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Sixth National Communication

under the United Nations Framework Convention on Climate Change – Report by the German Federal Government

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Executive Summary

This report on climate protection in Germany is the Sixth National Communication of the Federal Republic of Germany to the Conference of the Parties to the UN Framework Convention on Climate Change pursuant to Article 12 of the Convention. The federal government informs the Conference of the Parties about the state of implementation of climate protection measures in the Federal Republic of Germany. The Sixth National Communication on Climate Protection in Germany was prepared on the basis of the “UNFCCC reporting guidelines on international communications”, taking into account the review report to the Fifth National Communication of September 2011. It should be viewed in continuity with its predecessors from 1994, 1997, 2002, 2006 and 2010. This report presents German climate protection policies against the backdrop of legislative, political and socio-economic conditions, explores the effects of climate change and describes policies and measures that have been initiated to reduce greenhouse gas emissions and adapt to climate change. It also describes previous and projected effects of those measures. Finally, it reports on financial support, technology transfer, and activities in the field of education, training and public awareness. The data on which this report is based are for 2009 to 2013, depending on availability.

For the first time, Germany will also submit a Biennial Report at the same time as the National Communication in January 2014. This new format of biennial reporting was approved at the 17th Conference of the Parties in Durban in 2011. The deadline for submission of the Biennial Report coincides with submission of the National Communication for the group of industrialised countries (Annex I states), which includes Germany. The basis for reporting by the industrialised countries is the table format that was approved at the 18th Conference of the Parties in Doha. The first German Biennial Report will be published in early 2014 as an annex to this National Communication.

Climate protection policies in Germany have developed dynamically since publication of the Fifth National Communication:

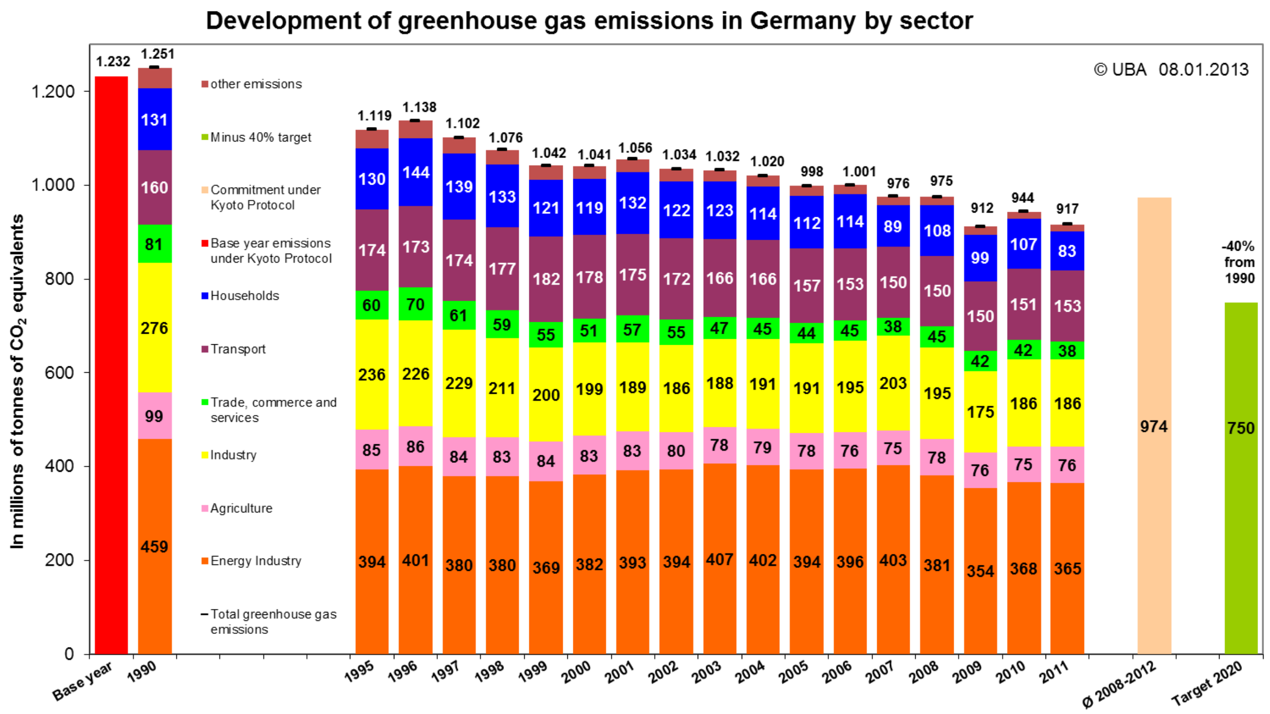
- Overall, Germany is well on its way to fulfilling the commitments it made during the first commitment period of the Kyoto Protocol (-21% on average for 2008-2012). According to the most recent National Inventory Report in 2013, emissions in 2011 were almost 26% lower than in the Kyoto base year (1990). Provisional estimates for 2012 show that emissions in Germany have fallen by more than 24% from the base year. Germany therefore achieved a total average reduction of about 24% from 2008 to 2012 compared with the base year, so it has more than fulfilled its Kyoto target. Provisional calculations indicate that greenhouse gas emissions totalling about 192 million tonnes of CO_2 equivalents were avoided during this period (2008-2012), exceeding the 21% reduction commitment.

- The federal government further increased financial support for developing countries in 2012 to fund measures to promote climate change mitigation and adaptation. This fulfils its commitment to provide new and additional financing under the Framework Convention on Climate Change.
- The German federal government set ambitious national climate protection targets in its Energy Concept of September 2010, aiming to reduce its greenhouse gas emissions from their 1990 levels between then and 2050: 40% by 2020, 55% by 2030, 70% by 2040 and 80 to 95% by 2050. The federal government's other ambitious targets for the expansion of renewable energies and increasing energy efficiency are based on those reductions. In this way, Germany intends to contribute to limiting global warming to no more than 2°C above preindustrial levels. Implementation of the Energy Concept is being supported by a monitoring process.
- In June 2011, Germany responded to the nuclear disaster in Fukushima, Japan, which showed that nuclear incidents cannot be avoided even in a high-tech country, by taking the decision to progressively phase-out of nuclear energy by 2022. The Bundestag (lower house of parliament) approved the decision by a large majority. Eight nuclear power plants have already been permanently taken off line. The Bundestag also approved a comprehensive package of measures to supplement the decisions on the Energy Concept and accelerate their implementation.
- The German term "Energiewende*"* refers to a comprehensive transformation of the energy supply in Germany. It was introduced by the Energy Concept and accelerated by the decision on the phase-out of nuclear energy. One

decisive driver of the Energiewende is the ambitious climate protection measures that are embedded in international commitments under the Kyoto Protocol and the UN Framework Convention on Climate Change.

- The effects of climate protection measures and the Energiewende are already being felt. However, current projections indicate that they are not sufficient to achieve Germany's ambitious climate protection targets. According to the federal government's 2013 Projection Report, measures that have been approved so far will be able to reduce greenhouse gases by between 33 and 35% by 2020, depending on economic developments. The Energy Concept called for a 40% reduction.

Figure 1: Development of greenhouse gas emissions in Germany by sector (not including emissions from land use, land use changes and forestry (LULUCF)



Germany is relying on a mix of measures and instruments to achieve its three energy policy targets: security of supply, affordability and environmental soundness. The regulatory framework is defined by primary and secondary legislation, and financial incentives are among the tools used to influence stakeholder behaviour. Other economic instruments, such as the European Emissions Trading Scheme, use a pricing signal to influence the actions of the relevant players. Funding programmes do their bit to support technological research, use of renewable energy and measures to eliminate impediments to and create acceptance of climate protection by providing advisory services and information and facilitating networking and public participation. Adaptation measures play an important role, as well. Germany will also fulfil its international responsibilities through financial support and technology transfer.

This report is divided into eight chapters:

1. National circumstances
2. Inventory of anthropogenic emissions of greenhouse gases
3. Policies and measures
4. Emissions scenarios and projections of the total effect of measures
5. Vulnerability, impact of climate change and adaptation measures
6. Financial support and technology cooperation
7. Research and development and systematic observation
8. Education, training and public awareness

1. National circumstances

The report contains key data that are relevant to climate protection for the following areas: legislation, population trend, geography and land use, climate and climate change, economic developments, energy, transport, buildings sector, industry, the trade, commerce and services sector, agriculture, forestry, resource efficiency and wastewater.

Protection of the natural basis for life has been enshrined as a state objective in the Basic Law (the constitution) of the Federal Republic of Germany since 1994. The Federal Republic of Germany is a federation in which legislative authority is divided between the federation and the states ("Länder") according to the Basic Law. The individual areas of environmental law are subject to concurrent legislation. This means that the Länder have the power to legislate as long as the federation does not exercise its legislative authority. However, the federation is able to influence environmental legislation and transpose EU directives related to the environment.

The term “environmental law” refers to the entire body of legislation that addresses protection of the natural environment and the preservation of ecosystems.

Germany has a population of 80.2 million. The 2011 census indicated that some 1.5 million fewer people live in Germany than was previously assumed. Germany is also undergoing demographic change. The average age of the population is rising. There has been very little research on the effects of the population trend and demographic change on climate and climate protection.

Where land use is concerned, there has been a slight decrease in agriculture and a slight increase in areas under forest. There has also been a considerable increase in the amount of land used for settlement and transport: 5.15% between 2004 and 2011. The use of land for housing has increased particularly sharply: 7.72%. The increase in land used for settlement and transport is associated with an increase in emissions that are relevant to climate and in pollution levels.

Assessment of climate trends in Germany is based on data from Germany’s National Meteorological Service (Deutscher Wetterdienst – DWD). The following general trends should be noted: the areal mean of Germany’s air temperature rose by about 1.2°C between 1881 and 2012. The decade from 1990 to 1999 was the warmest of the entire 20th century. The first few years of the 21st century were much warmer than the mean for the current climate normal period, 1961-1990 (“multi-year mean”). The temperature increase is greater in spring and autumn than in summer and winter. Changes in precipitation have also been observed in Germany. The areal mean annual precipitation in Germany has increased by about 11% since the late 19th century (1881), even though the first two decades of the 20th century were relatively dry. A seasonal analysis shows that winter precipitation (from December to February) increased considerably, by almost 50 mm or 27%, between 1881 and 2012, and less in the eastern parts of the country. However, when considering the winter trend it must be recalled that the amount of precipitation varies sharply from one year to another, which lessens the statistical significance. No pronounced overall trend can be observed for the summer; a slight decrease in summer precipitation has been measured in the states of Saxony and Saxony-Anhalt. Generally speaking, there are differences in the trends for precipitation in various parts of Germany. For example, the annual increase is for the most part limited to western Germany, while the increases during the six months of winter in the eastern Länder are mostly offset by decreases during the summer. No significant trend has been observed for wind speeds. Long series for mean wind speed indicate only a few periodic fluctuations.

Economic growth in Germany was moderate during the reporting period in light of the debt crisis; consolidation of the national budget continued, and employment rose. Worldwide growth of “green” markets has also ensured further growth for the German green tech sector, averaging 12% annually between 2007 and 2010. German green tech businesses have a 15% share of the world market. Green tech accounted for about 11% of GDP as early as 2010, with 15% predicted by 2025.[1]

Primary energy consumption in Germany has decreased slightly since the early 1990s. A portion of this effect is attributable to the determination of primary energy consumption using the physical energy content method. Improvements in efficiency are also responsible for this trend, however. The sectoral structure of final energy consumption has changed since 1990: the importance of the industry sector in total final energy consumption has declined slightly. Its share decreased from 31.4% in 1990 to 28.9% in 2012. The trade, commerce and services sector experienced a similar trend, falling slightly from 18.3% to 15.5%. In contrast, the share of private households the share of private households rose to 27%, and the transport sector climbed from 25.1% to 28.6%

A total of 33.6% of primary energy requirements was covered by oil in 2012. The corresponding figures for other fossil fuels were 20.8% for natural gas, 12.8% for coal and 11.6% for lignite. Nuclear energy met 8.7% of primary energy consumption, while renewables met 11%. The share of renewable energy in gross electricity generation rose to over 20%, while the shares of lignite, coal, and nuclear power declined. Natural gas has seen its share double since 1990.

