (mean daily maximum, average and minimum), precipitation (monthly total), water-vapour pressure (monthly mean); 21 derived parameters (number of days that meet certain conditions (e.g., frost days))	19	Variable, beginning between 1870 and 1912. End in 1980 at the earliest. 15 still in operation today	Deutscher Wetterdienst Gerhard.mueller-westermeier@dwd.de
HOMDAT2	Monthly mean temperature	69	Variable, beginning: 1881-1951	Deutscher Wetterdienst Gerhard.mueller-westermeier@dwd.de
HOMDAT3	Monthly precipitation totals	221	Variable, beginning: 1891-1951	Deutscher Wetterdienst Gerhard.mueller-westermeier@dwd.de
EUMETSAT Satellite Application Facility on Climate Monitoring	Daily values and monthly mean cloud data, radiation fluxes on the ground, and atmospheric water vapour	15x15km^2, Europe, Northern part of the Atlantic	From January 2005	http://www.cmsaf.dwd.de
EUMETSAT Satellite Application Facility on Climate Monitoring	Daily values and monthly mean radiation fluxes at the upper edge of the atmosphere	45x45km^2, Europe, Africa, Atlantic	From January 2005	http://www.cmsaf.dwd.de
EUMETSAT Satellite Application Facility on Climate Monitoring	Daily values and monthly mean atmospheric water vapour	45x45km^2, Europe,, Atlantic	From September 2005	http://www.cmsaf.dwd.de
Global radiation	Global radiation (satellite measurement)	~8 km, Germany	April 1985 continuously	http://www.dwd.de/research/satmet/global/index.html
3-hour synoptic ground observation	Air pressure, cloud cover/cloud elevation/cloud type, humidity, temperature (2m), visibility, wind speed and wind direction, weather	Neumayer Antarctic	Beginning in 1981	http://www.awi-bremerhaven.de/MET/Neumayer/obse.html

[132] Of these 45 stations are part of the WMO Regional Baseline Climatological Network (RBCN).

Name of data set	Climate parameters	Number of stations or grid width and region	Time period	References
	occurrences, course of weather	(70° 39' south, 8° 15' west)		gkoenig@awi-bremerhaven.de
Radiation-balance measurements	10-minute mean of global, reflex long-wave-downward, long-wave upward radiation, air pressure, humidity, temperature (2m, 10m), wind speed and wind direction (2m, 10m)	Neumayer Antarctic (70° 39' south, 8° 15' west)	Beginning in 1982	http://www.awi-bremerhaven.de/MET/Neumayer/radiation.html gkoenig@awi-bremerhaven.de
Baseline Surface Radiation Measurements	5-minute mean of global, reflex long-wave-downward, long-wave upward radiation, RG8. OG1. UV integral, UV spectral, solar photometry, air pressure, humidity, temperature (2m, 10m), wind speed and wind direction (2m, 10m)	Neumayer Antarctic (70° 39' south, 8° 15' west)	Beginning in 1992	http://www.awi-bremerhaven.de/MET/Neumayer/radiation.html gkoenig@awi-bremerhaven.de
Baseline Surface Radiation Measurements	5-minute mean of global, reflex long-wave-downward, long-wave upward radiation, RG8. OG1. UV integral, UV spectral, solar photometry, air pressure, humidity, temperature (2m, 10m), wind speed and wind direction (2m, 10m)	Ny Ålesund Spitsbergen (78° 55' north, 11° 55' east)	Beginning in 1992	http://www.awi-bremerhaven.de/MET/Neumayer/radiation.html gkoenig@awi-bremerhaven.de
Baseline Surface Radiation Measurements	1-minute mean of global, direct and diffuse, solar radiation, back radiation, air pressure, humidity and temperature	Lindenberg (52° 12'north, 14° 07' east)	As of 1994	

Tab. XI - 4 Systems for observing the free atmosphere (as of 31.12.2004)

Systems that are useful for national climate monitoring	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series: Number of stations/platforms (number data digitised)				Adequate quality assurance? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity: Number of stations/ platforms likely to be operated in 2010
		fully	partly	not suited	5-10y	10-30y	30-50y	>50y	fully	partly	not suited		
Radiosounding stations	15[133,134]	X			0	4	9	2	X			15 (100%)	14
Internationally used stations	15				0	4	9	2	X				14
Stations that report CLIMAT TEMP	11[135]				0	2	0	0	X				11
ASAP stations	4				0	0			X			4 (100%)	4
Vertical soundings*[136]	3				1	0			X			3(100%)	4

133 Of these, 3 are stations of the German Federal Armed Forces
134 Including 3 AWI stations: Ny Ålesund, Neumayer and Polarstern
135 Including 2 AWI stations: Ny Ålesund and Neumayer
136 Wind, temperature

Systems that are useful for national climate monitoring	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series: Number of stations/platforms (number data digitised)				Adequate quality assurance? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity: Number of stations/ platforms likely to be operated in 2010
		fully	partly	not suited	5-10y	10-30y	30-50y	>50y	fully	partly	not suited		
Aircraft (instrument platforms of airlines)*[137]	230				0	0			X			230 (100%)	approx. 250
GPS	6				0				X			6 (100%)	12
Total network for observing the free atmosphere			X										

* Wet temperature and wind

Tab. XI - 5 Available homogeneous data sets from observations of the free atmosphere

Name of data set	Climate parameters	Number of stations or grid width and region	Time period	References
Radiosounding, Neumayer station	Altitude profiles with high spatial resolution: temperature, humidity, wind speed, wind direction	Neumayer, Antarctic (70° 39' south, 8° 15' west)	Beginning in 1983	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de
Ozone sounding, Georg Forster station	Main pressure level: temperature, humidity, wind speed, wind direction, ozone	Georg Forster, Antarctic (70°46' south, 11°41'east)	1985 - 1992	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de
Ozone sounding, Neumayer station	Altitude profiles with high spatial resolution: temperature, humidity, wind speed, wind direction, ozone	Neumayer, Antarctic (70° 39' south, 8° 15' west)	Beginning in 1992	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de
Ozone sounding, Ny Ålesund	Altitude profiles with high spatial resolution: temperature, humidity, wind speed, wind direction, ozone	Ny Ålesund, Spitsbergen (78° 55' north, 11° 55' east)	Beginning in 1991	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de

137 Temperature, pressure, wind

Tab. XI - 6 Monitoring systems for climate-relevant trace gases

Trace gas	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)				Adequate quality assurance? (Please tick)			Available metadata Total number of stations (% digitised)	Continuity Number of stations/ platforms likely to be operated in 2010
		fully	partly	not suited	5-20y	20-30y	30-50y	>50y	fully	partly	not suited		
Carbon dioxide (CO_2)	3		X		3				X			3 (0%)	3
Ozone O_3 (ground level)	7		X		4	0	2		X			7 (40%)	7
Ozone O_3 (column)	4	X			1	0	2			X		4 (100%)	3
Ozone O_3 (profile)	4	X			0	0	2		X			4 (100%)	4
Atmospheric water vapour H_2O	2		X		1	0	0			X		2 (50%)	2
NO_2 (column)	1			X	1	0	0			X		1 (100%)	1
Methane CH_4	3		X		0	0	0		X			3 (0%)	3
Others: SF_6	2		X		0	0	0		X			2 (0%)	2
Aerosols	4		X		3	0	0			X		4 (50%)	5
Optical thickness of aerosol	4	X			3	0	0		X			4 (100%)	4

Tab. XI - 7 Available homogeneous data sets for climate-relevant trace gases

Name of data set	Trace gas	Number of stations or grid width and region	Time period	References
Zugspitze GAW global station	Carbon dioxide	1	1995 – today	
Zugspitze GAW global station	Ozone	1	1980 – today	
Zugspitze GAW global station	Water vapour	1	1994 – today	
Zugspitze GAW global station	Other greenhouse gases (CH_4)	1	1995 – today	

Name of data set	Trace gas	Number of stations or grid width and region	Time period	References
Schauinsland GAW regional station	CO_2 / O_3 / CH_4	1	1980 – today	
Neuglobsow GAW regional station	CO_2 / O_3 / CH_4	1	1990 – today	
Hohenpeissenberg ozone column	Ozone (column)	1	1968 – today	Arbeitsergebnisse der Abteilung Forschung im DWD, Nr. 31 [Working results of the DWD Research Department, No. 31]
Hohenpeissenberg ozone profile	Ozone (profile)	1	1968 – today	Köhler, U., and H. Claude, 1996
Lindenberg, AERO	Water vapour (profile)	1	1961-ongoing	Leiterer,U., Dier,H. and Naebert,T.,1998
Lindenberg, RSASAEULE	Water vapour (column)[138]	1	1993-ongoing	
Lindenberg SPECTROMETER	Aerosol optical depth	1	1986-ongoing	Weller,M. et al.
Lindenberg	Ozone (profile)	1	1975-ongoing	
Lindenberg, 0_3 DICKEN	Ozone (column)	1	1993-ongoing	Tagesmittel-Werte (Brewer 078) [Daily mean values]
Ozone sounding, Georg Forster station	Main pressure levels for: temperature, humidity, wind speed, wind direction, ozone	Georg Forster, Antarctic (70°46' south, 11°41'east)	1985 - 1992	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de
Ozone sounding, Neumayer station	Altitude profiles with high spatial resolution: temperature, humidity, wind speed, wind direction, ozone	Neumayer, Antarctic (70° 39' south, 8° 15' west)	Beginning in 1992	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de
Ozone sounding, Ny Ålesund	Altitude profiles with high spatial resolution: temperature, humidity, wind speed, wind direction, ozone	Ny Ålesund, SpitSbergen (78° 55' north, 11° 55' east)	Beginning in 1991	http://www.awi-bremerhaven.de/MET/ gkoenig@awi-bremerhaven.de
Solar photometry measurements (Georg Forster)	Optical thickness of aerosol in 350 – 1050 nm spectral range	Georg Forster, Antarctic (70°46' south, 11°41'east)	1988 - 1992	aherber@awi-bremerhaven.de
Solar photometry measurements (Neumayer station)	Optical thickness of aerosol in 350 – 1050 nm spectral range	Neumayer, Antarctic (70° 39' south, 8° 15' west)	Beginning in 1992	aherber@awi-bremerhaven.de
Solar photometry measurements (Ny Ålesund)	Optical thickness of aerosol in 350 – 1050 nm spectral range, vertical profile from aircraft-borne measurements	Ny Ålesund, SpitSbergen (78° 55' north, 11° 55' east)	Beginning in 1991	aherber@awi-bremerhaven.de
Aerosol lidar profiles	Aerosol in troposphere and stratosphere (backscattering coefficients)	Ny Ålesund, Spitsbergen (78° 55' north, 11° 55' east)	beginning in Jan. 1989, and then always in winter months	

[138] Reference data for microwave radar and GPS sounding within the sphere of the Lindenberg GVaP station

Name of data set	Trace gas	Number of stations or grid width and region	Time period	References
FTIR measurements of trace gases in Ny-Ålesund[139]	CO_2, N_2O, CH_4, CFC-12, CFC-22, HCl, HF	Ny Ålesund, Spitsbergen (78° 55’ north, 11° 55’ east)	beginning in 1992	http://www.awi-potsdam.de/www-pot/ftir jnotholt@awi-potsdam.de
FTIR measurements on board the Polarstern research ship[37]	CO_2, N_2O, CH_4, CFC-12, CFC-22, HCl, HF	Polarstern research ship (80°N to 70°S)	1994,1996,1999	http://www.awi-potsdam.de/www-pot/ftir jnotholt@awi-potsdam.de
Near-ground ozone	Continuous in situ measurements of near-ground ozone; temporall resolution: 3 minutes	Neumayer, Antarctic (70° 39’ south, 8° 15’ west)	Beginning in 1983	rweller@awi-bremerhaven.de
Condensation cores (CN)	Continuous in situ measurements of condensation cores (ø > 10 nm), temporal resolution: 1 minute	Neumayer, Antarctic (70° 39’ south, 8° 15’ west)	Beginning in 1983	rweller@awi-bremerhaven.de

[139] Absorption measurements are carried out, with the help of the sun (during the polar night, with the moon), in the infrared spectral range. The spectra yield the total concentrations of 20 to 30 atmospheric trace gases. The most important climate-relevant trace gases are listed.

XI.1.7. Oceanographic Observations

XI.1.7.1. General information

Monitoring climate change in the marine sphere requires coordinated observing systems for both the atmosphere and the ocean. Fluxes of energy and matter at the ocean-atmosphere interface determine a strong coupling of both systems.

The ocean plays an important role in the climate system. The heat capacity of water being 3100 times larger than the heat capacity of air, ocean currents are able to transport enor-mous quantities of heat over long distances, and this may result in regional climate changes. The North Atlantic Current, for example, contributes to the moderate climate that prevails in Europe and particularly in Scandinavia at geographic latitudes, which in Canada and Siberia are covered by permafrost and where, subsequently, the human population is sparse. Moni-toring the ocean heat transport is an important task in explaining and predicting climate change. The high heat capacity of water results also in the ocean's ability to store heat changes of the atmosphere and to release those later and / or in regions far away. This oce-anic mechanism moderates fast and strong changes in the atmospheric climate compart-ment.

The role of the world's oceans in the Earth's climate system can only be fully described by looking at the full-depth ocean from its surface to the abyss. With support from BMBF pilot monitoring systems are presently being developed and tested for key regions of the Atlantic Ocean. In the near future all oceanic data, from satellite data to those from autonomous pro-filing drifters and gliders will be assimilated into global circulation models.

Another important ability of the ocean is its capacity to store gases such as carbon dioxide (CO_2) and other greenhouse gases. While the atmosphere stores only some 700 gigatons (Gt) of CO_2 it is estimated that the ocean stores approx. 40,000 Gt. Deep-reaching convec-tive areas in the northern North Atlantic and in the Weddell Sea transport carbon dioxide and other greenhouse gases into the abyssal ocean where they are unavailable to the atmos-phere for long periods. Oceanic upwelling areas, for example offshore along the western coasts of Africa and South America, are able to release large amounts of CO_2 into the at-mosphere. CO_2 gas exchange rates and processes between the atmosphere and the ocean are still not fully understood.