More electricity was generated from renewables than from nuclear power for the first time in 2011. Prices for energy commodities continued to increase. Energy costs for consumers rose, both in absolute terms and as a share of household income or the value creation by trade and industry. The share of energy costs in overall economic value added has also risen. The ability of certain consumer groups to absorb the

[1] BMU, Umwelttechnologieatlas 2012

burden of energy costs may be reaching its limits, but the competitiveness and affordability of the overall energy supply have been ensured.

Transport has continued to increase in Germany since 1991. Passenger transport increased 29.7% between 1991 and 2011, with individual motor transport remaining in the dominant position. Air transport grew faster than any other type of passenger transport, at 144.2%. Passenger transport by rail also rose by 49.6%, giving it a 7.5% share in 2011. Goods transport, particularly by road, rose sharply (by 89.5%), so the share of road transport of goods in total goods transport rose to 71.5%, while the share of rail and inland waterways in total goods transport declined.

Greenhouse gas emissions from road transport declined considerably during the 1999-2009 period (-18%). The causes of this were a decrease in specific fuel consumption and increasing use of biofuels. The decrease was temporarily amplified by the 2008 economic crisis, when goods transport by road collapsed. Emissions rose again slightly after 2009 as more goods began to be transported by road. In spite of the considerable increase in goods transport and passenger transport between 1991 and 2011, greenhouse gas emissions from road transport were 4% lower in 2011 than in 1991, a major change in the trend. Overall, therefore, greenhouse gas emissions from the transport sector (not including international aviation and maritime shipping) were 6% lower than in 1991.

Requirements for energy efficiency in the buildings sector are governed by the Energy Saving Ordinance (EnEV) and the Energy Saving Act (EnEG), both of which were amended when the EU Buildings Directive was transposed into national law. The 2013 Energy Saving Act has already entered into force. The procedure for amending the 2013 Energy Saving Ordinance was completed with the cabinet decision on 16 October 2013. The German government supports energy-efficient refurbishing and construction of buildings in the context of the Energy-Efficient Construction and Refurbishment funding programmes of KfW, a government-owned development bank. New build and refurbishment projects in accordance with energy-efficiency standards that far exceed the minimum requirements of the energy-saving legislation are funded. Energy-efficiency work on some 3.1 million residences and more than 1,600 buildings at municipal level have received this type of support since 2006.

German industry as a whole was responsible for almost 21% of German greenhouse gas emissions in 2011. At the same time, it contributed 22% to gross value added. Emissions caused by the trade, commerce and service sector were far lower. In spite of a share of almost 70% in gross added value, its share of emissions was only about 4% in 2011. Protecting the climate requires considerable willingness by German industry to change and adapt, but it also offers opportunities. Increasing productivity and efficiency and reducing consumption of energy and resources offer cost advantages and can increase competitiveness.

Agriculture makes a considerable contribution to German greenhouse gas emissions. The reasons for this are primarily the use of mineral and organic fertilizers, animal husbandry in agriculture, ploughing up grasslands and draining bog lands. At the same time, agriculture is particularly affected by climate change, which can impact on crop yields.

Forests are natural sinks for carbon dioxide. They can also become emission sources when the wood removed from them exceeds regrowth. Climate change (or its impacts) can overtax the ability of forests to adapt, causing damage to them. That is why forestry is oriented to adapting to climate change.

The waste and closed cycle management system makes a major contribution to climate protection. Recycling and recovery rates have continued to rise in Germany over the past few years. The fundamental legislation governing waste management is the Closed Cycle Management Act (Kreislaufwirtschaftsgesetz) of February 2012. It establishes a clear hierarchy for dealing with waste: avoidance, preparation for reuse, recycling, other forms of recovery and disposal. Various methods for recovering biowaste and green waste also play an important role. The Closed Cycle Management Act requires biowaste and green waste to be collected separately starting in 2015. Landfilling untreated organic waste has not been allowed since 2005, thereby avoiding most emissions of methane gas from waste, which is harmful to the climate.

Efficient use of resources can make an important contribution to climate protection. The federal government included the goal of doubling the productivity of raw materials in Germany between 1994 and 2020 in its national sustainability strategy in 2002. The productivity of raw materials had risen 47% by 2010. Overall, this indicator has moved in the right direction, although the rate of increase over the past five years would not be sufficient to meet the target. Still, this indicator will have gone 82% of the way toward reaching the objective by 2020. The federal government approved the resource efficiency programme in February 2012.

Table 1: Relevant indicators for greenhouse gas emissions and sinks in Germany

Relevant indicators for greenhouse gas emissions in Germany	1990	1995	2000	2005	2010	Change 1990-2000 (%)	Change 2000-2010 (%)	Change 1990-2010(%)
Population (million)	79.4	81.7	82.2	82.5	81.8	3.53	-0.49	3.02
GDP (2006 USD billion, purchasing power parity)	2055.8	2271.4	2490.8	2556	2732.5	21.16	9.7	32.92
Primary energy consumption (Mtoe)	351.1	336.5	336.6	338.3	327.4	-4.13	-2.73	-6.75
GDP per capita (2006 USD billion, purchasing power parity)	25.89	27.8	30.3	30.98	33.4	17.03	10.24	29.02
Primary energy consumption per capita (Mtoe)	4.42	4.12	4.09	4.1	4	-7.4	-2.26	-9.49
GHG emissions not including LULUCF (Mt CO2 eq.)	1250.53	1118.59	1040.86	998.19	943.79	-16.77	-9.33	-24.53
GHG emissions including LULUCF (Mt CO2 eq.)	1214.51	1082.96	1005.79	1005.3	952.24	-17.18	-5.32	-21.59
GHG emissions per capita (t CO2 eq.)	15.75	13.69	12.66	12.1	11.54	-19.6	-8.88	-26.74
GHG emissions per unit GDP (kg CO2 eq. per 2006 USD, purchasing power parity)	0.61	0.49	0.42	0.39	0.35	-31.3	-17.35	-43.22
Energy intensity (primary energy consumption/GDP	0.17	0.15	0.13	0.13	0.11	-0.19	-0.28	-0.2
GHG intensity of energy consumption (GHG emissions*/primary energy consumption)	3.56	3.32	3.09	2.95	2.88	4.06	3.41	3.63

*GHG emissions not including LULUCF

Sources: IEA 2012: CO2 Emissions from Fuel Combustion; UBA 2013: National Inventory Report Germany.

2. Inventory of anthropogenic greenhouse gases

As a party to the Framework Convention on Climate Change, Germany has been required to prepare, publish and regularly update inventories of national greenhouse gas emissions since 1994. Germany submitted the National Inventory Report (NIR 2013), which describes the methods and data sources on which the calculations of

German greenhouse gas emissions are based, on 15 April 2013, along with the Greenhouse Gas Inventories covering the period from 1990 to 2011. The descriptions in this report are based on the 2013 National Inventory Report. It contains tables of information on the direct greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

In the context of the Kyoto Protocol, the European Community made the commitment to reduce its greenhouse gas emissions during the 2008-2012 period by 8% from the base year (1990 or 1995). That commitment was divided up among the participating EU Member States. As a result of this internal burden sharing within the EU, Germany made the commitment to reduce its emissions of all six Kyoto gases by an average of 21% per year from the base year (1990 or 1995) throughout the first commitment period (2008-2012). The commitment to reduce greenhouse gas emissions as part of EU burden sharing was fulfilled in 2011 with a 25.6% reduction from the base year. The individual greenhouse gases contributed to the change in different ways. The greatest reduction in direct greenhouse gases was for methane.

Carbon dioxide (CO_2) was the primary cause of greenhouse gas emissions in 2011, with a share of 87.1%. Its relative share rose due to the disproportionate decrease in other greenhouse gases. The reduction in CO_2 emissions is closely linked to trends in the energy sector. Emissions in all source groups of energy-related emissions fell by almost 236 million tonnes CO_2 from 1990 levels. In the transport sector, CO_2 levels fell during the period after 1999 in particular and are now below their outset level. Since 1990, N_2O emissions have decreased by about 34.2%. The main emissions sources are the use of nitrogen-containing fertilisers in agriculture, the chemical industry, use of fossil fuels, and animal husbandry in agriculture. Methane (CH_4) emissions, which are caused mainly by animal husbandry in agriculture, waste landfilling and distribution of liquid and gaseous fuels, have declined by 55.6% since 1990. Some decreases have been achieved for the F-gases group, but a further increase in overall emissions must still be anticipated.

Energy-related emissions were primarily responsible for greenhouse gas emissions in 2011, with an 83% share. Provisional estimates indicate that total greenhouse gas emissions in 2012 were 1.6% above the 2011 level, with energy-related emissions responsible for most of that.

3. Policies and measures

The federal government approved the Energy Concept in September 2010. It describes the orientation of Germany's energy policy up to 2050, specifying measures to expand the use of renewable energy sources and the grids and increase energy efficiency. The decisions on accelerating the Energiewende, Germany's energy transition, on 6 June 2011 were added to the measures contained in the Energy Concept. A total of 180 measures – legislation and funding measures – were implemented or initiated. The Energiewende is backed up by the "Energy of the future" monitoring process, which is documented in an annual report. The first Monitoring Report was published in December 2012.

The European Emissions Trading Scheme is the main multi-sectoral measure for reducing CO_2 emissions in Germany. As a climate policy instrument based on market principles, it uses a financial incentive to reduce energy consumption and increase energy efficiency while simultaneously minimizing costs. Participants in emissions trading include the energy industry, the energy-intensive industry and (since 2012) aviation.[2] The principle: relevant companies receive CO_2 allowances or, in the case of power plant operators, must buy them at auction. The allowances entitle each company to discharge a fixed quantity of CO_2. A company must buy more allowances if it causes more emissions. Conversely, a company that reduces emissions is allowed to sell its surplus allowances, thereby making a profit. Proceeds from the auctioning of emissions allowances go to an Energy and Climate Fund (EKF). They are used to fund an environmentally-friendly, reliable, affordable energy supply and for measures in the area of national and international climate and environmental protection.

Many different European and German measures also address the sectors that are relevant to climate protection: energy, buildings, transport, industry, the trade, commerce and services sector, agriculture, forestry, and water management. The most important measures include the following:

[2] Aviation has been included in the EU Emissions Trading Scheme since January 2012, but enforcement was suspended for non-European flights in the decision of 25 April 2013. Requirements for flights within the EU and other territories (such as overseas territories, accession states, and Switzerland) are not affected.

- The Renewable Energies Act (Erneuerbare-Energien-Gesetz)
- Various measures to promote electricity savings (such as the Energy Consumption Labelling Act (Energieverbrauchskennzeichnungsgesetz), minimum efficiency requirements and advice on energy)
- Regulatory measures to reduce waste inputs to landfills
- Biofuel blending
- KfW programmes for energy-efficient construction and refurbishment
- The Combined Heat and Power Act (Kraft-Wärme-Kopplungsgesetz)
- Introduction of the EU Regulation on new passenger and light commercial vehicles
- The Energy Saving Ordinance (EnEV)

The National Climate Protection Initiative (NKI), which was introduced in 2008 and expanded by the Energy Concept, makes an important contribution to fulfilling German targets for climate protection. Its aim is to tap existing potential for emission reductions in a cost-effective way and to move ahead with innovative climate protection programmes and projects. The new Energy Efficiency Fund is another supporting measure that began in 2011.

The initiatives of the Länder and local authorities also come into play. All 16 German Länder have their own concepts, programmes, plans, or laws on climate protection. Many local authorities have also actively set targets and are developing their own climate protection concepts and measures.