The marine atmosphere with its large share of the Earth's surface has a distinct role in the climate system. Due to the strong coupling between both spheres, particularly the feedback processes from the atmosphere to the ocean, this section also includes the relevant marine meteorological observing systems.

XI.1.7.2. The voluntary observing ships network (VOS)

The German Meteorological Service (DWD) has recruited approx. 800 merchant and re-search vessels that contribute to this voluntary meteorological observing network.

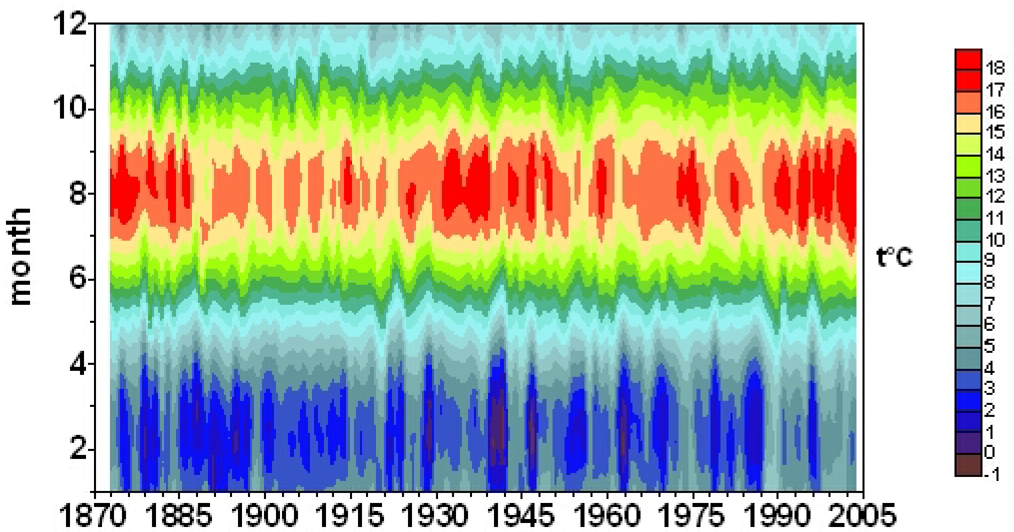
Most of the data is sent in near real-time into the GTS using satellite communication links. In the first place, it is used for weather forecasts and any other type of meteorological ser-vice. All data are stored on board as a back-up (log book, disks) and are retrieved routinely by the meteorological port officers.

For climatological purposes all observations are carefully checked and archived in the Na-tional Archive for Maritime Data (NAMD) of the DWD. The entire data set is also exchanged with other nations under the WMO Marine Climatological Summaries Scheme (MCSS). To this end, the DWD and the British Meteorological Service (Met Office) both operate under the auspices of WMO a Global Collecting Centre (GCC) for marine meteorological observations.

The MCSS member states (there are around 40 contributing members (CM) world-wide) send each quarter all their meteorological observations from voluntary observing ships to the GCCs. All data is checked for compliance with minimum quality standards and then trans-ferred with identical quality standards to 8 sub-centres (responsible members (RM)) which archive and evaluate these data according to JCOMM procedures.

VOS is subject to constant development with respect to climatological quality standards (VOS Climate project) and thus provides a reference for other data e.g. from remote satellite sensing and modelling.

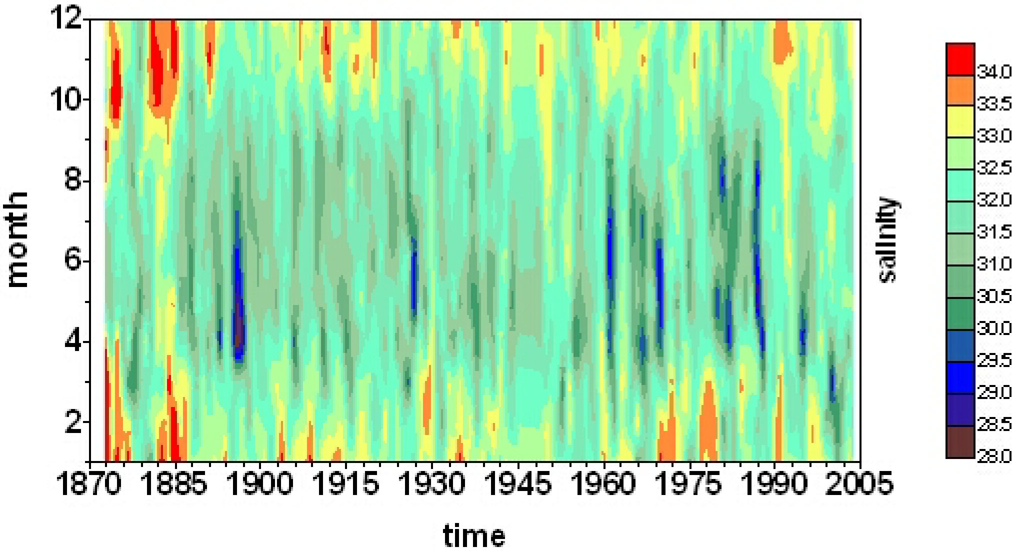
Fig. XI - 7 **Hovmoeller diagram of the sea surface temperatures at the 'Helgoland Reede' station (54° 11,18' N; 07° 54,00' E) from 1873 to 2004. The longest time series in the German Bight comes from the 'Helgoland Reede' and was started in 1873. The former positions of lightships have been abandoned or replaced by large automatic buoys (MARNET) partly since 1923.**



XI.1.7.3. Buoys

In addition to research vessels, oceanography uses fixed automatic platforms as well as surfaces drifters and profiling floats to the measure climate variables, e.g. temperature, salin-ity or currents. Moored surface buoys have replaced the former lightships and are equipped with meteorological and oceanographic sensors for observing the near-surface layers.

Fig. XI - 8 **‚Helgoland Reede': Maxima of salinity are dominant in the winter months 10 – 3 (vertical axis) until, later in the year, the freshwater of the river run-off dilutes the con-centrations. In general, salinities have decreased over the last century. The lowest salinity values occur in the months 3 to 8, but have been more frequent since 1960. At this position, a clear decrease in salinity since 1990 is observed indicating a signifi-cant freshening in spring whereas in summer the decrease is less pronounced.**



The scheme of VOS is complemented by drifting meteorological buoys, which in contrast to most oceanographical buoys carry dedicated meteorological sensors. They are deployed in data-sparse areas outside of the shipping lanes to contribute to a better meteorological coverage.

In the context of E-SURFMAR, a EUCOS programme of EUMETNET; the DWD provides drifting buoys. Quality control is carried out within the framework of E-SURFMAR whereas archiving is done within NAMD.

XI.1.7.4. Floats

Germany contributes to *Array for Real-time Geostrophic Oceanography* (ARGO) under a national programme funded by the BMBF and coordinated by the Leibniz Institute of Marine Sciences together with partners BSH and AWI. In addition, various contributions are made to ARGO within the framework of scientific programmes or EU-funded projects. ARGO is a global operational observing programme with profiling floats which, with a spatial resolution of 300 km in all ocean basins, regularly measure temperature and salinity profiles in the top 2000 m. The name ARGO also symbolises a close relation to the JASON satellite mission. ARGO, for the first time, allows a continuous monitoring of climatological variability of the upper ocean and thus is an indispensable component of the *Global Climate Observing System* (GCOS) and the *Global Ocean Observing System* (GOOS). The science of ARGO is defined under the *Climate Variability and*

Predictability Experiment (CLIVAR) of WCRP/WMO and in support of the *Global Ocean Data Assimilation Experiment* (GODAE).

ARGO floats drift freely at a predetermined depth and measure temperature and salinity profiles. After drifting for around 10 days deep in the ocean following the currents, they begin their ascent to the surface measuring and storing the parameters. At the sea surface the data is transmitted via satellite to shore and the float starts its descent to the predetermined depth to start a new operational cycle.

Fig. XI - 9 **Schema of the ARGO float operation: at the end of the deep drift phase there is a short descent to a maximum depth of 2000 m. Then, the ascent and the proper measuring phase begins.**

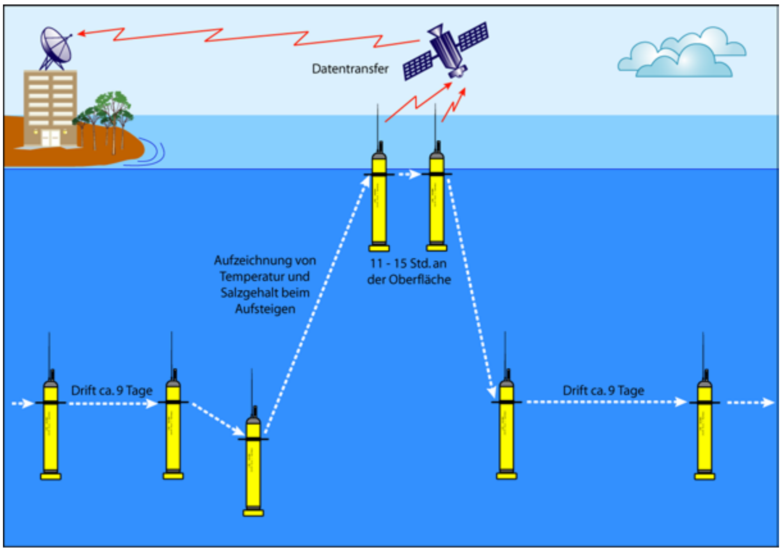
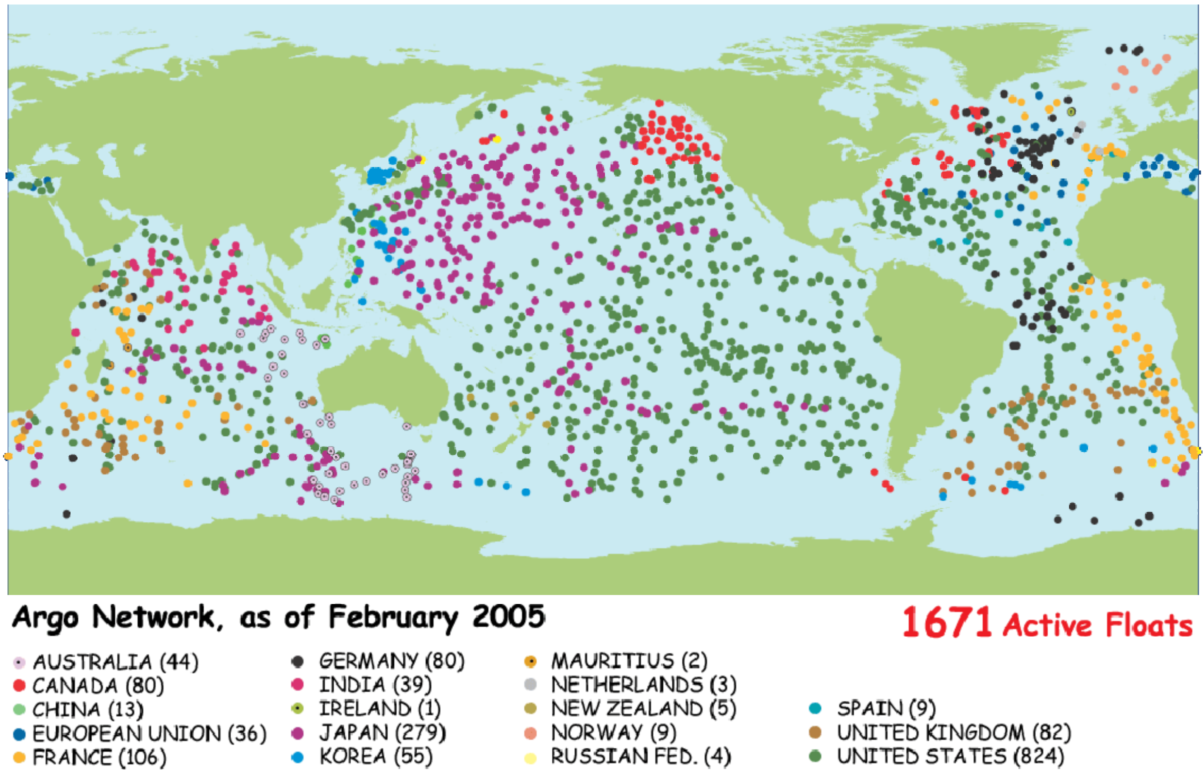


Fig. XI - 10 **Global distribution of active ARGO floats in February 2005; the German contribution in the Atlantic and Indian Oceans is marked by black dots.**



One milestone on the way to the required spatial resolution for the pre-operational phase of ARGO (3000 floats globally) has been already achieved; but there are still large gaps that need to be filled. Germany contributes significantly, with a share comparable to that of the United Kingdom and France. For the operational phase, planned to start in 2007, the future of the German contribution is not yet decided, a commitment of the Federal Ministry in charge is being sought.

Originally the floats were manufactured in the United States of America and have given the manufacturer a long technological lead. In the meantime, there are German, French and Japanese competitors. ARGO floats manufactured in Germany are called NEMO.

The technology for gliders is at present in a pre-operational development phase. This tech-nology is said to have a considerable potential for the routine observation of oceanographic parameters. Present trials have been successfully conducted in US American coastal waters, the Labrador Sea and the Mediterranean. Gliders typically are able to cover horizontal dis-tances of 2 – 4 km per dive, the forward speed being up to 1 knot (< 0.5 m/s). The life time of some months is, compared to ARGO floats, shorter due to the higher energy use. Target positions or mission details can be changed via two-way communication from the mission control. Applications with a rather short radius of action around a single position (virtual plat-form principle) are as much possible as long hydrographical sections with high spatial and temporal resolution. First field tests outside the US were successfully conducted by IFM-GEOMAR (Kiel) in the Ionian Sea in winter 2004/05.

Data from floats and gliders are collected in near real-time by the French Research Institute for Exploitation of the Sea (IFREMER). IFREMER transmits this data world-wide in near real-time to users who supply operational oceanographic products. These are also available at no charge on the Internet.

XI.1.7.5. The Automated Shipboard Aerological Programme (ASAP)

For meteorology, both the information about the sea surface as well as the conditions of the marine boundary layer and the free atmosphere are of relevance. Data collection for ma-rine aerology is organised in the Automated Shipboard Aerological Programme (ASAP). The DWD maintains up to four operational units which will be integrated until 2006 into the EUCOS/ E-ASP programmes of EUMETNET. This data will also be distributed via GTS, quality checked and archieved.

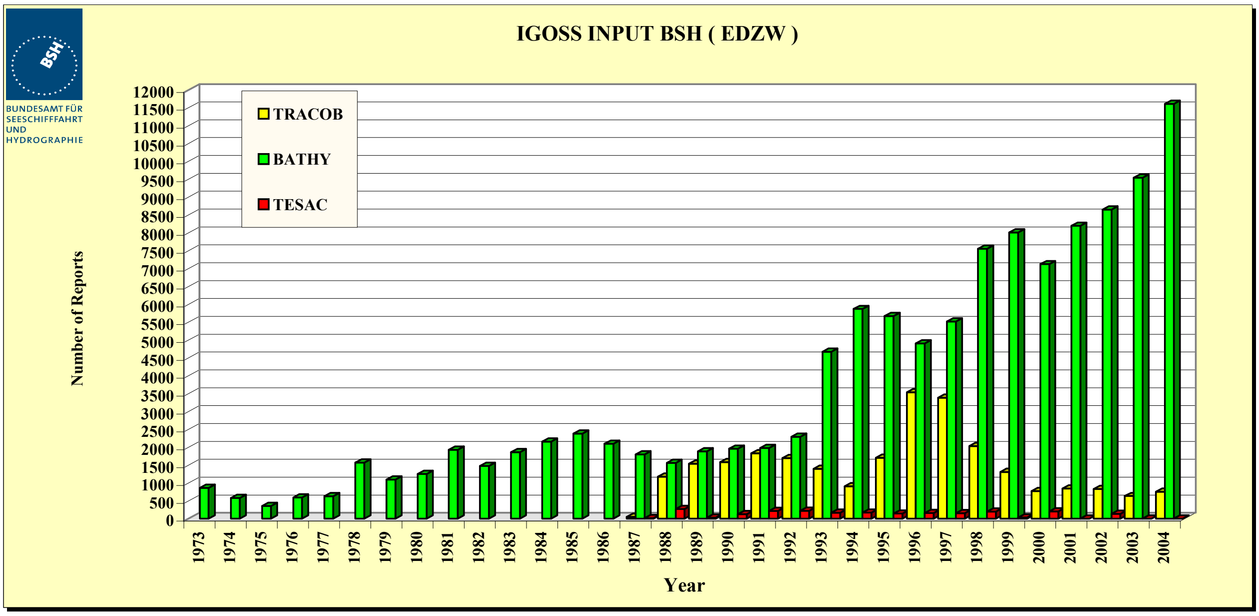
XI.1.7.6. The Ship of Opportunity Programme (SOOP)

Germany has taken part in the Ship of Opportunity Programme (SOOP) from its begin-ning. The BSH operates two SOOP lines in the Atlantic Ocean, where the temperature distri-bution down to 1100 m is routinely measured with XBTs on board merchant vessels. These are (a) the line AX-11 from the Western approaches of the English Channel to Rio de Janeiro and (b) the line AX-3 from the English Channel to the East coast of the USA. At times, some German research vessels, i.e. Meteor, Polarstern, Gauss and Walther Herwig, also contrib-ute to SOOP through XBT measurements.

Numerous merchant vessels are equipped with contact thermometers to measure the near-sea surface temperature.

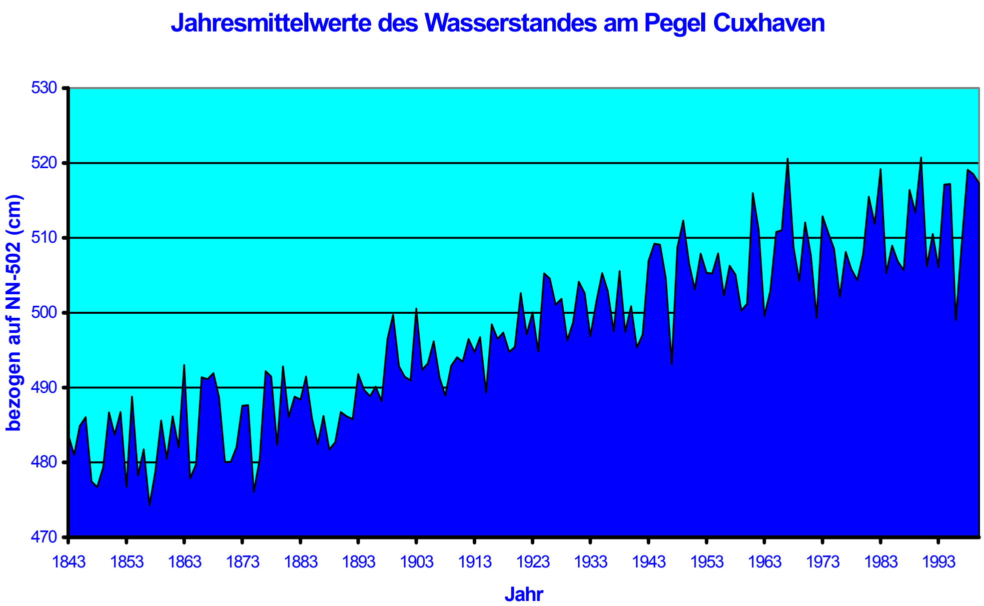
All data are recorded and transmitted in near real-time via the GTS in the following codes: BATHY (vertical temperature profiles), TESAC (vertical temperature and salinity profiles) and TRACKOB (sea surface temperature and salinity).

Fig. XI - 11 **Distribution of the number of German SOOP observations supplied to the GTS in 1972 to 2004**



XI.1.7.7. Observing sea level

Fig. XI - 12 **Annual means of the sea surface height at the tide gauge Cuxhaven since 1843**



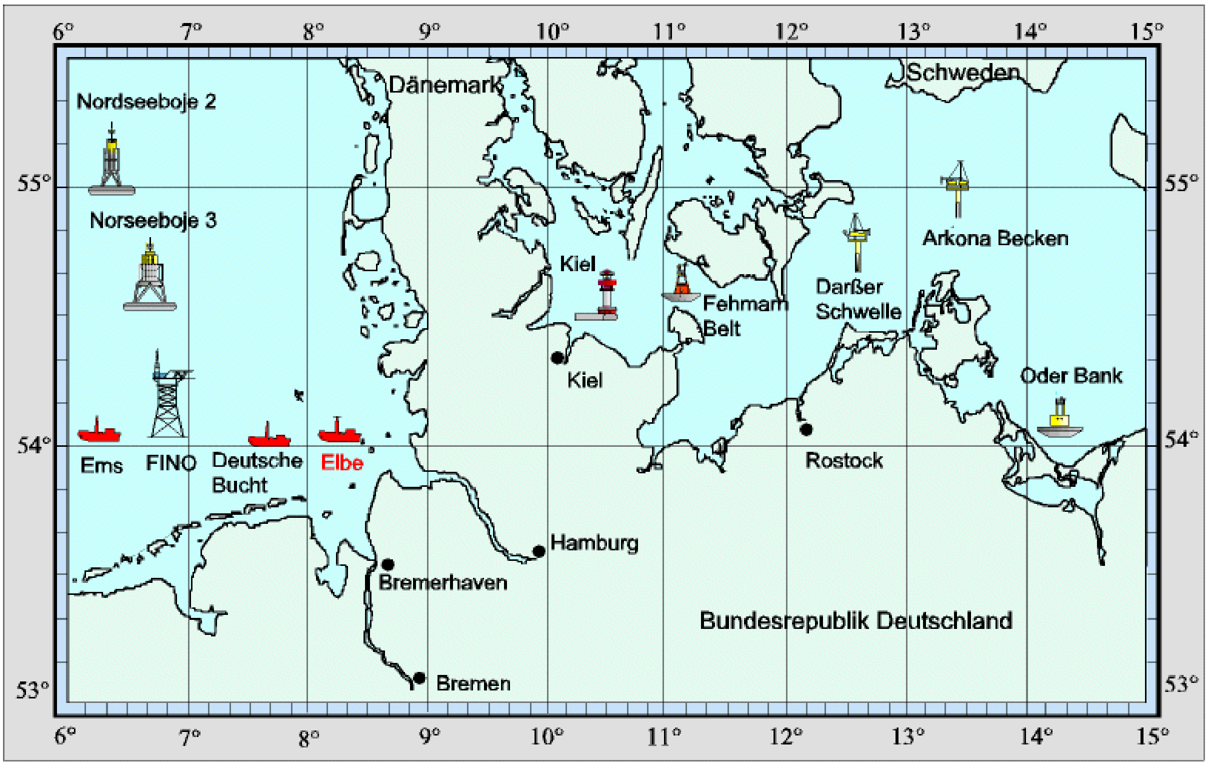
Tide gauges at the German coasts are operated by the *German Federal Waterways and Shipping Administration* (WSV). The BSH uses the data for tidal and storm surge height predictions. The sea level data from the tide gauges Borkum (Fischerbalje),

Cuxhaven (Steubenhöft) and Amrum (Wittdün) are forwarded to the *Permanent Service for Mean Sea Level* (PSMSL) in Birkenhead (United Kingdom) on a yearly basis.
The time series of sea level height go back to:

Borkum	1963
Cuxhaven	1843
Amrum	1963

Extensive information on the development of the tidal datum and Δt of the data of these 3 tide gauges is found on the web pages of PSMSL[140]. This tide gauge data is also collected and distributed for Europe in the framework of the ESEAS project at uniform standards[141].
In the open ocean, an increasing number of bottom pressure instruments are deployed and used for measuring sea surface height changes. The AWI deploys such instruments in the Atlantic sector of the Southern Ocean and the Fram Strait in the North.

Fig. XI - 13 Automated stations of MARNET of BSH in the North and Baltic Seas



XI.1.7.8. Other oceanographic observation systems

In the North Sea and the Western Baltic the BSH operates the Marine Environmental Monitoring Network in the North Sea and Baltic Sea (MARNET) with a current total of 9 plat-forms (Fig. 13). MARNET stations carry out hourly observations of air temperature, air pres-sure, wind direction and speed and, at several depth levels,

140 http://www.pol.ac.ak/psmsl/
141 European Sea Level Service (http://www.eseas.org/)

temperature, salinity, oxygen, gross gamma radiation and, at 2 stations, nutrients (nitrate, phosphate and silicate). Mete-orological observations as well as sea temperatures and salinities are sent to the GTS at hourly intervals.

Since September 2003, the FINO1 research operation has been in operation and, with its meteorological and oceanographic observations, it constitutes an additional component of MARNET. The above meteorological variables are observed up to a height of 100 m by a wind tower. In addition to the above oceanographic variables there are measurements of currents, waves and sea level.

The AWI also operates and archives oceanographic data that is fundamental to global climate observation. Table XI-8 gives an overview.

Tab. XI - 8 AWI archived oceanographic data (as of April 2005)

Instruments	Period	Total	North Polar region	South Polar region	Access
CTD	Nov. 1983 to Sep. 2003	5180	1851	3329	www.awi-bremerhaven.de/OZE/
Moorings	Sep. 1986 to Jan. 2003	2606	1351	1255	www.awi-bremerhaven.de/OZE/
XBT	Oct. 1984 to Dec. 2000	3874	-	-	www.awi-bremerhaven.de/OZE/

Since May 1993 thermosalinograph data (sea surface temperature and salinity) have been archived in the meteorological data bank. The data is quality checked and can be accessed via the AWI web page[142]. Since the beginning of 2004 all data sets from research cruises have been routinely processed and archived. Quality checked data is made available on a routine basis at the latest 6 months after the cruise.

[142] http://www.awi-bremerhaven.de/MET/Polarstern/met.html

Fig. XI - 14 **Long-term observing programme in the Greenland Sea with CTD sections across Fram Strait (A) and along 75°N (B). Dots mark current-meter arrays in Fram Strait.**

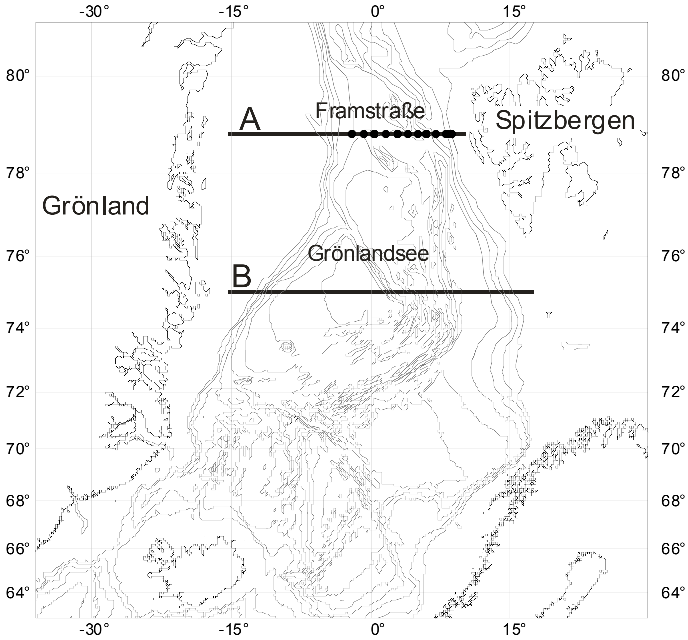
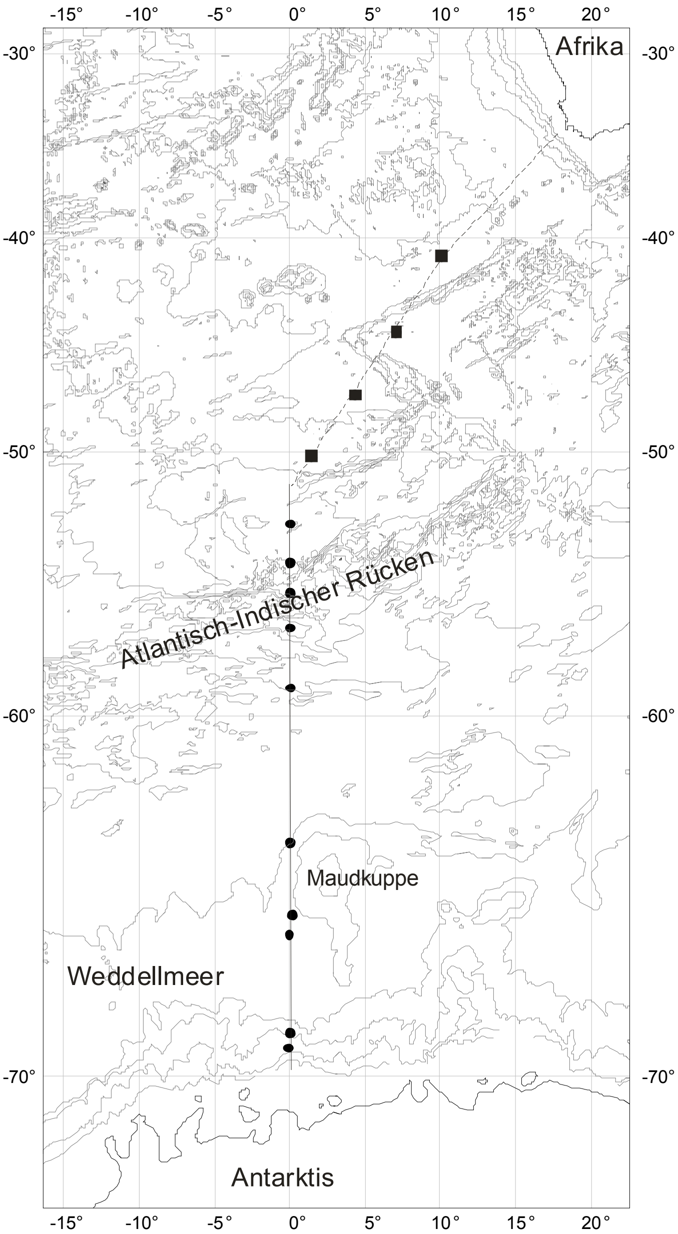