4. Emission scenarios

Based on current projections, the federal government assumes that measures that have been approved and implemented so far can reduce greenhouse gases by up to 35% by 2020. Current projections indicate that a series of additional measures will be needed if the 40% target is to be met.

The projections being presented are based on the 2013 Projection Report, which the federal government sent to the European Commission on 15 March 2013. A consortium of German research institutes developed scenarios for the development of greenhouse gas emissions in Germany for the report. The scenario analyses included a detailed analysis of measures initiated up to October 2012 on the basis of applicable law, looking at their effects on the development of greenhouse gas emissions in Germany (“with measures” scenario). This included emissions of the greenhouse gases covered by the Kyoto Protocol (carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6)) which are related to the source sectors energy, industrial processes, product use, agriculture and waste management. Land use changes and forestry were not included in the analyses.

The 2013 Projection Report also includes a “with additional measures” scenario that takes into account the effect of other conceivable instruments related to climate and energy (or corresponding targets). That scenario is not described in this report.

An energy system model and an emissions calculation model are used to develop the scenario by consolidating the results of detailed sectoral analyses, some based on models, into consistent figures for energy demand and greenhouse gas emissions. Those models are fully compatible with the German greenhouse gas inventories (as of the date of the 2012 Inventory Report). Specific studies were done for space heating and hot water, electrical appliances, industry, the trade, commerce and services sector, transport, electricity generation from renewable energies and fossil electricity generation, as well as for fugitive emissions in the energy sectors (process-related CO_2, CH_4 and N_2O emissions). The results of other studies were used or adapted for other source areas (HFCs, PFCs and SF_6 emissions).

A reduction of 32.8% from 1990 to 2020 results for all greenhouse gas emissions (not including land use, changes in land use and forestry) in the “with measures” scenario. Relatively constant, optimistic growth was assumed for the economy, based on the projected growth rates contained in the preliminary version of the OECD Economic Outlook 2012/1. A sensitivity analysis for the assumptions on economic development (annual average growth rate about 0.3 percentage points lower up to 2020) was therefore done in the Projection Report. It shows that this change in the basic assumptions for the emission levels could result in differences on the order of 23 to 24 million tonnes of CO_2 equivalents for 2020. Compared with the emission level for

1990, emission reductions of 34.8% would therefore be achieved by 2020 under the "with measures" scenario.

5. Vulnerability, impact of climate change and adaptation measures

Climate change influences nature and the environment. They can also have harmful effects on people and negatively impact on national economies. The projections indicate that there will be further changes to the climate and that some of the impacts of these changes can already be foreseen. Prompt adaptation to the impacts of climate change is therefore an increasingly important pillar of the climate policy. The German Strategy for Adaptation to Climate Change (DAS) created the legal framework for a national adaptation process in 2008. The goal of the adaptation strategy is to reduce vulnerability to the impacts of climate change and to maintain the ability of natural, societal and economic systems to adapt. The federal cabinet passed the Adaptation Action Plan of the Strategy for Adaptation to Climate Change in August 2011, an important milestone in implementation of the DAS. It contains selected projects and cooperative efforts with the Länder. Important activities include sharing knowledge and providing information, having the federal government set the framework (including for financial incentives), making adaptation to climate change part of evaluations of publicly-owned buildings and infrastructure and fulfilling international responsibilities.

6. Financial support and technology cooperation

In 2012, the German government further increased its funding to support developing countries in reducing greenhouse gases, adapting to the effects of climate change, and promoting forest conservation. Technology transfer and capacity building are components of virtually all the government's international cooperation projects. In this way, the government is meeting its commitments under the United Nations Framework Convention on Climate Change to provide new and additional funds. At the Conference of the Parties in Copenhagen at the end of 2009, the industrialised countries pledged to provide additional public funds amounting to USD 30 billion for 2010 to 2012 in what is known as fast-start finance for developing countries. The federal government contributed some €1,289 billion. The federal government is also providing financial support for bilateral and multilateral measures covering diverse subject areas related to climate change mitigation and adaptation all over the world.

In the area of international cooperation, Germany has increased financing for climate protection projects in developing countries, emerging economies and transition countries. This work has emphasized areas such as climate policy, national reduction strategies, renewable energies, increasing energy efficiency, adaptation to the effects of climate change and conservation of forests and biodiversity (including REDD+) and has had major positive effects on both climate change mitigation and adaptation.

Multilateral cooperation takes place under the Global Environment Facility (GEF), the Adaptation Fund (AF), the Climate Investment Funds (CIFs) and the Forest Carbon Partnership Facility (FCPF) of the World Bank.

7. Research and development and systemic observation

Many ministries in Germany and their associated institutions fund research into subjects such as renewable energy, energy efficiency, sustainable mobility, sustainability, climate change and adaptation to climate change. The research activities are very diverse and include the following:

- Climate system, variability and interactions in the Earth system
- Observation and data management
- Climate impact research
- Energy and mitigation research, including technological research
- Adaptation to climate change and assessing climate impacts
- Socio-economic research on the causes and effects of climate change

Application-based research into technology associated with renewable energy, energy efficiency, electricity and heating grids, energy storage units, CO_2 capture, innovative power plants, energy-efficient construction and mobility play an important role in supporting implementation of the Energiewende, Germany's energy revolution. The German government presented its sixth energy research programme, “Research for an environmentally sound, reliable and affordable energy supply” in 2011. The programme sets out the basic principles and priorities of its funding policy for the next years and represents an important cornerstone for implementation of the Energy Concept and the Energiewende. The federal government emphasizes four areas in funding research and development in the energy sector:

Focusing funding on particularly innovative energy technologies that promise long-term success, which are important for the transition to a sustainable energy supply in Germany

- Interministerial cooperation in selected areas of strategic importance such as energy storage, grids and construction
- International cooperation
- Increased consultation and coordination, for example through the coordination platform on energy research policies

Another research area is estimating future climate developments and the associated impacts. Applied research into adaptation to the impacts of climate change is based on this.

8. Education, training and public awareness

The federal government supports sustainable development through targeted education activities. A number of concepts and projects have been developed to promote environmental education in schools and within vocational training. Many educational projects in Germany also receive funding under the National Climate Protection Initiative.

The federal government supports climate protection and the Energiewende, Germany's energy transition, through public campaigns, providing material to inform and raise people's awareness. Communication and dialogue make members of the public aware of the need for an active climate policy. At the same time, they learn about areas where they themselves can take action.

Active public awareness work is also an integral part of funding programmes and projects related to climate protection. Almost all projects involving national and international climate protection, the Energiewende or mobility are supported with professional communications services.

1. National circumstances

1.1. Germany’s system of government

1.1.1. Environmental protection as a state objective

Since 1994 protection of natural resources has been enshrined as a state objective in Article 20a of the Basic Law of the Federal Republic of Germany, which refers to them as the “natural foundations of life”.

1.1.2. Government structure

The Federal Republic of Germany is a federation of 16 states (“Länder”). The Basic Law governs the division of responsibilities between the federation and the Länder. The administrations of the Länder are generally organised in three levels: Land (state) government, regional councils (Regierungspräsidien), and administrative districts (Landratsämter) or urban districts (Stadtkreise). As a rule, the Länder decide for themselves how their administrations are to be structured.

The German government and the Länder cooperate on environmental policy in specific working groups such as the Working Group on Climate and Sustainability (BLAG KliNa), which is made up of representatives of federal and Land government. Federal-Land summits to implement the Energiewende, Germany’s transition to a new energy era, have been held twice a year since 2012 at the invitation of the Chancellor.

An Undersecretaries’ Committee on Sustainable Development (Staatssekretärsausschuss für nachhaltige Entwicklung) is responsible for implementation and further development of aspects of the national sustainability strategy spanning multiple sectors. All of the ministries are represented on the Committee, which is chaired by the head of the Chancellor’s Office. It is the second-ranking decision-making federal government body after the cabinet where sustainability issues are concerned. Its work primarily involves further development of the sustainability strategy.

1.1.3. Legislation and enforcement

Legislative authority is shared between the federation and the Länder. The federation has exclusive powers of legislation in certain areas allocated to it under the Basic Law. The federation has the power of concurrent legislation when uniform regulation is necessary.

The individual areas of environmental law are subject to concurrent legislation. This allows the federation to influence environmental legislation and to transpose EU directives related to the environment into national law.

All federal laws are submitted to the Bundestag and the Bundesrat, with some laws requiring “acts of consent” and some requiring “acts of objection”, depending on their content. Stalemates frequently occurred in the past when majorities in the Bundestag and Bundesrat differed. The aim of the 2006 reform of Germany’s federalist system was therefore to distribute legislative authority more clearly between the federation and the Länder.

The Länder have primary responsibility for the enforcement of laws. They implement Land laws and most Federal laws pursuant to Article 83 of the Basic Law. Exceptions to this under which the federal administration enforces laws include those relating to the Foreign Service, the German Federal Tax Administration, the German Federal Border Police, or the German Federal Waterways Administration.

1.2. Population profile

1.2.1. Population trend and demographic change

Germany has a population of 80.2 million, according to the 2011 census. Demographic change is taking place in Germany, and the average age of the population is increasing. The German Federal Statistical Office (Statistisches Bundesamt) did a population projection[3] in 2009 which determined how the population and age structure would change up to 2060 based on various assumptions. The working-age dependency ratio is the ratio of the number of senior citizens (above age 65) to the number of people of working age (20 to 65 years). That ratio was 0.34 in 2008, and it will be between 0.63 and 0.67 by 2060, depending on

[3] Federal Statistical Office 2009.

the extent of immigration. Even if the retirement age is raised to age 67, the working-age dependency ratio will be much higher in 2060 than it is today.

There were 40.4 million private households in 2011, of which 20% included minor children. The average household in 2009 consisted of 2.04 people. That is projected to fall to 1.95 people in 2020 and 1.88 people in 2030.

Table 1: Development of private households by household size through 2030 (trends variant), Germany

	Total	Single-person households	Multi-person households with ... people				Average household size
Year	**(all figures in 1 000)**		**2**	**3**	**4**	**5 and up**	
2009	40 188	15 995	13 741	5 139	3 887	1 426	2,04
2015	40 700	16 687	14 419	4 765	3 553	1 275	1,99
2020	41 044	17 118	14 991	4 468	3 303	1 164	1,95
2025	41 144	17 486	15 337	4 143	3 098	1 080	1,91
2030	41 020	17 799	15 487	3 827	2 905	1 001	1,88
Percent							
2009	100	39,8	34,2	12,8	9,7	3,5	
2015	100	41	35,4	11,7	8,7	3,1	
2020	100	41,7	36,5	10,9	8	2,8	
2025	100	42,5	37,3	10,1	7,5	2,6	
2030	100	43,4	37,8	9,3	7,1	2,4	

Source: Federal Statistical Office 2011b

Germany’s population increased by 196,000 (+0.2%) year-on-year in 2012, according to the Federal Statistical Office (Destatis), reaching 80.5 million people at the end of the year. As in previous years, the number of births was well below the number of deaths. The main cause of the population increase was high immigration numbers, as was the case in 2011.[4]

[4] Federal Statistical Office, press release 283 of 27 August 2013.

1.2.2. Effects on greenhouse gas emissions

There has been only limited research on the effects of the increasing average age, the population trend, and regional differences in demographic change on the trend for greenhouse gas emissions and on climate protection in Germany.