Fig. XI - 15 **Long-term observing programme in the Weddell Sea with a CTD section along the Greenwich Meridian (continuous line) and current-meter arrays (dots). Squares mark stations with bottom pressure recorders. The CTD section is continued towards Cape Town as an XBT section (dashed line).**



XI.1.7.9. Hydrography programme

In continuation of the North Atlantic studies under the World Ocean Circulation Experi-ment (WOCE; 1990 – 1996) since 1998, the BSH has regularly been carrying out, within the framework of its GOOS contribution, a modified hydrographic programme in the transition zone between the subtropical and subpolar gyres. Along a hydrographic section from the English Channel to the Newfoundland Banks (A2) measurements of temperature, salinity, oxygen and nutrients are made over the entire water column. This section allows a better assessment of the geostrophic transports and thus of the oceanic heat transport and its changes relevant to Northern Europe. This programme is complemented by the additional XBT measurements carried out on board freight vessels in 3-month intervals for the oceanic mixed layer down to 1500 m in the so called A2 corridor as part of the SOOP programme AX-3.

Tab. XI - 9 Participation in global ocean-observing systems

	VOS	SOOP	TIDE GAUGES	SFC DRIFTERS	SUB-SFC FLOATS	MOORED BUOYS	ASAP
How many platforms are under the responsibility of the contracting party?	793[143]	2 (XBT) 5 (SST)	3	2-6	80	10	4
How many of these deliver data to international data centres?	793[41]	2 (XBT) 5 (SST)	3	2-6	80	9	4
How many of these are likely to be in operation in 2010?	approx. 600[41]	2 (XBT) 5 (SST)	3	2-6	80	10	4

[143] Not including the German Federal Armed Forces

Tab. XI - 10 Oceanographic monitoring systems for climate

System component	Total number of stations / sections	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)			Adequate quality control? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/platforms likely to be operated in 2010
		fully	partly	not suited	30-50y	50-100y	>100y	fully	partly	no		
SOOP: - TRACKOB[144]			X						X			X
- XBT[145]	AX-3:160 sections		X					X			9058 stations (digital)	X
	AX-11: 107 sections		X					X			5644 stations (digital)	X
MARNET (moored oceanogr. stations in North and Baltic Seas)[146]	7		X		1 (digital)	2 (digital)			X		7 stations	10 stations
Profiling deep-drift buoys	18[149]		X					X			80	80[150]
-	+22[151]			X				X			100%	
GYROSCOPE[147]	10		X					X			10	40
WECCON[148] -	92		X					X			92	40
Circulation measurements	2 moorings 15[152]		X					X			2 moorings 50 %	X

144 TRACKOB: SST measurements on irregular routes in the North and Baltic Seas
145 XBT: on 2 SOOP lines (AX-3 and AX-11) of the BSH
146 MARNET: Information about the *marine environmental monitoring network* of the BSH in the North and Baltic Seas is available at http://www.bsh.de/Meeresumweltschutz/MARNET/MARNET.html or http://www.bsh.de/Marine_Environment/MARNET/MARNET.html.
147 GYROSCOPE is an EU-financed project that is contributing to ARGO and in which the Institute for Marine Research at the University of Kiel is participating.
148 WECCON: Weddell Sea Convection Control, i.e. an AWI contribution to CLIVAR (http://www.awi-bremerhaven.de/Research/IntCoop/Oce/weccon.html).
149 Deep-drift buoys deployed by the BSH as a contribution to ARGO.
150 BMBF-funded joint-research project by AWI, BSH and IfM Kiel, as a contribution to ARGO.
151 Institute for Marine Research at the University of Kiel: a) deep-drift buoys in CLIVAR – tropical and subtropical interactions (15 buoys) b) deep-drift buoys in SFB 460 – TP A4 subpolar North Atlantic (7 buoys); data is provided to GTS.
152 Leibniz Institute of Marine Sciences at the University of Kiel (IFM-GEOMAR): a) Arrays for circulation measurements in the Labrador Sea (11 moorings)

System component	Total number of stations / sections	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)			Adequate quality control? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/platforms likely to be operated in 2010
		fully	partly	not suited	30-50y	50-100y	>100y	fully	partly	no		
	6 moorings[153]	X						X			X	6
Atlantic hydrographic section (48° N) - WOCE-A2[154] - A2 corridor[155]	4 sections 4 sections	X X						X X			4 sections 4 sections	2 sections 2 sections
'Helgoland Reede' long-term data series (T,S, nutrients, meteorol.)	1	X					(digital)		X		Method descriptions, (50% digital)	1
Annual Autumn Groundfish Survey round Greenland	140	X			(digital)			X				140
Water levels	3		X		2 (digital)		1 (digital)	X			3 (digital)	3
Meteorological observations (e.g., temperature, air pressure, wind)	793		X		X[156]			X			793 (100%)	approx. 600
Other programmes (if necessary, described in greater detail in the notes)		X[157]						X			X	

b) Arrays for circulation measurements off the coasts of Brazil (4 to 5 moorings)

153 Institute of Oceanography, Hamburg: Denmark Strait Overflow & East Greenland Current Freshwater content.

154 In 1993, 1994, 1996 and 1997, work was conducted on the WOCE-A2/AR19 hydrographic section, within the framework of the World Ocean Circulation Experiment (WOCE). Between 1998 and 2002 by the BSH within GOOS; since 2003 in cooperation with the Institute of Environmental Physics at the University of Bremen and the IFM-GEOMAR in Kiel.

155 In 1998 and 2000, the BSH extended the WOCE-A2 section with another section situated further North. Both sections form a corridor (A2 corridor). Since 2002 the A2/AR19 section is again done along 48°North alone.

156 To this end, a sea region measuring was considered the size of which was around 5°x5° and for which data series of sufficient duration could be formed.

157 Ireland-Greenland Atlantic hydrographic section, two-year intervals.

System component	Total number of stations / sections	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)			Adequate quality control? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/platforms likely to be operated in 2010
		fully	partly	not suited	30-50y	50-100y	>100y	fully	partly	no		
AWI 75° - Greenland Sea and Fram Strait	12 moorings 2 sections	X							X		10 sections 12 moorings (100%)	12 moorings 2 sections
AWI Weddell Sea	9 moorings 1 section	X							X		10 sections 9 moorings (90%)	0

Tab. XI - 11 Available homogeneous data records for oceanographic observations (oceanographic contribution)

Integrated data records; Name and short description	**Climate parameters**	**Number of platforms and/or grid width and region**	**Time period**	**References**
'Deutsche Bucht'	Wind direction, wind force, sea state, water temperature, salinity, oxygen, radioactivity	54° 10‘ N, 07° 27‘ E	1969 – 1988, 1989 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Fehmarn Belt'	Wind direction, wind force, sea state, water temperature, salinity, oxygen, radioactivity, air temperature, wind direction, wind speed, air pressure, circulation	54° 36‘ N, 11° 09‘ E	1924 – 1945, 1947 – 1984, 1984 – 1996, 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Kiel'	Wind direction, wind force, sea state, water temperature, salinity, air temperature, radioactivity	54° 30‘ N, 10° 16‘ E	1936 – 1945, 1947 – 1967, 1969 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Ems'	Water temperature, salinity, oxygen , radioactivity	54° 10‘ N, 06°20.8‘ E	1989 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Nordseeboje II'	Water temperature, salinity, oxygen, air temperature, wind direction, wind speed, air pressure	55° 00‘ N, 06° 20‘ E	1991 – 1998; 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Darsser Schwelle'	Water temperature, salinity, oxygen, pressure, air temperature, wind direction, wind speed, air pressure, humidity, solar radiation, rainfall, radioactivity	54° 41.9‘ N, 12° 42‘ E	1993 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by the BSH
'Oder Bank'	Water temperature, salinity, oxygen, pressure, air temperature, wind direction, wind speed, air pressure, humidity	54° 04.6‘ N, 14° 09.6‘ E	1996 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by the BSH
'Elbe'	Wind direction, wind force, sea state, water temperature, salinity, oxygen, radioactivity	54° 00‘ N, 08° 06.5‘ E	1924 – 1939, 1945, 1947 – 1988, 1989 – 1999	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Arkona'	Wind direction, wind speed, water temperature, salinity, oxygen, air temperature, air pressure, radioactivity, pressure, sea state, circulation	54°53´N, 13°52´E	2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'FINO1'	Water temperature, salinity, oxygen, air temperature, air pressure, wind direction, wind speed, sea state, circulation	54° 01´N, 06° 35´E	2003 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'NSB III'	Wind direction, wind speed, water temperature, salinity, oxygen, air temperature, air pressure	54° 41`N, 06° 47´E	2003 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH

Integrated data records; Name and short description	Climate parameters	Number of platforms and/or grid width and region	Time period	References
SOOP section AX-3	Water temperature (XBT) spatial resolution: 30 sm	North Atlantic: corridor from English Channel to Newfoundland	1988 – 2004	BSH Reports (Berichte aus dem BSH): ISSN 0936-0298; ISSN 0936-0298; ISSN 0946-6010
SOOP section AX-11	Water temperature (XBT) spatial resolution: 60 sm	Atlantic: Route from English Channel to Rio de Janeiro	1990 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
Borkum	Water level	53° 33.48‘ N; 06° 44.91‘ E	1963 – 2004	
Cuxhaven	Water level	53° 52.08‘ N; 08° 43.17‘E	1843 – 2004	
Amrum	Water level	54° 37.91‘ N; 08° 23.12‘E	1963 – 2004	
Annual Autumn Groundfish Survey round Greenland since 1	Temperature, salinity	East Greenland, West Greenland	1963 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
'Helgoland Reede'	Temperature, salinity, nutrients, meteorological variables	54° 11.18‘ N; 07° 54.00‘ E	1873 – 2004	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH
Denmark Strait Overflow	Cold-water transport (temperature, salinity, circulation)	SE Greenland	1997 – 2004	
N Atlantic hydrographic section at 55° N	Warm-water transport (temperature, salinity, circulation)	Ireland – Greenland	since 1991, at 2-year intervals	
North Atlantic section along 48°N (A2/AR19)	Heat and fresh water transport (temperature, salinity, circulation, nutrients)	Ireland - Banks of Newfoundland	Since 1993 10 repetitions	Archived in the *German Oceanographic Data Centre* (DOD) operated by BSH and: http://whpo.ucsd.edu/data/tables/repeat/subs/ar19_table.htm
Fram Strait 79°N CTD section and moorings	Warm-water transport (temperature, salinity, circulation)	Spitsbergen - Greenland	1987, 1988, since 1997 yearly	Archived in the AWI database http://www.awi-bremerhaven.de/OZE/ and in the *World Data Center for Marine Environmental Sciences* http://www.wdc-mare.org/
Greenland Sea 75°N CTD section	Water mass modification (temperature, salinity)	Greenland Sea along 75°N from 18°E to 16°W	Since 1994 yearly	AWI, Bremerhaven, Dr G. Budeus Gbudeus@awi-bremerhaven.de
WOCE Global Hydrographic Climatology	T, S, nutrients, oxygen	Globally, 0.5 x 0.5°, 45 depth levels	1900 - 1998, focus: WOCE 1990 - 1998	BSH Report 35[158]
Weekly SST map North and Baltic Seas	Surface temperature	North and Baltic Seas	North Sea since 1968 Baltic Sea since 1995	http://www.bsh.de/de/Produkte/Buecher/Berichte/Bericht35/index.jsp
Weddell Sea, Greenwich Meridian	Water mass modification (temperature, salinity)	Greenwich Meridian (approx. 50°S to 69.5°S)	1986, 1991, 1992, since 1996 two-year intervals	Archived in the AWI database http://www.awi-bremerhaven.de/OZE/ and in the *World Data Center for Marine Environmental Sciences* http://www.wdc-mare.org/

158 http://www.bsh.de/de/Produkte/Buecher/Berichte/Bericht35/index.jsp

Notes:

Deutsche Bucht:	Manned lightship from 1969 – 1988. 2 hourly values: wind direction, wind speed, sea state and current, water temperature and salinity, daily at 08:00 hours and at spring, neap and mean tide. Unmanned lightship, since 1989: hourly measurements of water temperature at 7 depths, salinity and oxygen content at 2 depths; since 1998; ammonia, nitrate and phosphate, since 2001: radioactivity
Fehmarnbelt:	Manned lightship from 1924 – 1984. 2 hourly values: wind direction, wind speed, sea state and current, water temperature and salinity, daily at 08:00 hours and at spring, neap and mean tide. Unmanned ship, since 1984: hourly measurements of water temperature at 6 depths (since 2001: 7 depths), salinity and oxygen content at 2 depths, air temperature, wind direction, wind speed and air pressure, radioactivity; since 2001: ammonia, nitrate and phosphate; since 2005: current
Kiel:	Manned lightship from 1936 to 1967. 2 hourly values: wind direction, wind speed, sea state and current, water temperature and salinity, daily at 08:00 hours and at spring, neap and mean tide. Kiel lighthouse, since 1969: hourly measurements of water temperature at 6 depths, salinity at 2 depths, air temperature, radioactivity.
Ems:	Unmanned lightship, since 1989: hourly measurements of water temperature at 7 depths, salinity and oxygen content at 2 depths, radioactivity.
Nordseeboje II:	Large unmanned buoy, since 1991: hourly measurements of water temperature at 7 depths (since 2000: 8 depths), salinity and oxygen content at 2 depths, air temperature, wind direction, wind speed and air pressure.
Darsser Schwelle:	Unmanned measuring tower, since 1993: hourly measurements of water temperature at 6 depths, salinity at 4 depths and oxygen content at 2 depths, pressure, air temperature, wind direction, wind speed, air pressure, humidity, solar radiation and rainfall, radioactivity.
Oderbank:	Large unmanned buoy, since 1996: hourly measurements of water temperature at 2 depths, salinity at 2 depths and oxygen content at 2 depths, pressure, air temperature, wind direction, wind speed, air pressure, humidity.
Elbe:	Manned fire ship from 1924 to 1988. 2 hourly values: wind direction, wind speed, sea state and current, water temperature and salinity, daily at 08:00 hours and at spring, neap and mean tide. Unmanned lightship, since 1989: hourly measurements of water temperature at 5 depths, salinity and oxygen content at 2 depths, radioactivity; since 1998: ammonia, nitrate and phosphate. Since December 1999, no data, as the station was given up after it was damaged.
NSB III:	Large unmanned buoy, since 2003: hourly measurements of water temperature at 8 depths, salinity and oxygen content at 2 depths, air temperature, air pressure, wind direction, wind speed, humidity, radioactivity.
Arkona:	Large unmanned buoy, since 2002: hourly measurements of water temperature at 5 depths, salinity and oxygen content at 3 depths, air temperature, air pressure, wind direction, wind speed, humidity, radioactivity, current, sea state.
FINO1	Research platform, since 2003: hourly measurements of water temperature at 6 depths, salinity and oxygen content at 2 depths, air temperature, air pressure, wind direction, wind speed, humidity, current, sea state.
Helgoland Reede	Since 1873 continuously with only war-related interruptions. Sea surface temperature and salinity, nutrients, biological samples, meteorological parameters.
SOOP line AX-3:	Commercial ships of Hapag-Lloyd shipping company ('Köln Express' and 'Bonn Express') and the research ships 'Gauss', 'Meteor', 'Prof. Multanovsky'.
SOOP line AX-11:	Commercial ships of Hamburg-Süd shipping company ('Monte Rosa' and 'Cap Finisterre').

XI.1.8.5 Terrestrial Observations

XI.1.8.1. General Information

On the national level programmes for the observation of terrestrial variables are carried out by several institutions. Partly, the responsibility for monitoring lies within the competence of the Laender, whose network of observation sites is not included in this report. On the na-tional level e.g. the German Meteorological Service (DWD) carries out a range of monitoring programmes that can be considered as contributions to terrestrial observation systems (see Table Xi-13 and Table XI-14). Other terrestrial monitoring systems on the national level, e.g. in the field of hydrology, are carried out by the Federal Institute of Hydrology (BfG) or the Federal Agency for Nature Conservation (BfN).

XI.1.8.2. Participation in GTN-P

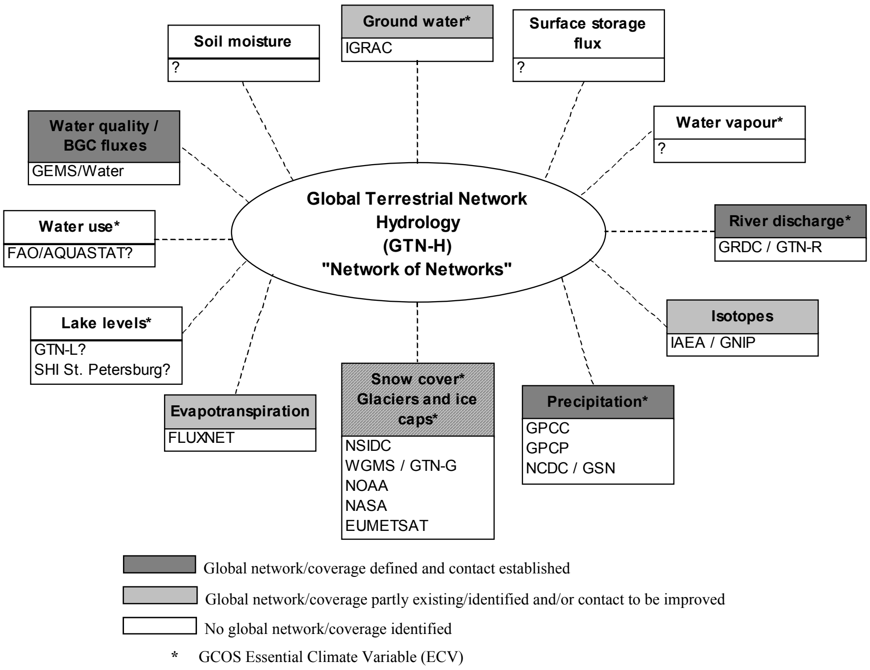
By virtue of Germany's geographic location, permafrost soils are of minor relevance.

XI.1.8.3. Participation in GTN-G

Only a few university institutes are participating in worldwide monitoring of glaciers. There are no significant glaciers on Germany's territory.

XI.1.8.4. Participation in GTN-H

Fig. XI - 16 Structure and Status of the Global Terrestrial Network for Hydrology (GTN H). The acronyms stand for organisations which already deal with the respective hydrological variables. Question marks point to variables for which no international data centre has been identified so far.



Within the framework of the *Global Terrestrial Network for Hydrology* (GTN-H[159]), an initiative by GCOS and WMO, networks are to be developed, which will collect and enhance accessibility of data concerning ten different hydrological variables in a timely manner (GCOS, 2000, 2002, 2003a and b), see Fig. 16.

The *GCOS Surface Network Monitoring Centre* (GSNMC, see 2.1.4) verifies the quality of the precipitation data provided by the GSN stations.
The information and data thus obtained are also a contribution to the GTN-H.

An important component of the GTN-H is the *Global Precipitation Climatology Centre* GPCC[160]) which is operated by the *German Meteorological Service* (DWD). On a monthly basis it provides the following global precipitation analysis:

- Since October 2003 an almost real-time First Guess Analysis for the global monthly precipitation anomaly, based on information from around 6,000 synoptic stations. Maps are available 5 days after the observation;
- A monitoring product with monthly analysis of precipitation from 1986 onwards until now, based on quality checked data from around 7,000 stations. Data related to 1°x1° and 2.5°x2.5° grid cells in ASCII-format are available within 2 months after the observation. They are available for downloading from the Internet[161];
- The full data product with monthly precipitation analysis for the period 1951-2003 based on the comprehensive GPCC data set, which includes the GTS data set as for the monitoring product, and integrates the large data collections of the *Climatic Research Unit* (CRU), the *Food and*

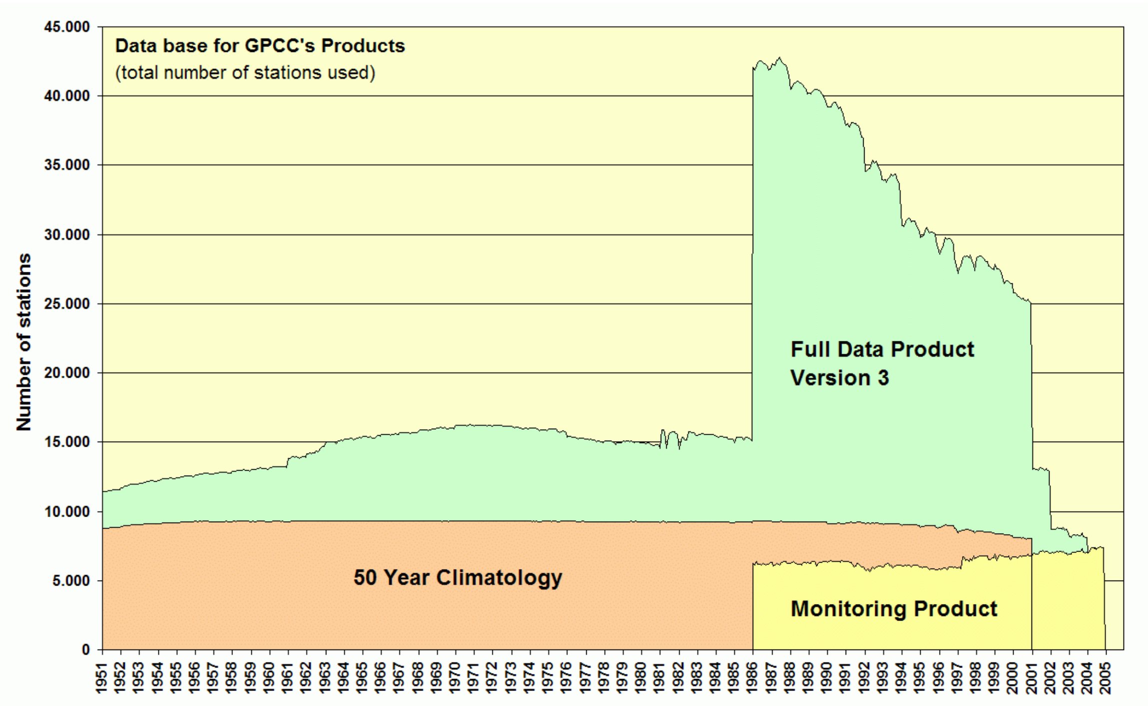
[159] http://gtn-h.unh.edu/
[160] http://gpcc.dwd.de/
[161] ftp://ftp.dwd.de/pub/data/gpcc/download.html

Agriculture Organization (FAO), and the *Global Historical Climatology Network* (GHCN) as well as numerous data sets provided by National Meteorological or Hydrological Services from more than 170 countries (max. 43,000 stations).

- The 50-year climatology for the period 1951-2000 based on data sets for 9,343 stations which are as homogenous and complete as possible. The analysis of the relative anomaly based on these stations was overlaid on a basic climatology based on around 28,000 stations.

Within the GTN-H the *Global Runoff Data Centre* (GRDC) located at the *Federal Institute of Hydrology* (BfG) takes responsibility for the collection of the so-called 'near real-time" runoff data.

Fig. XI - 17 The data set for the above-mentioned GPCC products (first guess analysis excluded) presented as number of precipitation data available for the respective months.

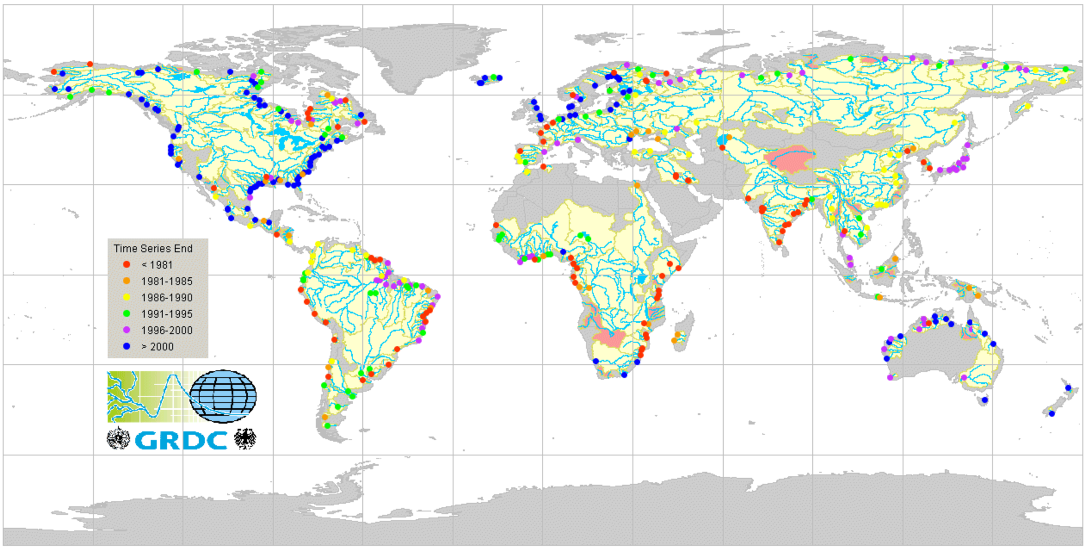


XI.1.8.5. Participation in Global Terrestrial Network for River Discharge (GTN-R)

The *Global Terrestrial Network for River Discharge* (GTN-R[162]) presented in Fig. XI-18 represents the basic measuring network for GCOS (2004), with currently 380 named stations.

[162] http://gtn-r.bafg.de/

Fig. XI - 18 **The runoff measuring stations of the Global Terrestrial Network for River Discharge (GTN-R). They represent the basic measuring network for GCOS (2004). The 380 stations along the continental coasts are located in 355 of the 391 presented catchment areas. For the 36 (mostly small) catchment areas marked in red, no GRDC stations exist so far (as of February 2005).**



The GTN-R is relevant for a growing number of projects, inter alia:

- As a GRDC contribution to the runoff component of the GTN-H project;
- As a global basic measuring network for runoff in the framework of the *Implementation Plan for the Global Observing Systems for Climate in Support of the UNFCCC* (GCOS, 2004);
- As a basis for future editions of the GRDC product 'Long Term Mean Annual Freshwater Surface Water Fluxes into the World Oceans' (see http://grdc.bafg.de/?1034);
- As a basis for the GRDC cooperation with the *UN GEMS/Water Programme Office of UNEP/DEWA* in Burlington, Ontario/Canada, for the survey of biogeochemical fluxes into the world's oceans (see http://www.gemstat.org);
- As the GRDC contribution to a map layer within the WHYMAP project, which is supported inter alia by UNESCO, see http://www.iah.org/whymap.