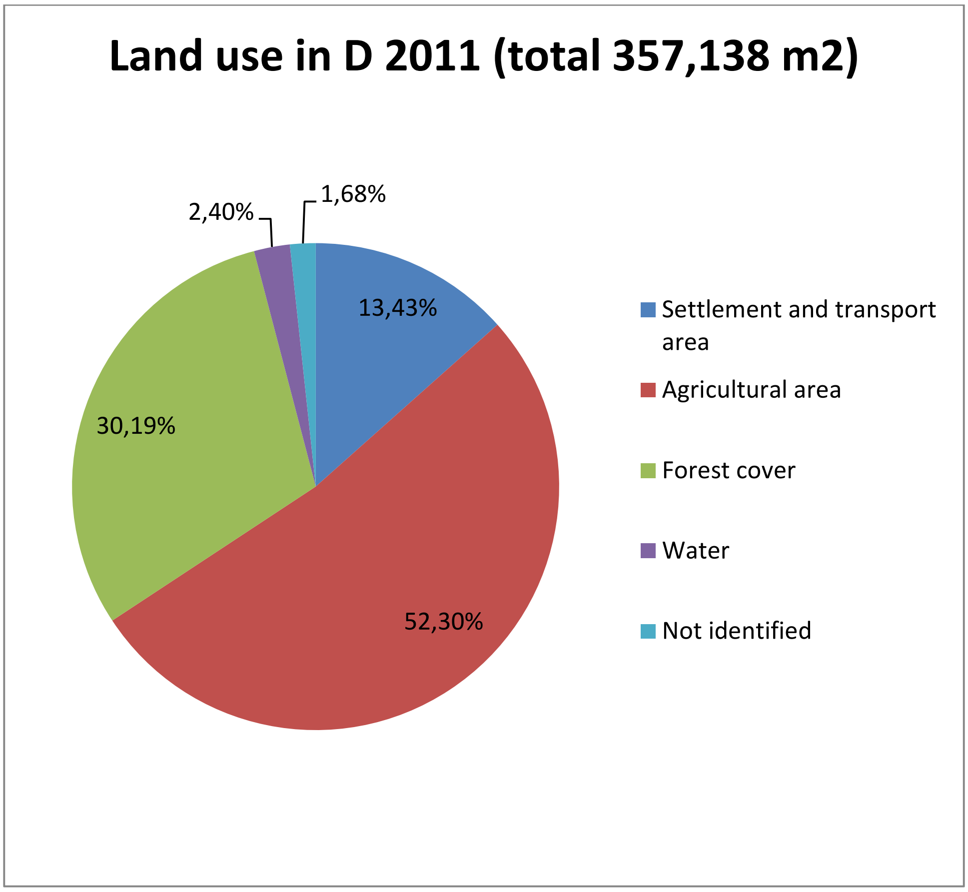
As part of the federal government's interdisciplinary funding initiative "Social Dimensions of Climate Protection and Climate Change", scientists in the CLIMAGE[5] project are investigating how climate protection policies can be configured in aging societies. Research is being done on how an aging society will respond to the challenge of investing in a future from which they will not be able to benefit. The objective of the "EMIGMA – Empowerment of Migrants in the Area of Climate Protection" project is to investigate the environmental behaviour and attitudes of Turkish and Russian speaking immigrants and to increase their active involvement in climate protection.

1.3. Geography and land use

The total area of Germany was 357,138 km^2 in 2011.[6] Agricultural land (including bog and heath land) accounted for a total of 52.3% (186,771 km²). This means that Germany's agricultural land area decreased by 1.3 percentage points compared with 2004. In contrast, the area under forest increased by 1.2 percentage points from the 2004 level. In 2011, 30.2% of Germany was covered by forest (107,814 km²). Only 2.4% of the country's total area (8,576 km²) is covered with water. Compared with 2004, the area covered by water has increased by 297 km², largely as a result of flooding and renaturing of former sand, gravel and lignite extraction sites.

[5] Heidelberg University Clinic.
[6] Federal and Länder Statistical Offices, 2013.

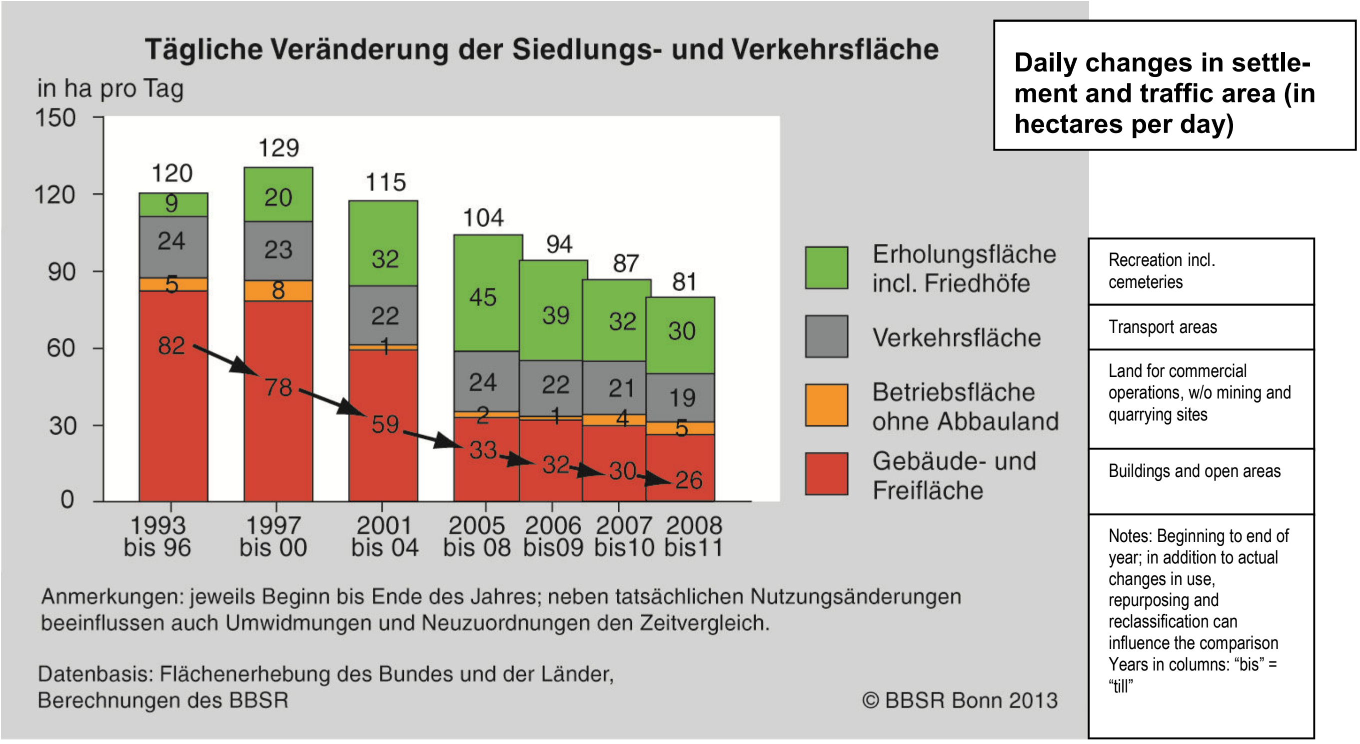
Figure 2: Land use in Germany 2011



Source: Federal and Länder Statistical Offices 2013, our own calculations

The land used for settlement and transport (referred to below as settlement and transport area) amounted to 13.4% of the total area of Germany (47,971 km²) in 2011. This is an increase of 5.15% or 2,350 km² since 2004. Settlement and transport area spread by 115 hectares (ha) daily during the 2001-2004 period, while the daily increase for 2008-2011 was only about 81 ha (see Figure 2). Even if the trend for the past few years continued, that would not be sufficient to meet the German federal government's target of reducing the increase in settlement and transport area to 30 ha per day by 2020.

Figure 3: Daily changes in settlement and transport area



Source: Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), Bonn 2013

Table 2: Increase and decrease in land use for settlement areas

Increase and decrease in use of settlement areas

by type of use 2004-2011

Type of use	Incr./Decr.
Settlement area	
Buildings and open space	**3.08%**
Buildings and open space, residential	7.72%
Buildings and open space, trade and industry	4.18%
Commercial operations	**-1.47%**
Commercial operations, mining and quarrying sites	-7.99%
Recreation	**30.42%**
Green areas	40.88%
Traffic area	**3.13%**
Roadways, paths and squares	1.03%
Agricultural space	**-1.35%**
Bog	3.72%
Heath	39.15%

Increase and decrease in use of settlement areas

by type of use 2004-2011

Type of use	Incr./Decr.
Forested areas	**1.25%**
Water	**3.59%**
Other uses	**-19.94%**
Cemeteries	2.73%
Waste land	19.70%

Source: Federal Statistical Office 2013a[7]

1.3.1. Effects on greenhouse gas emissions

At this time there are no reliable conclusions from research on the effects of increased use of land for transport and settlement on greenhouse gas emissions.

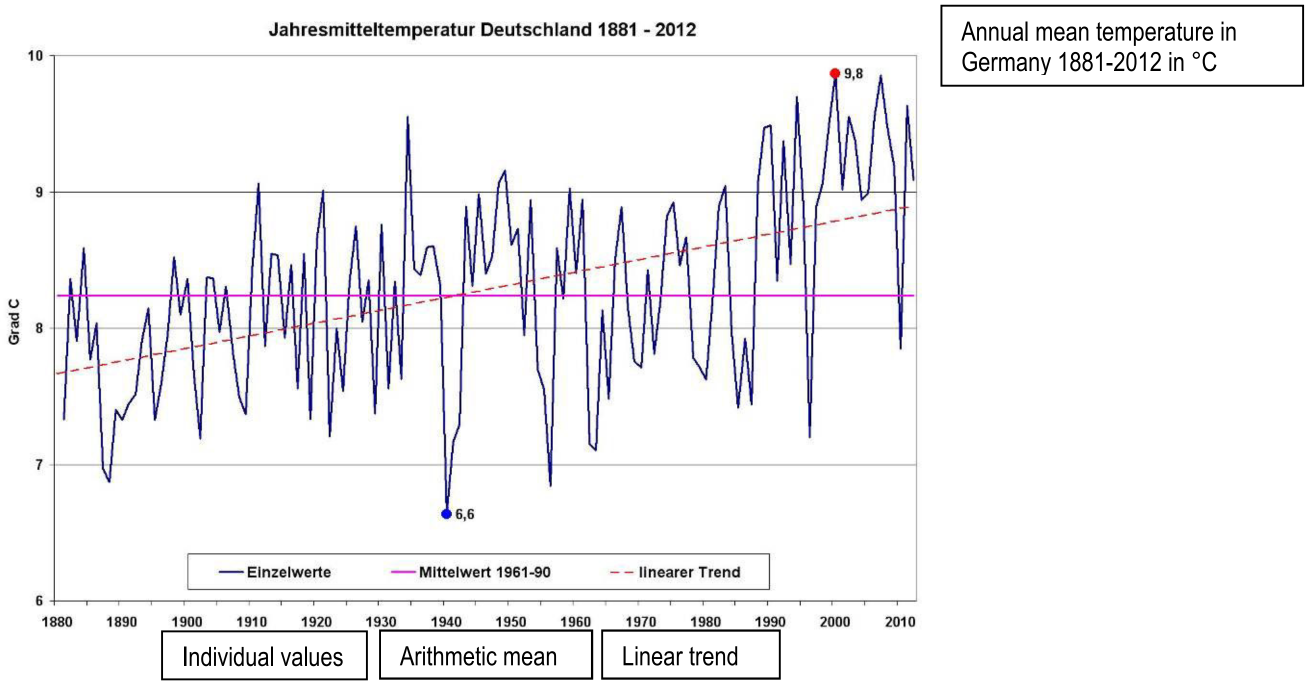
1.4. Climate and climate change in Germany

The climate is generally described using the same factors as for weather, such as temperature, precipitation, wind, humidity, and radiation. The combination of weather patterns over a prolonged period at a specific location or in a larger area is referred to as climate.

The Deutscher Wetterdienst (DWD), the German Meteorological Service – as the successor of earlier meteorological services – has over 150 years of experience in observing the weather and the climate. One of the longest well-documented climate series began as early as the late 18th century. To increase the reliability of the available information, since 2005 DWD has been supplementing its basic daily digital data by systematically digitalizing historic weather records. The data for the early 19th century is primarily based on records kept by interested amateurs, but the introduction of meteorological services led to the creation of a uniform observation network (at least in some places), so measurements are also representative beyond the individual location.

[7] Federal Statistical Office 2013a. The terms are taken from "Verzeichnis der flächen bezogenen Nutzungsarten im Liegenschaftskataster und ihrer Begriffsbestimmungen" (1991 version) of the Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland (Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany) (AdV-Nutzungsartenverzeichnis).

Figure 4: Annual mean temperature in Germany



Source: DWD 2013

The areal mean of Germany's air temperature rose by about 1.2°C between 1881 and 2012 (linear trend; see Figure 4). The decade from 1990 to 1999 was the warmest of the entire 20th century. The first few years of the 21st century were much warmer than the mean for the current climate normal period, 1961-1990 ("multi-year mean"). The observed temperature increase since 1882 has been particularly high in the southern and western parts of Germany, with the exception of the state of Baden-Württemberg. The average annual temperature in the German states Rhineland-Palatinate and Saarland rose by almost 1.4°C. Temperatures in north-eastern Germany have increased somewhat less since 1881, for example by about 1.1°C in the state of Mecklenburg-Western Pomerania. The temperature increase is greater in spring and autumn than in summer and winter.

Changes in precipitation have also been observed in Germany. The areal mean annual precipitation in Germany has increased by about 11% since the late 19th century (1881). A seasonal analysis shows that winter precipitation (from December to February) increased considerably, by almost 50 mm or 27%, during the 132 years between 1881 and 2012, and less in the eastern parts of the country. However, when considering the winter trend it must be recalled that the amount of precipitation varies sharply from one year to another, which lessens the statistical significance. No pronounced overall trend can be observed for the summer; a slight decrease in summer precipitation has been measured in the states of Saxony, Saxony-Anhalt, and Thuringia. Generally speaking, there are differences in the trends for precipitation in various parts of Germany. For example, the annual increase is for the most part limited to western Germany, while the increases during the six months of winter in the eastern Länder are mostly offset by decreases during the summer. No significant trend has been observed for wind speeds. Long series for mean wind speed indicate only a few periodic fluctuations.

It is also difficult to arrive at reliable conclusions for extreme weather events. A clear trend can be discerned only for the number of hot days on which the maximum temperature exceeds 30°C. The mean frequency for Germany's areal mean has risen from 3 to 8 days per year since 1951. The frequency with which various precipitation limits are exceeded has increased slightly, but those trends cannot be considered statistically significant due to their great variability over time and in different places. The trend for storm activity shows a development similar to that for mean wind speed, without a major trend being apparent.

1.5. Economic development

1.5.1. National economic indicators[8]

The German economy grew by 0.7% in 2012, losing momentum continuously over the course of the year. The primary causes were a noticeable cooling of the world economy and uncertainty among market participants due to the high level of debt in industrialized countries, which massively inhibited the German economy's willingness to invest. Growth of about 0.5% is forecast for 2014. The federal government expects inflation-adjusted gross domestic product (GDP) to grow by 1.6% in 2013 (figures as of April 2013). The primary assumption for the debt crisis is that there will be no further negative developments and that the financial sector will remain stable. The national budget regarding net lending/borrowing was balanced in 2012. The German federal government will stick to its growth-friendly consolidation policy plan in coming years for both the 2014 federal budget and the financial plan up to 2017. The federal government will comply with the debt rule – a structural deficit of no more than 0.35% of GDP – by 2013.

[8] BMWi 2013.

German companies are very well positioned in the international growth markets, and their competitiveness is outstanding. They remain highly innovative thanks to research and development.

Net borrowing went down from -4.1% of GDP in 2010 to a slight surplus of 0.1% in 2012. Public spending as a percentage of GDP is down slightly. Solid public budgets and economic growth are not a contradiction in Germany, but are mutually reinforcing.

1.5.2. Employment by economic sector

There were 41.6 million gainfully employed people in Germany in 2012, another record for employment.[9]

Some 28.9 million people held jobs subject to social insurance contributions in 2012, the most in 20 years. The cornerstones of the social market economy – collective bargaining autonomy, open labour markets, and equal opportunity – contributed to this. The rate of employment for women has increased sharply and was over 71% during the second quarter of 2012. Employment among people between the ages of 55 and 64 also grew considerably, to 61% during the second quarter of 2012. These trends on the labour market are due among other things to labour market reforms, reliable working conditions, and moderate wage agreements.

Most of the total of 41.6 million gainfully employed people in Germany (30.6 million) worked in the service sector in 2012. It has again grown year-on-year, this time by more than 300,000. The corporate services sector has experienced particularly strong growth. It employed slightly more than 4.7 million people in 2007, rising to 5.4 million in 2012. More than 7.8 million people were employed in industry, primarily manufacturing. This does not include construction, a separate sector that employs almost 2.46 million people. Some 670,000 people worked in agriculture, forestry, and fisheries in 2012. About 37 million of the country's 41.6 million-strong-workforce were in employment agreement in 2012.

[9] BMU 2013.

1.5.3. Green economy

Green economy is an integrated economic strategy for countering the global megatrends of climate change and increasingly heated competition for resources and for making progress towards sustainable development. The challenge is to promote ecological modernization of the economy by using energy and materials (resources) more efficiently, using more renewable energy sources, and developing a modern recycling system that closes most material cycles.

This will require the use of “green technologies”. Worldwide growth of “green” markets has also ensured significant growth for the German green tech sector, averaging 12% annually between 2007 and 2010. German green tech providers have a 15% share of the world market. Green tech accounted for about 11%[10] of GDP as early as 2010, with 15% predicted by 2025.[11]

An international comparison of German companies in the green economy sector:[12]

- Environmentally-friendly power generation: German manufacturers’ share of the world market for biogas power plants was around 90%, with 25% for wind energy, 23% for solar thermal, and 21% for photovoltaics.
- Energy efficiency: German companies’ share of the world market is more than 10%.They have a 15% share of the world market for heating and air conditioning, as well as for measurement, control, and regulation technology. Their share of the electric motors, thermal insulation, and white goods sectors is 10%.
- Material efficiency: At 11%, German has the largest total share of world market. It is a leader in various technologies and in the midrange in some cases.

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10 Calculation: A market volume of €282 billion was calculated for the green tech industry in Germany (six main markets: energy efficiency, sustainable water management, environmentally-friendly power generation and storage, sustainable mobility, material efficiency, and waste management and recycling) for 2010. Germany’s GDP in 2010: €2,497.6 billion. Green tech’s share: approximately 11.3%.

11 BMU, Environmental Technology Atlas 2012.

12 BMU, UBA 2011. As in the Environmental Technology Atlas, six main markets are defined as green economy markets: energy efficiency, sustainable water management, environmentally-friendly power generation and storage, sustainable mobility, material efficiency, and waste management and recycling. Those market segments are also used when making comparisons with other countries.

- Sustainable mobility: Germany’s share of the total world market is about 18%. German companies produce some 50% of the world’s filter and catalytic converter systems. Germany is the leading product developer in some less advanced markets such as fuel cell technology. A series of research and development projects involving the second generation of biofuels are being conducted in Germany.
- Waste management and recycling: Germany’s share of the world market for waste management and recycling systems is approximately 24%. Germany has a 66% share of the automatic material separation market.
- Sustainable water management: Germany’s share of the world market is around 10%. Its share of the world market for increasing efficiency and for decentralized water management is particularly high at 20%. At 17%, Germany is second only to the United States in world trade in the products used for water treatment and waste water technology.

1.5.4. Effects on greenhouse gas emissions

In preparation for the 2013 German Projection Report, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) commissioned a research consortium to prepare scenarios for the development of greenhouse gas emissions in Germany from 2005 to 2030. For economic development, the scenarios assumed relatively constant, optimistic growth up to 2030 based on the projected growth rates contained in the preliminary version of the OECD Economic Outlook 2012/1. That projection is more optimistic than other projections (see section 4.3.2). It was impossible to include official data published later (after June 2012) during the modelling activities for the 2013 Projection Report. The official data shows slower economic growth for 2012, which tends to correspond to the low-growth scenario described in this report.

A sensitivity analysis for the assumptions on economic development (annual average growth rate about 0.3 percentage points lower up to 2020) was therefore done in the Projection Report. It shows that this change in the basic assumptions for the emission levels could result in differences on the order of 23 to 24 million tonnes CO_2 equivalent for 2020 or from 32 to 37 million tonnes CO_2 equivalent for 2030.

Compared with the emission level for 1990, emission reductions of 34.8% would therefore be achieved by 2020 under the “with-measures scenario”. The somewhat lower rate of economic growth would lead to a 45% reduction in emissions by 2030.

1.6. Energy

1.6.1. Changes due to the Energiewende

In the Energy Concept of September 2010 and the energy policy decisions of June 2011, the federal government set the objective of converting Germany into an energy-efficient, environmentally-friendly national economy while ensuring competitive energy prices and a high level of prosperity. This objective necessitates extensive changes in the way energy is generated and used. It offers opportunities for innovation, growth and employment.

The initial successes of the Energiewende, Germany’s transition to a new energy era, can already be seen: energy consumption in Germany is declining, and the reduction targets under the Kyoto Protocol have more than been fulfilled in spite of a slight increase in greenhouse gas emissions in 2012.[13] The power supply is reliable, even though eight nuclear power plants were permanently taken off line in 2011. Finally, the foundation has been laid for accelerated expansion of the grid.

The increasing energy costs remains a challenge. The primary causes are rising prices on world markets for petroleum, natural gas, and hard coal, with the first two reaching unprecedented levels in 2012. An increase in the surcharge for electricity under the German Renewable Energy Sources Act (EEG surcharge) has also contributed to the increase in the price of electricity.

The trends mentioned here are described in greater detail in the sections below, as well as in Chapter 3.

The German federal government publicises current information on the progress and development of the German transition to a new energy era once a year. Those reports are published at the end of each year for the previous year. The first Monitoring Report, “Energy of the future”, was published in December 2012 and

[13] UBA 2013a. Provisional data.

covers 2011.[14] A more extensive progress report will be published every three years, for the first time in 2014.

1.6.2. Energy consumption by sector and type of energy source

The consumption of conventionally generated energy almost always pollutes the environment. Preventing and reducing energy-related environmental pollution requires a detailed analysis of energy consumption. Primary energy consumption is an important indicator. Primary energy consumption is the net balance of domestically produced energy and energy traded with other countries minus marine bunkers and taking into account changes in inventory. It includes both primary and secondary fuels.[15]

Primary energy consumption in Germany has decreased slightly since the early 1990s (see Figure 5). This effect is to some extent attributable to the determination of primary energy consumption using the physical energy content method. Energy sources (including biogenic) that are to be combusted are assessed on the basis of the quantities used and their calorific value. When generating electricity from wind, hydropower, and photovoltaics, it is agreed that their energy conversion efficiency is 100%, while the efficiency of geothermal is 10% and the efficiency of nuclear energy is 33%. As a result of this calculation method, the previous expansion of renewable energy sources (assessed by definition as having a conversion efficiency of 100%) leads to lower primary energy consumption by squeezing out other energy sources with a lower conversion efficiency. Improvements in efficiency regarding energy use are also responsible for this trend, however.

Provisional data indicates that primary energy consumption was 13,745 petajoules (PJ) in 2012,[16] slightly higher than for the previous year.

According to the Working Group on Energy Balances (AGEB), primary energy consumption at 13,599 PJ[17] in 2011 reached its lowest level since the early 1970s

[14] Available at http://www.bundesnetzagentur.de/cln_1911/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutio-
tio-
nen/MonitoringEnergiederZukunft/ErsterMonitoringbericht/erstermonitoringberichtundoeffentlichediskussion-node.html.

[15] First Monitoring Report, “Energy of the future”, 2012.