XI.1.8.6. Participation in FLUXNET

Within the framework of FLUXNET, a global network of stations that is studying the exchange of CO_2, water vapour and energy between the atmosphere and terrestrial ecosystems, CarboEurope[163] is developing a prototype of a reliable, continually operating monitoring system expected to produce a comprehensive carbon balance sheet for Europe. The European network comprises over 30 stations that are carrying out *in situ* measurements of carbon and energy flows in boreal, temperate

[163] http://www.carboeurope.org/

and Mediterranean forests. FLUXNET was established in spring 2000 and now consists of 70 research institutions in 17 European countries. An overview of the locations in Europe, with descriptions of the involved stations, is available in the Internet[164].

XI.1.8.7. Other terrestrial monitoring networks

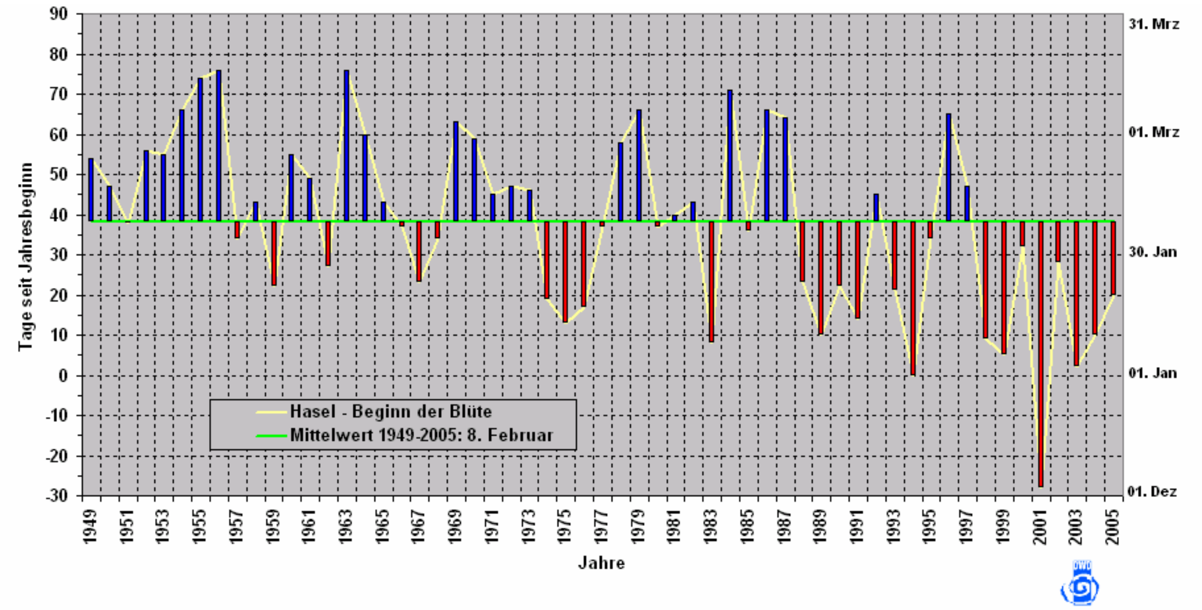
XI.1.8.7.1. Soil

Many stations of the German Meteorological Service (DWD) also measure soil tempera-tures at various depths, including a maximum depth of 100 cm. One station (Potsdam) has been measuring ground temperature now for over 100 years at various depths up to a depth of 12 m. Soil-temperature data is exchanged on the basis of bilateral agreements.

XI.1.8.7.2. Biota

The phenological monitoring data of the DWD (Table XI-14) is not exchanged internationally, since there are no agreements in place for the exchange of such data between the Meteorological Services. In addition, such monitoring is carried out in only a few countries. In the 1950s, the International Phenological Gardens (IPG) network was founded as a means of obtaining a basis for such comparisons. This network was coached until 1995 by the DWD. In the context of cost-saving measures in 1996 the DWD transferred this responsibility to the Humboldt University in Berlin, the operation of the IPGs not being considered as one of the central tasks of the DWD.
Additional information about the phenological monitoring carried out by the DWD is avail-able from the DWD Climate Information System (KLIS) on the Internet.

Fig. XI - 19 Beginning of hazel bloom at Geisenheim, 1949 to 2005; presenting the deviation from the mean value



164 http://daac.ornl.gov/FLUXNET

ICP Forests is a joint programme of the European Union and the United Nations that was established on the basis of EC Council Regulation (EEC) No 3528/86.

This programme monitors and assesses the condition of forests on the basis of various indicators. It comprises the following study areas in Germany:

- Annual surveys on a systematic sampling network (with about 420 points in a 16 x 16 km grid, with some areas of higher sampling density) that covers all of forested areas in Germany and include the assessment of tree crown condition. This forest-damage survey (known as *Waldschadenserhebung*, WSE, of Germany) has an intensity level referred to as 'level I'.
- Level I also includes the soil-condition survey (known as *Bodenzustandserhebung*, BZE, of Germany), which to date has been carried out once (in the 1987 to 1993 period), on an 8 x 8 km grid (with some areas of higher sampling density) at around 1800 points. This survey covers foliar nutrient status as well as soil chemistry and capacity and intensity parameters. Current plans call for repeating this survey every 10 to 15 years.
- Level II includes observations on 89 permanent observation plots, carried out at intervals ranging from weeks to years (some observations are also continuous). Level II surveys gather data (in addition to that collected in Level I) on deposition of air pollutants via precipitation, substance movements in groundwater, and meteorological data.

The surveys are carried out and evaluated by the Laender. The Federal Government coordinates the work and prepares national summaries.

Regular monitoring of range shifts of plants and animals can provide indications of climate changes. The great majority of relevant studies focus only on individual species, however. The *Federal Agency for Nature Conservation* (BfN) maintains a database of monitoring data on vascular plant occurrence and distribution (FLORKART[165]) and a similar database on the occurrence and distribution of butterfly species (LEPIDAT). The current data set of the database on vascular plants (FLORKART) of about 14 million single observations is based on the consolidation of data derived from monitoring projects of the Laender and regional monitoring projects, which is unique so far. It provides nationwide data on the distribution in Germany of all vascular plants (around 4,500, neophytes included), which may serve as a baseline for the determination of range shifts. With the *Centre for Phytodiversity Germany* (ZePhyD), there exists a national structure of loosely coordinated centres of competence, which takes responsibility for the continued collection, centralized consolidation and provision of data on the population status and distribution of plants in Germany. It is yet to be determined whether this organizational structure could be used to facilitate a nationwide monitoring of climate-relevant indicator species at shorter time intervals.

Ecological Area Sampling (ÖFS) provides methods and concepts for surveying the distribution of biotopes and species. Applied at five-year intervals, the methods would detect changes in factors such as species and structural diversity, and yield results that would be representative for all of Germany. No decision on the implementation

[165] http://www.floraweb.de

of this monitoring method has yet been taken. The UK has been applying a similar method (Countryside Survey) for some time now. In 2001, Switzerland also launched a *Biodiversity Monitoring Programme* (BDM) that collects species-diversity data throughout a sampling grid. It is still unclear whether a standardized biodiversity-monitoring programme will be introduced on a European-wide basis.

In reporting obligations under the FFH Directive and the EC Bird Directive, countries are required to gather information on the condition of NATURA 2000 areas. According to the European Commission, representative data for the whole geographical scope of the Directive are required in addition.

Changes in the migratory behaviour of migratory animal species can also be used to verify climate changes. There is no nationwide long-term series of relevant monitoring data available. It remains to be determined whether the findings from bird-migration research of various universities and of the Radolfzell bird station[166] could be applied to such studies. Possibly, surveys carried out pursuant to the reporting obligations under the Bird Directive and the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA) might be applicable in this regard in future.

XI.1.8.7.3. Hydrological Measurements in Surface Waters

In Germany, hydrological measurement networks are operated by the water-resources ad-ministrations of the Laender and, along federal waterways, by the German Federal Water-ways and Shipping Administration (WSV). The 'water-level regulation' (Pegelvorschrift), which was first issued in 1935, provides the basis for these networks. The 4th version of the regulation, in force since 1997, was prepared by the Working Group of the Laender on Water Issues (LAWA) and the Ministry of Transport, Building and Urban Affairs (BMVBS).

The legal basis for collection, evaluation and use of water-level data consists of the Federal Water Act, the water acts of the Laender and Federal Waterway Act, in their applicable ver-sions.

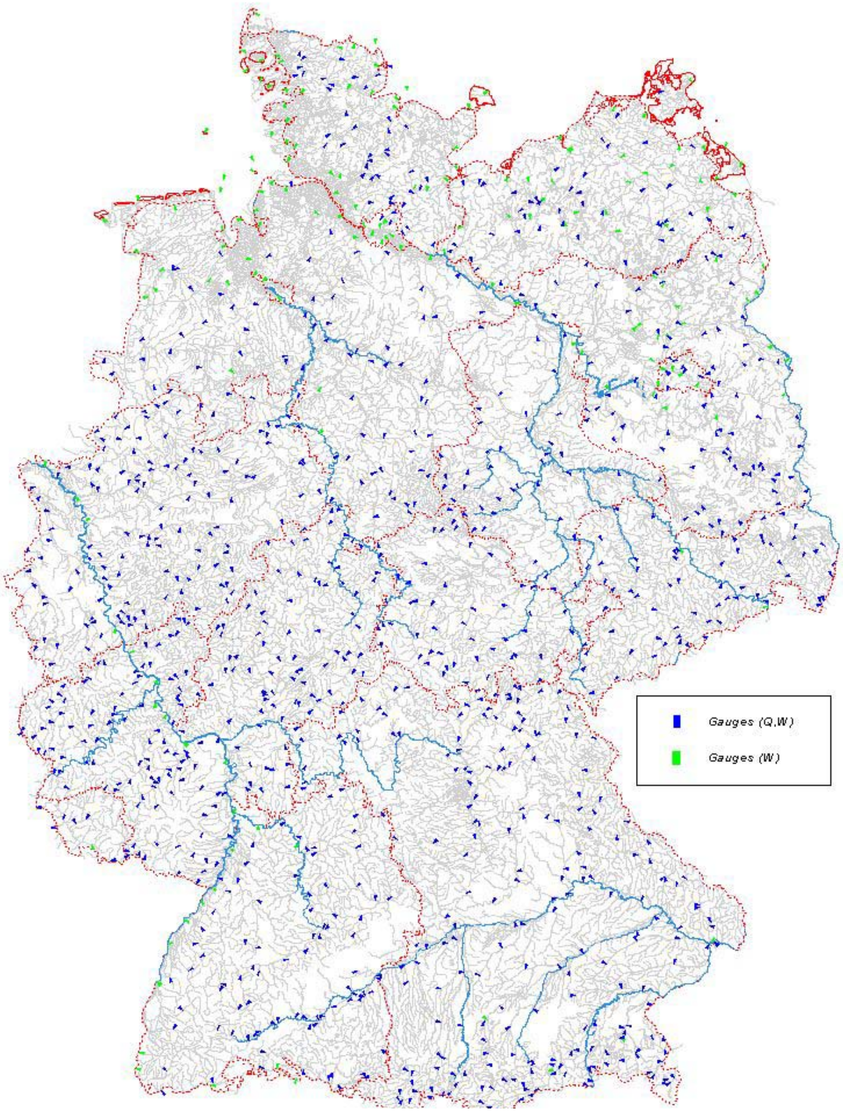
The German water level measuring network for surface waters currently comprises a total of about 4,400 water level monitoring points. In addition to monitoring water levels, around 3,000 measuring stations also measure rates of flow. On average each measuring station comprises a catchment area of 120 km². The longest continuous series of monitoring data for daily flow rates are those compiled by stations on the River Rhine (1802 Rees), River Elbe (1806 Dresden) and the River Weser (1820 Vloto). On the River Danube, continuous records of water levels have been taken at the Passau point since 1876.

From these measuring stations the data of representative measuring points are published annually (Fig. XI-20). The determining factors are the stations' importance with regard to water-resource management, flood protection, waterway transports as well as planning, documen-tation and research. Monitoring data from these stations is published in the German Hydro-logical Yearbook (DGJ), which has been

[166] http://vowa.ornithol.mpg.de

appearing since 1901. This work, which is divided into 10 volumes covering the different river basins, now contains monitoring data from around 1,000 hydrological measuring points. In addition to water-level data and flow rates, the DGJ also publishes monthly mean levels for suspended particulates, as measured at around 50 stations, and groundwater-level data obtained at around 200 selected measuring stations.

Fig. XI - 20 Hydrological water-level data in the DGJ



The Federal Waterway and Shipping Administration (WSV) operates about 560 hydrological measuring stations of regional and supra-regional importance (this number does not include the measuring points required simply for the technical operation of the facilities). Around 160 of the WSV measuring stations also determine the flow rates. The DGJ publishes the water levels from 190 WSV measuring stations and the flow rates from around 80 WSV stations. In addition to the pure collection of hydrological data, federal stations also measure a range of other parameters (drift, radioactivity, conductivity and various chemical quantities). Further-more, around 250 stations also measure air and water temperature.

A range of different agencies review and archive water-level and runoff data independently, under their own responsibility. The German Federal Institute of Hydrology (BfG), maintains a hydrological database for water-level and runoff data, which contains data series from the federal measuring stations as well as historical data series for selected measuring stations operated by the Laender.

Fig. XI - 21 Online measuring stations in ELWIS

Data exchange among the Laender, and between the Laender and the Federal Government, is regulated by mutual administrative agreements. International data exchange with neighbouring countries is also regulated by agreements. Furthermore, Germany is actively involved in maintaining and continuing the *WMO Global Runoff Data Centre* (GRDC). A total of 94 German stations regularly provide the GRDC with updates to the flow rate series filed by the centre.

With a view to fast availability of environmental information, the *Federal Waterway and Shipping Administration* (WSV) has been operating the ELWIS Electronic Waterway Information System (Fig. XI-21) for several years. This system, which is accessible for all interested parties, shows the current hydrological situation on federal waterways. At present, current water levels for around 100 different measuring stations are shown on the Internet[167].

From 2006 onwards the data which have been analysed but not yet published in print will be publicly available on the Internet (DGJ on the Internet), starting with data from federal measuring stations and continuing in the medium term with all DGJ data from the Laender.

Runoff data in monographs of the River Rhine and River Danube will be completed and updated by international experts at irregular intervals.

In addition, overviews of current hydrological data have been published since 1965 annually in the Yearbook published by the UNESCO *International Hydrological Programme* (IHP). Therein, additional hydrometeorological and hydrological parameters from selected measuring stations and river basins in Germany (before 1990 only West Germany) are compiled and published. The variables comprise area precipitation, air temperature, evaporation, soil moisture and infiltration, groundwater level as well as runoff and discharge per unit area.

There is a standardized methodology for calculating runoff and water balances for the German territory, and the German river basins or the German parts of the international river basins of the Danube, Rhine, Maas, Weser, Ems, Elbe, Oder as well as the coastal areas of the North and Baltic Seas. Those data are also fed into the international statistics of EUROSTAT and the OECD. For the German territory (after reunification) balances for individual years are available for the time period 1990 until 2002 whereas long-term mean values exist for the time series between 1931/60 and 1961/90. Within the context of the *German Hydrological Atlas* there are plans to calculate retroactively the runoff and water balances for each year until 1951 for the above-mentioned areas and to extend the balance series with a reduced data frequency back to 1901. This way, the required reference data for monitoring the water balance (including runoff) on a national level are available.

For the standard period of 1961/90, area-specific (1 km x 1 km grid cells) hydrometeorological parameters (like precipitation, characteristics of snow cover development, grass reference evaporation, real evaporation, and runoff) where compiled in the *Hydrological Atlas of Germany* (with contributions from the DWD, the *Federal Institute for Geosciences and Natural Resources* (BGR), and the *Federal Agency for Cartography and Geodesy* (BKG)) on the basis of available data from

[167] http://www.elwis.bafg.de

measuring stations and standardized methodologies for regionalisation and calculation. They provide further reference data sets to describe and evaluate future changes in parameters which characterize the water balance.

All this hydrological data together is of utmost importance for the investigation of long-term climatic changes.

Tab. XI - 12 Participation in global terrestrial observation systems

	GTN-P	**GTN-G**	**GTN-R**	**FLUX NET**	**ICP IM**	ICP Forest/ Level II	ICP Vegetation/ Crops	ICP Materials	ICP Freshwater	ICP Mapping
How many observation sites are under the responsibility of the contracting party?	0	0	3	3	1	89	5	6	41	n.d.
How many of these sites are currently in operation?	0	0	3	2	1	89	5	6	41	*
How many deliver data to international data centres?	0	0	3	2	1	89	5	6	41	n.d.
How many are likely to be in operation in 2010?	0	0	3	3	2	89	5	6	n.d.	n.d.

Tab. XI - 13 Terrestrial climate observation systems

Systems which are meaningful for national climate monitoring	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)			Adequate quality control? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/ platforms likely to be operated in 2010
		fully	partly	not suited	30-50y	50-100y	>100y	fully	partly	not suited		
Snow	3143		X		1150	2638	104	X			3143 (100%)	2100
Soil temperature (2, 5,10, 20, 50, 100 cm under surface)	308		X		20	19	0		X		308 (100%)	315
Soil temperature (2, 3, 4, 5, 6, 7, 8, 9, 10, 12 m under the surface)	1			X	0	0	1		X		1 (100%)	1
CORINE: land use, land cover (satellite data)	500x500 m		X		0	0	0	X			100 %	
UBA air quality measuring network: precipitation, temperature, wind direction and wind speed, relative humidity, air pressure, O_3, SO_2 (24); CO_2 (8)	24		X		0	0	0	X			24 (100%)	reduction planned
Permanent soil monitoring: land use, KAK, carbon and carbonate content	~700		X		0	0	0			X	700 (100%) but not all plots are digitised	X
Soil-condition surveys: carbon, organically dissolved humus, C/N and C/P ratio	16x16 km grid (about 1800)		X		0	0	0		X		X (at BMELV)	repetition planned
Flow rate	3019	(X)	X		456	376	42	X			100%	?

Tab. XI - 14 Ecological climate observation systems

Systems which are meaningful for national climate monitoring	Total number of stations	Suitable for characterising national/regional climate? (Please tick)			Time series Number of stations/platforms (number data digitised)				Adequate quality control? (Please tick)			Available metadata Total number of stations (%digitised)	Continuity Number of stations/ platforms likely to be operated in 2010
		fully	partly	not suited	30-50y	50-100y	100-300y	>300y	fully	partly	not suited		
Phenology	6500[168]		X		730	410	2			X		9000 (70%)	1400
NDVI[169]	1km grid resolution	X			0	0	0	0	X			X (100%)	X
Degree of plant cover[67]	around 7 km grid resolution	X			0	0	0	0	X			X (100%)	X

[168] Number of stations in the DWD observing network that are currently active: 1420 (as of 31.12.2004)
[169] Product derived from radiation parameters measured by satellite (NOAA).

XI.1.9. Space-based Monitoring Programmes

XI.1.9.1. General information

Under the German National Space Exploration Support Act (Raumfahrtaufgabenübertra-gungsgesetz -RAUeG), the German Aerospace Center (DLR) is responsible for designing Germany's space programme, for implementing this programme and for maintaining interna-tional contacts, as the representative of the Federal Government. In carrying out these tasks, the DLR cooperates closely with the involved Federal Ministries, especially the Federal Min-istry of Education and Research (BMBF) and the Federal Ministry of Transport, Building and Urban Affairs (BMVBS). Via the DLR Space Flight Committee (composed of representatives of the Federal Ministries concerned) and its programme panels (here: earth observation), regular consultations are held with the other Federal Ministries, for example, the Federal Min-istry of Defence (BMVg), Federal Ministry for the Environment, Nature Conservation and Nu-clear Safety (BMU), Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) and Federal Ministry of the Interior (BMI); with the industry and scientists (for example, rep-resentatives of the National Committee on Global Change Research (NKGCF) of the Ger-man Research Foundation (DFG) and the Expert Committee of the BMBF on Global Envi-ronmental Issues (SVGUA)). The activities of the Interministerial Committee for Geoinforma-tion (IMAGI) include the integration of remote-sensing data in GIS for national applications. The DLR advises various organisations with regard to the use of remote sensing data – for example, the German Committee for Disaster Reduction (DKKV).

In the implementation of the National Space Exploration Support Act, the DLR represents the national interests of Germany with the European Space Agency (ESA). With regard to earth observation, this involves mainly the dealings with the Earth Observation Programme Board (PB-EO) and the technical sub-committee Data Operation Scientific and Technical Advisory Group (DOSTAG). The German contribution to ESA amounts to some 545 million € per year. Within this sum, the German contribution to various earth-observation programmes amounts to around 85 million euros per year. In addition, Germany, i.e. the BMVBS, made contributions, directly or via EUMETSAT, to ESA for the development of future satellite sys-tems (i.e. at first the Meteosat Second Generation (MSG) and then MetOp-A, the first polar-orbiting satellites of EUMETSAT).

XI.1.9.2. EUMETSAT

The national meteorological services in Europe coordinate their operational satellite activi-ties via the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The contributions to the compulsory programmes with EUMETSAT being based on the gross domestic product, the Federal Republic of Germany, represented by the German Meteorological Service (DWD), is the largest contributor to EUMETSAT. In 2005, for example, the German share of the compulsory programmes was 22.73%, and its share of the optional oceanographic programme, i.e. Jason-2, was 26.82 %, which amounts to a total contribution of 61.3

million euros provided by the Federal Ministry of Housing, Building and Urban Affairs (BMVBS).

The EUMETSAT programmes, which besides various national and ESA missions such as ENVISAT represent the major part of the European contribution to the implementation of WMO programmes and the space component of the Global Observing System of WMO (GOS), are of great importance for GCOS for the following reasons:

- the long-term commitments of EUMETSAT programmes (especially important with regard to climate monitoring);
- the advantages of space-based observations over in-situ measurements:
- different parts of the world can be observed with one and the same observation system,
- collected information is largely complete-coverage information,
- observations have high repetition frequencies.

It should be noted that the EUMETSAT Convention was expanded to cover tasks in the area of climate monitoring. Article 2 of the EUMETSAT Convention states: 'A further objec-tive of EUMETSAT is to contribute to the operational monitoring of the climate and the detec-tion of global climatic changes'.

With Meteosat, EUMETSAT operates a geostationary satellite system; with the EUMETSAT Polar System (EPS), it is carrying out a programme for operational development of polar-orbiting meteorological satellites. The earliest Meteosat data dates from 1977. The same Meteosat system, now known as MTP (Meteosat Transition Programme), remained in opera-tion above Europe, Africa and the Atlantic until the end of 2005 and will be operated above the Indian Ocean even longer. The first satellite of the new Meteosat Second Generation (MSG) started operation at the beginning of 2004 under the name of Meteosat-8. Within the MSG programme, which was agreed upon as binding, it is planned to launch altogether 4 satellites and to guarantee operational data availability until around 2019. According to the current plans, the EUMETSAT Polar System (EPS) will provide operational data from 2006 to approximately 2020.

MSG and EPS already carry or will carry certain instruments for climate monitoring and cli-mate research. In the context of EPS (EUMETSAT Polar System) these include, for example, the Geostationary Earth Radiation Budget (GERB) instrument on board MSG and the Global Ozone Monitoring Experiment (GOME-2) instrument on board MetOp (Meteorological Opera-tional Satellite Programme). In addition, all other payloads on board the MSG and EPS/MetOp satellites will provide information of essential relevance to GCOS. Details about EUMETSAT, including its programmes, data and products, are provided on the EUMETSAT website . As guaranteed long-term availability of data from the outset is of particular impor-tance for climatological issues, reference is made to Section 2.1.3 which describes the plans for a Meteosat Third Generation (MTG) to be operational by approximately 2030 and the first considerations given to an EPS successor system that will reach far into the future.

Within the so-called Satellite Application Facilities (SAF) initiated by EUMETSAT, the Ger-man Meteorological Service (DWD) has taken over the task of the lead institution for the tasks of deriving climate-suitable parameters transmitted by the new satellite generations (MSG, EPS / MetOp), and of building up, operating and further developing the SAF on Cli-mate Monitoring (CM-SAF). The CM-SAF started operations in a pre-operational mode at the beginning of 2005. The German Aerospace Center (DLR) and the DWD take also part in the Satellite Application Facility for Ozone Monitoring (Ozone SAF). These SAFs form a network of European centres of competence for the exploitation of satellite data where Meteorological Services and research institutions work together. As each SAF combines several Consortium partners, the SAF network as one part of the EUMETSAT ground segment for the processing of satellite data is, so to speak, a European network of networks.

XI.1.9.3. Other Satellite Systems

Apart from the operational meteorological satellites, the following other satellite systems are operated by Germany or co-financed via the German contribution to ESA. On the national level these are:

- BIRD (High temperature event detection like fires, volcanoes, Start in 2001)
- CHAMP (CHAllenging Minisatellite Payload, for geoscientific and atmospheric research, seit 2000)
- GRACE (Gravity Recovery And Climate Experiment, Start in 2002)
- MOS (Ocean Colour, chlorophyll and other water constituents, atmospheric aerosol mapping, seit 1996)
- SRTM (Global digital elevation models by single pass SAR interferometry in 2000)
- TerraSAR (High-Resolution X-Band SAR for Land observation, forestry, agriculture, regional planning, cartography, biomass, Start in 2005)
- RapidEye (Optische Kartierung von Landoberflächen mit hoher Wiederholrate, Start in 2007)

At the ESA:

- ERS-2 (Earth Remote Sensing Satellite –2, seit 1995)
- ENVISAT (Environmental Satellite, Start in 2002)
- GOCE (Gravity Field and Steady-State Ocean Circulation Explorer, Start in 2006)
- CRYOSAT (Messungen der Eisbedeckung der Polkappen, Veränderungen Meeresspiegel, Start 2005)
- SMOS (Soil Moisture and Ocean Salinity, Start in 2007)
- Aeolus/ADM (Atmospheric Dynamics Mission, Start in 2008)
- SWIFT (auf GCOM, 2007)
- SWARM (Konstellation von 3 Satelliten zur Vermessung des Erdmagnetfeldes, Start 2009)
- EarthCare (Earth Clouds, Aerosols and Radiation Explorer, Start 2011)

Sowie zukünftige noch auszuwählende Earth Explorer Missionen.

XI.1.9.4. Data availability

The EUMETSAT Secretariat extracts geophysical parameters from Meteosat data, archives them in its *Unified Meteorological Archiving and Retrieval Facility* (U-MARF) and makes them available to interested parties. These data include a number of products, such as climate data records, precipitation index, various cloud products and sea surface temperature data (SST product), that are of special interest for climatological applications. Details about U-MARF and about how the archived data can retrieved are available at http://www.eumetsat.int (click on 'Access to Data' and then on 'Archive Services').

Within the *Satellite Application Facility on Climate Monitoring* (CM-SAF), the DWD maintains an archive where the climate values derived from satellite data are stored and made available to interested meteorological services and other users. CM-SAF data are available via the website of the CM-SAF[170].

At the German *Remote Sensing Data Centre* (DFD) in Oberpfaffenhofen, the DLR receives, processes, stores and provides satellite data. This includes data from NOAA-AVHRR and -ATOVS, data from GOME on board ERS-2, and the data from MIPAS, GOMOS and SCIAMACHY on board ENVISAT as well as from the MODIS imaging instrument which delivers image data with high spectral and geometrical resolution and is carried on board the NASA platforms EOS Aqua and EOS Terra.

Within the framework of *Announcements of Opportunity* for research, ESA makes the data available at no cost. Outside these announcements, data is provided for research purposes, upon application, at reduced rates (*costs for fulfilling the user request*). Full rates are charged for commercial/operational uses. Special terms for subscriptions or large-area coverage may be negotiated.