[16] AG Energiebilanzen e.V., 08/2013.

and was 5% lower than in 2010. The relatively mild weather in 2011 considerably influenced the consumption trend. High energy prices were another major factor. According to AGEB, energy consumption in 2011 would have fallen by only 1% if it had been adjusted for temperature effects. The permanent shut-down of eight nuclear power plants in 2011 reduces the calculated consumption by about 0.5%. Other major factors caused consumption to rise in 2011: production by the manufacturing industry increased 9%, and inflation-adjusted gross domestic product rose 3%.[18]

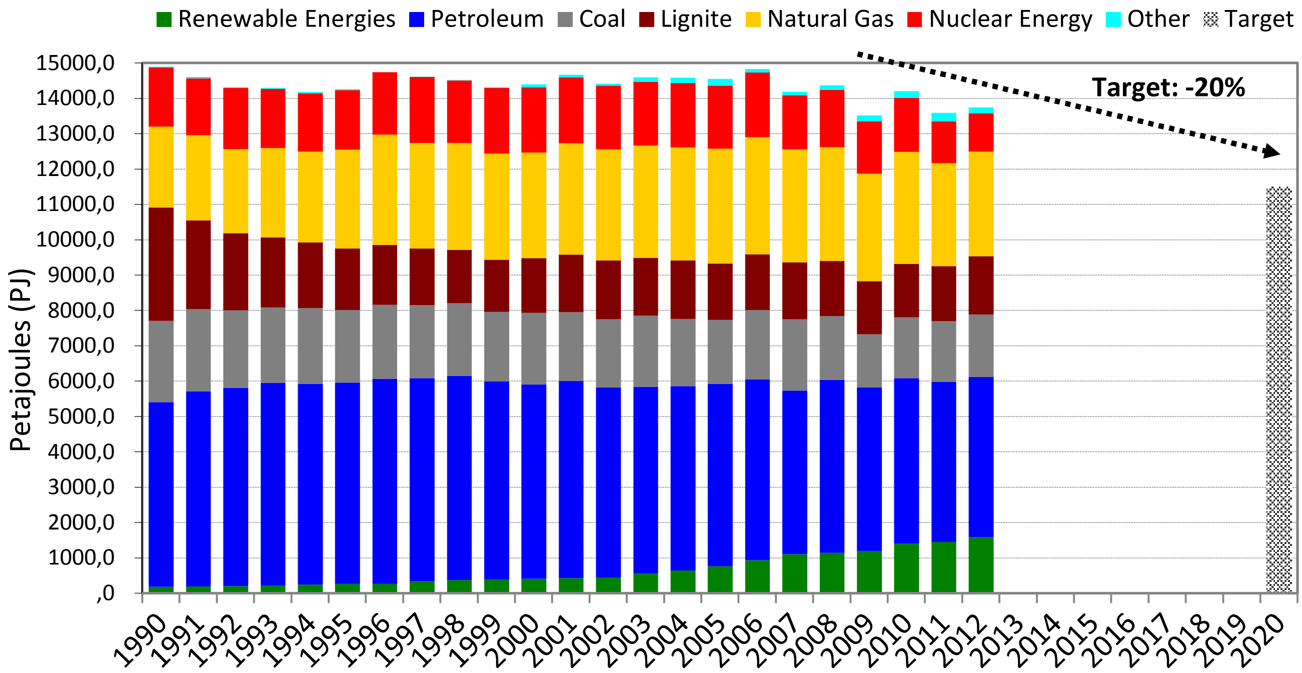
The sectoral structure of final energy consumption has changed since 1990: the importance of the industry sector has declined slightly. Its share in total final energy consumption decreased from 31.4% in 1990 to 28.9% in 2012. The trade, commerce and services sector experienced a similar trend, falling from 18.3% to 15.5%. In contrast, the share of private households rose to 27%, and the transport sector climbed from 25.1% to 28.6%.

The final energy sectors accounted for 65.5% of total primary energy consumption in 2012, while non-energy-related consumption accounted for 7.1%. Over 27% of primary energy consumption consisted of losses and consumption to generate and supply electricity and other secondary energy sources, such as district heating or vehicle fuels.[19]

A total of 33% of primary energy requirements was covered by petroleum in 2012. The corresponding figures for other fossil fuels were 21.5% for natural gas, 12.9% for hard coal and 12% for lignite. Nuclear energy covered 7.9% of primary energy consumption. The greatest shifts in energy sources since 1990 are a 44% decrease in consumption of lignite and a 40% increase in consumption of natural gas.[20]

[17] Ibid.
[18] See First Monitoring Report, “Energy of the future”, 2012.
[19] AGEB 2012, Table 1.
[20] Ibid., Table 3.

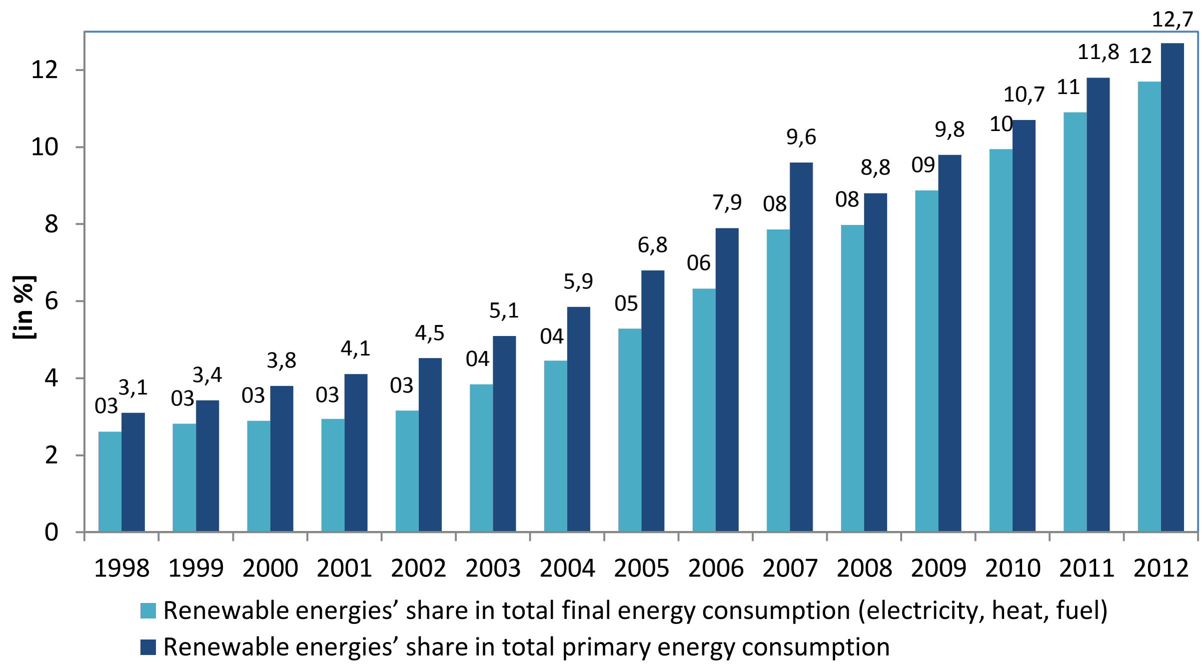
Figure 5: Primary energy consumption by energy source (in petajoules)



Source: AG Energiebilanzen e.V.: Tables evaluating energy balances, Table 4

Renewable energies – including hydropower, wind energy, biomass, photovoltaics and geothermal - have rapidly multiplied their share in primary energy consumption, rising from 1.9% in 1995 to 11.7% in 2012.

Figure 6: Renewable energies' share in total primary and final energy consumption



Source: AGEE-Stat 2013, AGEB e.V., 2013

1.6.3. Electricity generation by energy source

It is estimated that gross electricity generation in Germany was 628.7 TWh in 2012.[21] After factoring in the power exchange balance of imports, (-23.1 TWh), gross domestic electricity consumption was therefore 605.6 TWh (2011: 606.8 TWh). This report includes data up to the end of 2012.

Gross electricity generation in Germany increased continuously by around 12% or almost 72 TWh between 1990 and 2012. Gross electricity consumption increased by 8% or 43 TWh.[22] Since 1990, electricity consumption has increased most in the transport sector, by 21%, followed by the trade, commerce and services sector at 20%, households at 17% and the industrial sector at 9%.[23] In terms of the absolute shares of the sectors, industry consumes the most electricity (43%), followed by the trade, commerce and services sector (27%), private households (26%) and transport (3%).

The share of the energy sources used for gross electricity generation has changed considerably since 1990 (see Table 3: 3). Most noteworthy is the increase in renewables from 4.5% to 23.5% and the decline of the fossil fuels lignite and hard coal along with nuclear energy from a total of almost 85% in 1990 to 60% in 2012. The use of natural gas to generate electricity doubled during the same period. More electricity (123.5 TWh) was generated from renewables than from nuclear power for the first time in 2011.[24] A total of 142.1 TWh of electricity was generated from renewable energy sources in 2012, ten percent more than in 2011.

Table 3: Energy sources' share in gross electricity generation in Germany [%]

	1990	**2011**
Lignite	31.1	24.7
Nuclear power	27.7	17.7
Coal	25.6	18.5
Natural gas	6.5	13.5
Petroleum products	2.0	1.1
Renewable energies	3.6	20.3
Other energy sources	3.5	4.2
Source: AG Energiebilanzen e.V., Gross electricity generation in		

[21] AGEB 2013.
[22] Ibid.
[23] AGEB 2012.
[24] AGEB 2013.

Germany from 1990 to 2012 by energy source, 2/2013 version

The share of renewable energy sources in gross electricity consumption was 4.7% in 1998 and continued to rise throughout the period under consideration. A strong upward trend has been observed since entry into force of the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz – EEG), from 6.8% in 2000 to 20.5% in 2011 and 22.9% in 2012. Their share thus increased sharply by more than 2 percentage points from 2011 to 2012. Wind energy contributed the most to this in 2012, at 7.1% and 46 TWh, followed by biomass, which includes the biogenic portion of waste and accounted for a total of 6.9% of gross electricity consumption or 40.9 TWh. Photovoltaics increased to a record share of 7% or 28 TWh of gross electricity consumption, while hydropower, at 3.6% or 21.2 TWh, increased slightly from the previous year's level for the first time due to the weather. In spite of some growth, at 25 GWh geothermal still had the smallest share. Inputs of these energy sources to generate electricity between 1990 and 2011 declined overall by 2% as gross electricity generation increased. The reason is the improved fuel efficiency of these energy sources. This indicator shows the efficiency of different types of power plants. The total gross fuel efficiency of Germany power plants improved from 39 to 42% between 1990 and 2011.[25]

[25] UBA calculations based on AGEB and DBEW.

Table 4: Electricity generation from renewable energy sources, 1998 to 2012 [in GWh]

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012*	
Hydroelectric power[1)]	17,216	19,647	21,732	22,733	23,124	17,722	20,095	19,638	20,008	21,170	20,443	19,031	20,953	17,671	21,793	
Geothermal energy	0	0	0	0	0	0	0	0	0	0	18	19	28	19	25	
Wind power	4,489	5,528	9,513	10,509	15,786	18,713	25,509	27,229	30,710	39,713	40,574	38,648	37,793	48,883	50,670	(since 2009 onshore+offshore)
Biomass[2)]	1,642	1,849	2,893	3,348	4,089	6,603	8,218	11,102	14,793	19,832	23,121	26,255	29,561	32,848	38,650	
Biogenic fraction of waste[3)]	1,618	1,740	1,844	1,859	1,949	2,238	2,253	3,252	3,907	4,531	4,671	4,323	4,746	4,755	4,900	
Photovoltaic	35	30	60	76	162	313	557	1,282	2,220	3,075	4,420	6,583	11,729	19,599	26,380	
Total	25,000	28,794	36,042	38,525	45,110	45,589	56,632	62,503	71,638	88,321	93,247	94,858	104,810	123,775	142,418	
Share in gross electricity consumption [%]	4.5	5.2	6.2	6.6	7.7	7.6	9.3	10.2	11.6	14.2	15.1	16.3	17.0	20.4	23.5	
Share in primary energy consumption[4)] [%]	2.6	2.8	2.9	2.9	3.2	3.8	4.5	5.3	6.3	7.9	8.0	8.9	9.9	10.9	11.6	

[1)] For pumped storage power plants, only power generated from natural flow.