Similar policies also apply to the aforementioned projects in the national framework.

XI.1.9.5. Conformance with GCOS-Standards

In this context the demand for continuity of the measurements is of fundamental impor-tance; while the above-mentioned systems attempt to ensure this, and EUMETSAT's opera-tional meteorological missions meet these requirements, they cannot always be met by other missions. In many cases, such missions are for demonstration purposes or intended to help answer a specific issue regarding the earth system. Thanks to close cooperation between ESA and EUMETSAT, a number of successful demonstrators have been transferred to rou-tine operation, and this practice is to be continued in future where possible. With the Earth-watch programme, ESA has created the necessary organisation and programme framework for this purpose. The Global Monitoring for Environment and Security (GMES) programme, as part of the European space strategy jointly defined by ESA and the EU, is one such ele-ment. At present, the exact definition and the working out of contractual agreements relating the implementation of GMES and its corresponding service elements are still going on. Yet, the question of how to finance GMES must still be answered.

[170] http://www.cmsaf.dwd.de

The said GCOS standards for calibration/validation, quality assurance, temporal overlap-ping of old and new sensor data, archiving and access define the requirements that, basi-cally, all aforementioned satellite systems should – and actually do – meet. In particular the Satellite Application Facility for Climate Monitoring (CM-SAF), which is operated under the lead of the DWD, gives particularly great significance to validation, best possible data quality, homogeneity and reliability of service. It goes without saying that the results are available to all interested users without any restrictions.

XI.1.10. List of Abbreviations

Aeolus-ADM	Atmospheric Dynamics Mission; launch in 2008
AEWA	Agreement on the Conservation of African-Eurasian Migratory Waterbirds
ARGO	Array for real-time geostrophic oceanography
ASAP	Automated Shipboard Aerological Programme
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
AWI	Stiftung Alfred-Wegener-Institut für Polar- und Meeresforschung (Alfred Wegener Institute for Polar and Ocean Research)
BAPMon	Background Air Pollution Monitoring Network
BATHY	GTS Code for bathythermal observations
BBodSchG	Bundesbodenschutz-Gesetz (Federal Soil Act)
BDM	Biodiversity Monitoring Programme
BfG	Bundesanstalt für Gewässerkunde (German Federal Institute of Hydrology)
BfN	Bundesamt für Naturschutz (German Federal Agency for Nature Conservation)
BfS	Bundesamt für Strahlenschutz (German Federal Office for Radiation Protection)
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (German Federal Institute for Geosciences and Natural Resources)
BIRD	Bi-spectral InfraRed Detection, a DLR mission for the detection of high temperature events like fires, volcanoes
BKG	Bundesamt für Kartographie und Geodäsie (German Federal Agency for Cartography and Geodesy)
BMBF	Bundesministerium für Bildung und Forschung (German Federal Ministry of Education and Research)
BMELV	Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz (German Federal Ministry of Food, Agriculture and Consumer Protection)
BMI	Bundesministerium des Innern (German Federal Ministry of the Interior)
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety)
BMVBS	Bundesministerium für Verkehr, Bau und Stadtentwicklung (German Federal Ministry of Transport, Building and Urban Affairs)
BMVg	Bundesministerium der Verteidigung (German Federal Ministry of Defence)
BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung (German Federal Ministry for Economic Cooperation and Development)
BSH	Bundesamt für Seeschifffahrt und Hydrografie (Federal Maritime and Hydrographic Agency)
BSRN	Baseline Surface Radiation Network of the WCRP
BZE	Bodenzustandserhebung (Soil-condition survey)
CANVAS	Contaminants and Nutrients in Variable Sea Areas funded by BMBF
CDM	Clean Development Mechanism (of the Kyoto Protocol)
CEOP	Coordinated Enhanced Observation Period
CEOS	Committee on Earth Observation Satellites

CHAMP	CHAllenging Minisatellite Payload, a German small satellite mission for geoscientific and atmospheric research and applications, managed by Germany's National Research Centre for Geosciences, GFZ Potsdam
CliC	Climate and Cryosphere (a WCRP project)
CLIVAR	Climate Variability and Predictability
CLRTAP	UN/ECE Convention on Long-range Transboundary Air Pollution
CM-SAF	EUMETSAT Satellite Application Facility on Climate Monitoring
CORINE	Coordination of Information on the Environment project
CRU	Climatic Research Unit (of the University of East Anglia, UK)
CRYOSAT	Satellite for monitoring the polar ice coverage (launch in 2006)
CSCE	Conference for Security and Co-operation in Europe
CTD	Conductivity-Temperature-Depth measuring instrument
DFD	Deutsches Fernerkundungsdatenzentrum (Remote Sensing Data Centre)
DFG	Deutsche Forschungsgemeinschaft (German Research Foundation)
DGJ	Deutsches Gewässerkundliches Jahrbuch (German Hydrological Yearbook)
DKKV	Deutsches Komitee für Katastrophenvorsorge e.V. (German Committee for Disaster Reduction)
DLR	Deutsches Zentrum für Luft- und Raumfahrt e.V. (German Aerospace Center)
DOD	Deutsches Ozeanographisches Datenzentrum (German Oceanographic Data Centre)
DWD	Deutscher Wetterdienst (German Meteorological Service)
E-ASAP	EUMETNET-ASAP
ECT/LC	European Topic Centre on Land Cover
EEA	European Environment Agency
EGOS	European Group on Ocean Stations
ELWIS	Elektronisches Wasserstraßen-Informationssystem (Electronic Waterway Information System)
EMDS	Einheitlicher Meteorologischer Datenspeicher (Standardised meteorological data storage medium)
EMEP	European Monitoring and Evaluation Programme
ENVISAT	European Environmental Satellite (ESA)
EPS	EUMETSAT Polar System
ERS-2	Second European Earth Remote Sensing Satellite (ESA)
ESA	European Space Agency
ESEAS	European Sea-Level Service
E-SURFMAR	EUCOS Surface Marine programme
ETC	European Topic Centre
EU	European Union
EUCOS	EUMETNET Composite Observing System
EUMETNET	Network of European Meteorological Services
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EUROBATS	Agreement on the Conservation of Bats in Europe
EuroGOOS	European Global Ocean Observing System
FAL	Bundesforschungsanstalt für Landwirtschaft (Federal Agricultural Research Centre)
FAO	Food and Agriculture Organization
FCCC	(United Nations) Framework Convention on Climate Change
FFH	EU directive on Fauna, Flora and Habitat

FLORKART	Data base of vascular plants at the BfN
FLUXNET	Network of regional networks which coordinates regional and global analysis of observations from micrometeorological tower sites
FTIR	Fourier Transform Infrared Spectroscope
GABLS	GEWEX Atmospheric Boundary Layer Studies
GAW	Global Atmosphere Watch
GAWTEC	GAW Training and Education Centre
GCC	Global Collecting Centre
GCOS	Global Climate Observing System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GERB	Geostationary Earth Radiation Budget
GEWEX	Global Energy and Water Cycle Experiment
GHCN	Global Historical Climatology Network
GHG	Greenhouse gas
GISCO	Geographical Information System of the European Commission
GMES	Global Monitoring for Environment and Security
GMO	Genetically modified organisms
GOCE	Gravity Field and Steady-State Ocean Circulation Explorer (ESA)
GODAE	Global Ocean Data Assimilation Experiment (IOC)
GOME	Global Ozone Monitoring Experiment (instrument to measure ozone profiles, ERS-2 and EPS satellites)
GOMOS	Global Ozone Monitoring by Occultation of Stars
GOOS	Global Ocean Observing System
GOS	WMO Global Observing System
GPCC	Global Precipitation Climatology Centre
GPCP	Global Precipitation Climatology Project
GPS	Global Positioning System
GRACE	Gravity Recovery And Climate Experiment
GRDC	WMO Global Runoff Data Centre
GSN	GCOS Surface Network
GSNMC	GSN Monitoring Centre
GTN-G	Global Terrestrial Network for Glaciers
GTN-H	Global Terrestrial Network for Hydrology
GTN-P	Global Terrestrial Network for Permafrost
GTN-R	Global Terrestrial Network for River Discharge
GTOS	Global Terrestrial Observing System
GTS	WMO Global Telecommunication System
GTZ	Gesellschaft für Technische Zusammenarbeit GmbH (German Agency for Technical Co-operation)
GUAN	GCOS Upper Air Network
GVaP	GEWEX Global Water Vapor Project
GYROSCOPE	Development of a real-time in situ observing system in the North Atlantic Ocean, by an array of Lagrangian profiling floats
HELCOM	The Baltic Marine Environment Protection Commission (Helsinki Commission)
ICP IM	International Co-operative Programme on Integrated Monitoring
ICP M	International Co-operative Programme on Mapping
ICSU	International Council for Science
IfM	Institut für Meereskunde (Institute for Oceanography) in Hamburg
IFM-GEOMAR	Leibniz-Institut für Meereswissenschaften (Leibniz Institute of Marine Sciences) at the University of Kiel
IFREMER	Institut Francais de Recherche pour l'Exploitation de la Mer (French Research Institute for Exploitation of the Sea)

IGOS	Integrated Global Observing Strategy
IHP	International Hydrological Programme
IMAGI	Interministerieller Ausschuss für Geoinformation (Interministerial Committee for Geoinformation)
IMIS	Integrated Measuring and Information System for Radioactivity
IOC	Intergovernmental Oceanographic Commission of UNESCO
IPG	International Phenological Garden
ISO	International Organization for Standardization
JASON	JASON Ocean Altimetry Programme
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
KfW	KfW Bankengruppe (KfW Banking Group)
KLIS	Climate information system of the Deutscher Wetterdienst (available on the Internet)
LAWA	Länderarbeitsgemeinschaft Wasser (Working Group of the German Laender on Water Issues)
LEPIDAT	Macrolepidoptera database of BfN
MARNET	Marines Umweltmessnetz in Nord- und Ostsee (Marine Environmental Monitoring Network in the North Sea and Baltic Sea) of the BSH
MCSS	Marine Climatological Summaries Scheme of WMO
MERMAID	Marine Environmental Remote-Controlled Measuring and Integrated Detection
MetOp	EUMETSAT Meteorological Operational Satellite Programme
MIPAS	Michelson Interferometer for Passive Atmospheric Sounding
MISAWI	Meteorological Information System of the Alfred Wegener Institute
MOL-RAO	Lindenberg Meteorological Observatory – Richard Assmann Observatory
MOS	Modular Optoelectronic Scanner
MSG	Meteosat Second Generation
MTG	Meteosat Third Generation
MWP	Microwave profiler
NABAM	Nationales Basismessnetz (National Base Observing Network)
NAMD	Nationales Archiv für Maritime Daten (National Archive for Maritime Data) of the DWD
NASA	National Aeronautics and Space Administration
NDSC	Network for the Detection of Stratospheric Change
NDVI	Normalised Difference Vegetation Index
NILU	Norsk institutt for luftforskning (Norwegian Institute for Air Research)
NKGCF	German National Committee on Global Change Research
NOAA	National Oceanic and Atmospheric Administration, USA
NP	Norsk Polarinstiutt (Norwegian Polar Institute)
OECD	Organisation for Economic Co-operation and Development
ÖFS	Ökologische Flächenstichprobe (Ecological Area Sample)
OSPARCOM	Oslo-Paris Commission for the Protection of the North Sea
POP	Persistent Organic Pollutants
PSMSL	Permanent Service for Mean Sea Level
PUMA	Preparation for the Use of MSG in Africa
RADOLAN	Radar-Online-Aneichung (Radar Online Calibration, official title of the project: Routine procedure for an online calibration of radar precipitation data by means of automatic surface rain gauges/ombrometers)
RapidEye	Satellite mapping of land surface at high refresh rates
RASS	Radio Acoustic Sounding System

RAUeG	Raumfahrtaufgabenübertragungsgesetz (German Law governing the transfer of responsibilities for space activities)
RBCN	WMO Regional Baseline Climatological Network
RCS	Reference Climate Station
SAF	EUMETSAT Satellite Application Facility
SCAPP	Scanning Pyrheliometer Pyranometer
SCIAMACHY	Scanning Imaging Absorption Spectrometer for Atmospheric Cartography
SeaNet	European Workshop on Fixed Monitoring Networks in the North Sea Region
SFB	Special Research Area (Sonderforschungsbereich) of the Deutsche Forschungsgemeinschaft (DFG)
SMOS	Soil Moisture and Ocean Salinity; launch in 2007
SNDI	SeaNet Data Interface
solas	WCRP programme 'Surface Ocean - Lower Atmosphere Study'
SOLAS	International Convention for the Safety of Life at Sea
SOOP	Ship of Opportunity Programme
SPARC	WCRP project 'Stratospheric Processes and their Role in Climate'
SRTM	Shuttle Radar Topography Mission
SVGUA	Sachverständigenkreis für Globale Umweltaspekte (Expert Committee on Global Environment Issues)
SWARM	ESA mission for the surveying of the geomagnetic field with a constellation of three satellites; launch 2009
TerraSAR	German radar satellite
TESAC	GTS code for transmitting temperature, salinity, currents vs. depth
TIROS	Television and Infrared Operational Satellite
TOVS	TIROS Operational Vertical Sounder
TRACKOB	GTS code for marine surface observations along ships' tracks
UBA	Umweltbundesamt (Federal Environmental Agency)
U-MARF	EUMETSAT Unified Meteorological Archiving and Retrieval Facility
UN-ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UTC	Coordinated Universal Time
UVA	Radiation at the longer UV wavelengths
UVB	Radiation at the shorter UV wavelengths
VOC	Volatile organic compound
VOS	Voluntary Observing Ships
WCRP	World Climate Research Programme
WDC	ICSU World Data Centre
WGHC	WOCE Global Hydrographic Climatology
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WSE	Waldschadenserhebung (Forest damage survey)
WSV	Wasser- und Schiffahrtsverwaltung des Bundes (German Federal Waterways and Shipping Administration)
XBT	Expendable Bathythermograph
ZePhyD	Zentralstelle für Phytodiversität in Deutschland (Centre for Phytodiversity Germany)