[2)] Until 1998, only feed-in to the general supply grid. Information after 2003 also includes industrial electricity generation from liquid biomass, including vegetable oil.

[3)] Share of biogenic waste estimated to be 50% in waste incineration plants.

[4)] Primary energy consumption calculated using the efficiency method.

Source: BMU- E I 1, according to Working Group on Renewable Energies (AGEE-Stat): Erneuerbare Energien in Zahlen - Nationale und internationale Entwicklung (Renewable Energies in Figures - National and International Development), Internet update, July 2013

Table 5: Energy inputs for electricity generation [in PJ], production and consumption in Germany from 1990 to 2012 [TWh]

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Primary energy inputs for electricity generation[1)] (in PJ)																							
Coal	1,270	1,354	1,285	1,323	1,308	1,332	1,370	1,281	1,365	1,273	1,268	1,231	1,200	1,230	1,182	1,161	1,234	1,259	1,083	943	1,012	961	1,007
Lignite	1,731	1,634	1,562	1,484	1,458	1,455	1,433	1,392	1,346	1,335	1,420	1,507	1,537	1,507	1,487	1,458	1,433	1,475	1,416	1,369	1,364	1,410	1,491
Biomass and renewable waste[2)]	64	62	61	61	70	60	65	70	86	84	56	48	48	41	50	78	92	111	112	113	120	131	137
Nonrenewable waste, waste heat, etc.	0	0	0	0	0	0	0	0	0	0	40	36	28	50	48	68	75	84	82	88	95	85	87
Other renewable energies	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heating oil	108	125	112	80	78	84	79	68	69	65	71	78	73	78	84	92	76	71	72	77	63	51	60
Gases	435	416	368	362	414	431	454	477	490	489	481	489	505	524	535	590	627	648	703	615	681	636	564

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Of which: natural gases[3)]	336	326	282	282	327	346	374	384	395	396	396	402	411	436	450	504	532	528	600	548	581	543	474
Hydroelectric power, wind power, photovoltaic and other plants[4)]	58	53	62	64	67	104	94	98	99	110	149	146	168	202	247	277	351	460	514	549	611	706	792
Nuclear energy	1,663	1,608	1,732	1,674	1,649	1,681	1,763	1,858	1,763	1,855	1,851	1,868	1,798	1,800	1,822	1,779	1,826	1,533	1,623	1,472	1,533	1,178	1,085
Total	5,329	5,252	5,183	5,047	5,045	5,148	5,258	5,244	5,218	5,211	5,335	5,403	5,357	5,431	5,455	5,503	5,712	5,641	5,606	5,226	5,480	5,158	5,223
Electricity production (in TWh)																							
Total gross electricity generation	550	540	538	527	529	537	553	552	557	556	577	586	587	609	618	623	640	641	641	596	633	613	629
Electricity imports	32	30	28	34	36	40	37	38	38	41	45	44	46	46	44	53	46	44	40	41	42	50	44
Electricity consumption (in TWh)																							
Electricity exports	31	31	34	33	34	35	43	40	39	40	42	45	46	54	52	62	66	63	63	55	60	56	67
Losses, own consumption, pumping electricity consumption	96	91	88	87	85	84	82	80	82	80	85	91	87	90	93	96	96	95	94	86	88	86	86
Net electricity consumption	455	449	445	441	446	458	465	469	475	477	494	494	500	510	517	518	524	526	524	495	527	521	519
Of which: industry	208	194	189	180	185	190	188	195	199	201	208	208	209	219	225	228	229	236	233	200	222	227	226

[1)] Calculations based on the physical energy content method

[2)] From 1995 to 1999, waste and other biomass; from 2000 to 2002, biomass and renewable waste, non-renewable waste, waste heat, etc.

[3)] Natural gas, petroleum gas and pit gas from mines.

[4)] Wind power from 1995 including photovoltaics. After 2003 including feed-ins from renewables.

Source: AG Energiebilanzen e.V., Auswertungstabellen zur Energiebilanz für die Bundesrepublik Deutschland 1990 bis 2012 (Evaluation tables for the energy balance for the Federal Republic of Germany), version: 08/2013 (provisional data for 2012)

AG Energiebilanzen e.V., Bruttostromerzeugung in Deutschland von 1990 bis 2012 nach Energieträgern (Gross electricity generation in Germany from 1990 to 2012 by energy source), version: 08/2013

1.6.4. Energy prices

Energy costs for consumers have risen both in absolute terms and as a share of household income or the value creation by trade and industry. The share of energy costs in the overall creation of value has increased. Nonetheless, the competitiveness and affordability of the overall energy supply have been ensured. The price of electricity is higher in Germany than in other countries in Europe and the rest of the world. However, no direct effect on prices as a result of the decisions in favour of the Energiewende, the transition to a new energy era, in 2011 can be observed.

<u>Energy raw materials and emissions allowances</u>

The prices of the energy raw materials oil, natural gas, and hard coal have increased since the turn of the century, due among other things to increased international demand. Prices fell by more than 30% for a short time after the world economic crisis in 2008 and then rose sharply again.

Oil and gas prices were again at a historically high level in 2012. The OPEC Basket Price per barrel of oil rose slightly, averaging $109.49/bbl (import price: €646.62/t). The German border price for natural gas rose year-on-year by 12% to €8.129/TJ. In contrast, the price of importing coal into Germany declined 13% to €93.02/t tce from the 2011 level due to lower world demand.

A clear downward trend can be observed for the prices of EU emissions allowances (EEX spot market) due to a surplus of allowances. The annual average price for 2012 was €7.68/tonne CO_2, which is €5.29/tonne CO_2 lower than in 2011. Prices declined further to less than €4/tonne CO_2 in March 2013 and then rose slightly.

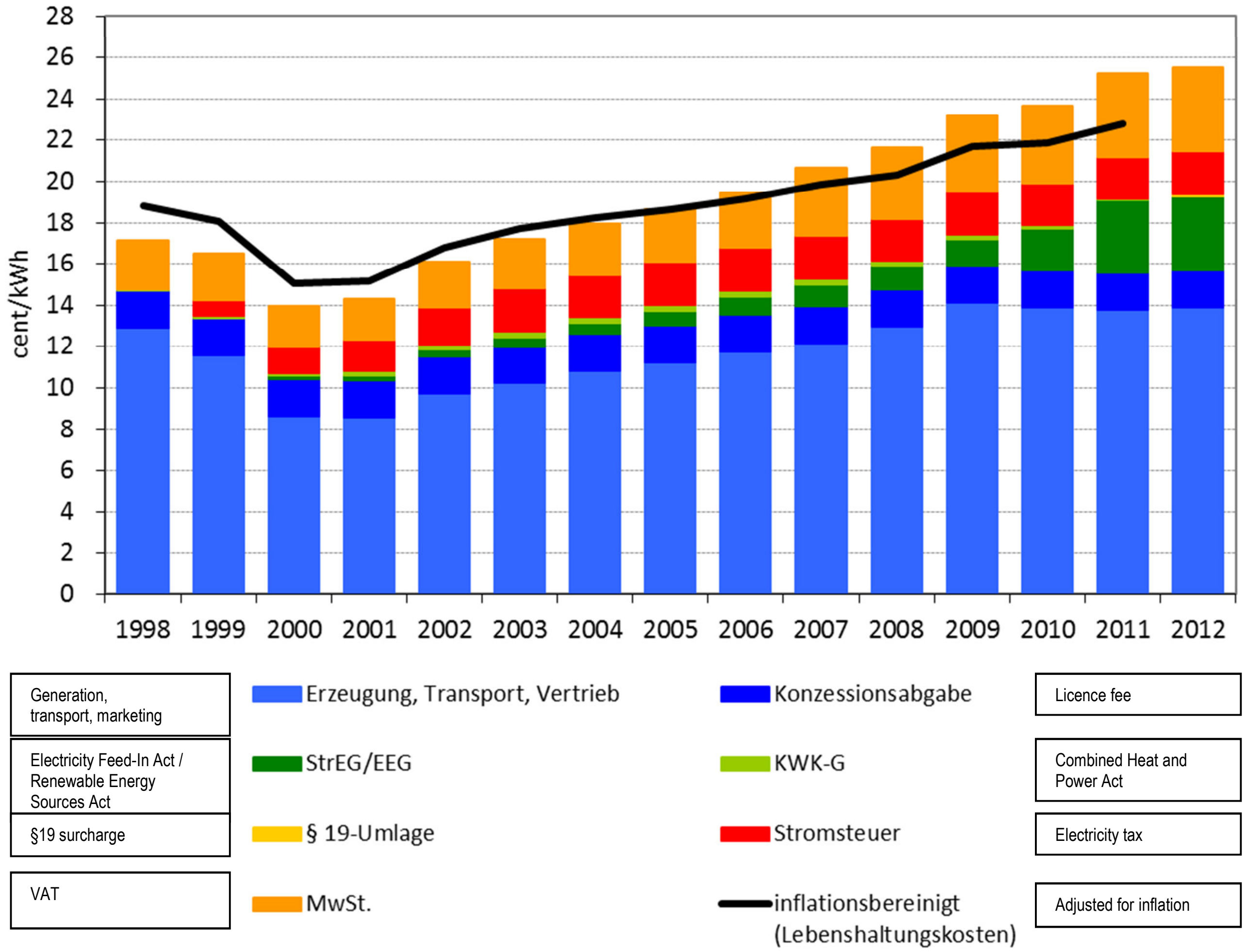
These European and international price trends are important drivers of energy price and cost trends for end consumers in Germany. The price of natural gas for households rose to 7.03 euro cents/kWh in 2012. The average price of gas for commercial and industrial customers was 3.97 euro cents/kWh in 2012. Prices of petroleum products also rose by as much as 11%. The average household price for light heating oil in 2012 was €88.8 /100l; for super petrol it was €1.65 /l. The price of diesel fuel rose to €1.49/l. Unlike in the case of gas, prices of petroleum have risen in the past few years even after adjusting for inflation.

Electricity

The annual average wholesale price of electricity on the EEX exchange in Leipzig (futures market) fell by 7% to €52.16/MWh compared with 2011. The falling trend in wholesale prices since the second half of 2011 continued in 2013 at an average of €42.66/MWh (January-February). Changes in the wholesale price affect the prices paid by end consumers, subject to a time lag.

The annual average for household electricity prices rose by 0.66 euro cents/kWh (2.6%) to 25.89 euro cents/kWh from the 2011 level (for consumption of 3,500 kWh/year, including taxes and surcharges). Over the past few years, the main influence on the electricity prices paid by residential customers has been rising price components imposed by the government. Commercial and industrial customers who are not eligible for exemptions from taxes and surcharges experienced trends for taxes, charges, and other price components imposed by the government which were similar to those for households. Electricity prices for commercial and industrial customers that did not receive favourable treatment remained at the 2011 level of 14.02 euro cents/kWh (BDEW - German Association of Energy and Water Industries: medium-voltage supply with consumption between 100 kW/1,600 h and 4,000 kW/5,000 h, including electricity tax). The price increase in these consumption sectors is more moderate after 1998 if an adjustment is made for inflation.

Figure 7: Electricity prices for household customers



Source: BDEW

These electricity prices for customers in trade and industry do not apply to companies that are intensive users of electricity. Large electricity consumers may benefit from different types of relief if they fulfil the relevant criteria. Accordingly, electricity prices may be significantly lower for those customers. There are no statistical surveys for this consumer segment, and the actual prices vary considerably. The federal government's Monitoring Report on "Energy of the future" assumes prices of 5.5 euro cents/kWh for large-scale-customers. This means that electricity prices for large-scale customers rose nominally by 0.1 euro cents/kWh to 5.5 euro cents/kWh and declined slightly after adjusting for inflation.

1.6.5. Effects on greenhouse gas emissions

Energy-related emissions were primarily responsible for greenhouse gas emissions in 2011, with an 83%[26] share. Energy-related emissions refers to emissions of greenhouse gases and air pollutants that are released by converting energy sources into electrical or thermal energy (electricity and heat production). Energy-related emissions are produced when generating electricity and heat in power plants. In the industrial sector, they are the result of certain industrial processes. In the household and small-scale consumer sector, energy-related emissions primarily result from using fossil fuels for heating. Combustion of solid, liquid or gaseous biomass is assessed as CO_2-neutral in accordance with international balancing requirements, although other conventional air pollutants such as nitrogen oxides are balanced. In the transport sector, energy-related emissions come from the exhaust of internal combustion engines. Diffuse emissions from agriculture, abandoned landfills or mines, are not included among energy-related emissions.

Energy-related emissions of direct and indirect greenhouse gases are primarily influenced by the economic situation in an industrialized country such as Germany. Such emissions are strongly dependent on the mix of energy sources that is used, the efficiency and mode of operation of the fossil fuel power station fleet, the efficiency of other technologies that are used, and – given the need for heating – weather conditions.

Initial provisional calculations and estimates by the German Environmental Agency (UBA) indicate that total greenhouse gas emissions in 2012 rose 1.6% from the previous year. A total of about 931 million tonnes of carbon dioxide equivalents (CDE) were released in 2012, 14 million tonnes more than in 2011. The increase is primarily due to CO_2 emissions, which are up by 2%. The reason is that more lignite and hard coal was burned to generate electricity and more natural gas was used for heating due to the weather. However, further expansion of renewables made it possible to limit the increase in emissions. The decline in nuclear energy was offset by renewable energy sources. Further efforts will be needed to pave the way for the transition to a climate-friendly energy supply.

[26] UBA 2013b.

1.7. Transport

1.7.1. Transport services (passenger and goods transport)

The trend for transport since 1991 is characterized by a moderate increase in passenger transport services (measured in terms of billions of passenger kilometres, Table 6) and a significant growth in goods transport (measured in terms of tonne-kilometres, Table 7).[27] Passenger transport increased 29.7% between 1991 and 2011. Individual motor transport increased 28.5%, remaining in the dominant position. Its share in total passenger transport fell only slightly, from 81.6% to 80.8%. Air transport grew faster than any other type of passenger transport. Passenger transport by air via Germany increased 144.2% from 1991 to 2011. As a result, its share in all passenger transport rose from 2.6 to 4.9%.

Public road passenger transport declined by 4.7% during the same period. Its share in all passenger transport services declined as a result from 9.3% to 6.9%. Passenger transport by rail increased dramatically by 49.6%. Its share in all passenger transport therefore rose from 6.5% in 1991 to 7.5% in 2011. Overall, the shares of public passenger transport by road and by rail, which are less energy-intensive, remained between 14% and 16% during the relevant period.

Table 6: Motorized passenger transport in Germany, measured in billions of passenger-kilometres (1991-2011)

Year	Railways	%	Road-based public transport	%	Air transport	%	Individual motor transport	%	Total
1991	57	6.5	81.6	9.3	22.6	2.6	713.5	81.6	874.7
1992	57.2	6.4	80.4	9	25.6	2.9	731.5	81.8	894.8
1993	63.4	7	79.6	8.7	27.7	3	740.8	81.3	911.5
1994	65.2	6.6	77.5	7.8	30	3	821.4	82.6	994
1995	71	7	77	7.6	32.5	3.2	830.5	82.2	1011
1996	71.7	7.1	76.7	7.6	33.6	3.3	831.8	82	1013.8
1997	72.4	7.1	76.2	7.5	35.8	3.5	833.4	81.9	1017.9
1998	72.7	7	75.7	7.3	37.5	3.6	845.3	82	1031.2
1999	73.8	7	76.2	7.2	39.9	3.8	866.7	82	1056.5
2000	75.4	7.2	77.3	7.4	42.7	4.1	849.6	81.3	1045.1
2001	75.8	7.1	77	7.2	41.9	3.9	872	81.8	1066.7
2002	70.8	6.6	75.7	7.1	40.8	3.8	880.3	82.5	1067.6
2003	71.3	6.7	75.8	7.1	43.3	4.1	875.6	82.1	1066.1

27 The German term used here, “Verkehrsaufwand” is equivalent to the German term “Verkehrsleistung”.

Year	Railways	%	Road-based public transport	%	Air transport	%	Individual motor transport	%	Total
2004	72.9	6.7	82.8	7.6	48.4	4.4	887.1	81.3	1091.2
2005	76.8	7.1	82.5	7.6	52.6	4.8	875.7	80.5	1087.6
2006	79	7.2	81.8	7.4	55.6	5.1	882.6	80.3	1099
2007	79.1	7.2	81.3	7.4	58.8	5.3	883.4	80.1	1102.6
2008	82.5	7.4	79.6	7.2	60.8	5.5	888.5	79.9	1111.4
2009	82.3	7.4	78.6	7	58.4	5.2	898.7	80.4	1117.9
2010	84	7.5	78.1	7	52.8	4.7	902.4	80.8	1117.3
2011	85.3	7.5	77.8	6.9	55.2	4.9	916.6	80.8	1134.9

Source: BMVBS 2012

Goods transport increased continuously from 1991 to 2008 to over 651 billion tonne-kilometres (tkm). It decreased by more than 10% in 2009 due to economic trends, but by 2011 had returned to nearly the 2008 level as a result of the economic recovery.

Goods transport increased by 62.8% during the entire period (1991-2010). Air transport, which more than tripled, experienced the greatest growth, although this started from a very low level.

Road transport increased by 89.5% during the same period. The share of goods transported by road therefore increased from 61.4% in 1991 to 71.5% in 2011. This resulted in part from the increase in transit traffic – on which Germany has no influence under international treaties – due to the fall of the “Iron Curtain” and the eastward expansion of the EU.

The share of the more energy-efficient rail and inland waterway transport fell from 34.6% to 25.8% between 1991 and 2008. Freight trains, at least, have increased their share slightly since 2004.

Table 7: Goods transport in Germany, measured in billions of tonne-kilometres (1991-2011)

Year	Railways	%	Inland waterways	%	Road	%	Pipelines	%	Air transport	%	Total
1991	82.2	20.6	56	14	245.7	61.4	15.7	3.9	0.4	0.1	400
1992	72.8	18.3	57.2	14.4	252.3	63.3	15.7	3.9	0.4	0.1	398.5
1993	65.6	16.8	57.6	14.7	251.5	64.3	16.1	4.1	0.5	0.1	391.2
1994	70.7	16.7	61.8	14.6	272.5	64.5	16.8	4	0.5	0.1	422.3
1995	70.5	16.3	64	14.8	279.7	64.9	16.6	3.8	0.5	0.1	431.3
1996	70	16.4	61.3	14.4	280.7	65.7	14.5	3.4	0.5	0.1	427.1
1997	73.9	16.4	62.2	13.8	301.8	66.8	13.2	2.9	0.6	0.1	451.6
1998	74.2	15.8	64.3	13.7	315.9	67.2	14.8	3.1	0.7	0.1	469.9
1999	76.8	15.5	62.7	12.6	341.7	68.8	15	3	0.7	0.1	496.9

Year	Railways	%	Inland waterways	%	Road	%	Pipelines	%	Air transport	%	Total
2000	82.7	16.2	66.5	13	346.3	67.7	15	2.9	0.8	0.2	511.3
2001	81	15.7	64.8	12.6	353	68.5	15.8	3.1	0.7	0.1	515.3
2002	81.1	15.7	64.2	12.4	354.5	68.7	15.2	2.9	0.8	0.2	515.8
2003	85.1	15.7	58.2	10.7	381.9	70.5	15.4	2.8	0.8	0.1	541.4
2004	91.9	16.1	63.7	11.2	398.4	69.8	16.2	2.8	1	0.2	571.1
2005	95.4	16.4	64.1	11.1	402.7	69.4	16.7	2.9	1	0.2	580
2006	107	17.2	64	10.3	435.7	69.9	15.8	2.5	1.2	0.2	623.7
2007	114.6	17.6	64.7	9.9	454.1	69.8	15.8	2.4	1.2	0.2	650.5
2008	115.7	17.7	64.1	9.8	457.6	69.9	15.7	2.4	1.4	0.2	654.3
2009	95.8	16.4	55.5	9.5	415.6	71.1	15.9	2.7	1.3	0.2	584.2
2010	107.3	17.1	62.3	9.9	441.9	70.2	16.3	2.6	1.4	0.2	629.2
2011	113.3	17.4	55	8.4	465.6	71.5	15.6	2.4	1.5	0.2	651.1

Source: BMVBS 2012

1.7.2. Fleet of motor vehicles

A total of 50.9 million vehicles were registered in the centralized registry of the Federal Motor Transport Authority (KBA) in 2011, including 42.3 million passenger cars, 3.8 million motorcycles, and 2.6 million trucks and tractors. When mopeds and other small motorized bikes and scooters for which registration is not required are included, the fleet of motor vehicles in Germany totals 52.9 million vehicles.[28]

Following a change to the KBA vehicle registry in 2008, vehicles whose registration has been provisionally cancelled are no longer included in the reported fleet. This means that data after 2008 is no longer comparable with data for 1991-2007 and must be analysed separately. However, it is clear that the fleet of motor vehicles in Germany has increased constantly (Table 8). It rose by 27.8% from 1991 to 2007 and increased 3% during the 2008-2011 period based on the new definition. The number of passenger cars increased by 26.6% from 1991 to 2007 and by another 2.7% from 2008 to 2011. In 2011, 27% of passenger cars had a diesel engine, while only 12% did in 1991. If diesel cars' large share (2011: 47%) of new registrations continues, their share in the total fleet will continue to grow in coming years.

The number of trucks increased much faster than the number of passenger cars: by 55.6% from 1991 to 2007 and by 4% during the 2008-2011 period. Due to their powerful engines and the long distances they travel, trucks are responsible for a disproportionate amount of the emissions caused by motor vehicles. The fleet of two-

[28] Federal Ministry of Transport, Building and Urban Development (BMVBS) 2012

wheeled motorcycles also increased considerably (1991-2007: 58%; 2008-2011: 6%; see Table 8).[29]

Table 8: Vehicle fleet

Year	Saloon and estate cars	Motorised two-wheelers	HGVs and semi-tractor trailers	Other motor vehicles	Total
1991	36.8	3.7	1.8	2.6	**44.9**
1992	37.9	4	2	2.5	**46.4**
1993	38.9	3.9	2.1	2.4	**47.3**
1994	39.8	3.8	2.2	2.5	**48.2**
1995	40.4	3.9	2.3	2.5	**49.2**
1996	41	4.2	2.4	2.5	**50.1**
1997	41.4	4.4	2.5	2.5	**50.7**
1998	41.7	4.6	2.5	2.5	**51.2**
1999	42.3	4.9	2.6	2.5	**52.4**
2000	42.8	5.1	2.7	2.5	**53.1**
2001	43.8	5	2.8	2.5	**54.1**
2002	44.4	5.2	2.8	2.5	**55**
2003	44.7	5.2	2.8	2.5	**55.2**
2004	45	5.4	2.8	2.5	**55.7**
2005	45.4	5.6	2.8	2.6	**56.3**
2006	46.1	5.7	2.8	2.2	**56.7**
2007	46.6	5.9	2.8	2.2	**57.4**
2008 (*)	41.2	5.6	2.5	2.1	**51.3**
2009	41.3	5.9	2.5	2.1	**51.8**
2010	41.7	5.9	2.6	2.1	**52.3**
2011	42.3	5.9	2.6	2.2	**52.9**

(*) After 2008, not including vehicles with provisionally cancelled registrations.

Source: BMVBS 2012

1.7.3. Fuel consumption

Sales of fuel (all liquid and gaseous fossil fuels and biofuel) for the entire transport sector (not including maritime shipping) increased 6% during the 1991-2011 period. Trends differed for land-based and air transport.

[29] Ibid.

Absolute fuel consumption for land-based transport[30] increased from 1991 to 1999. After sharp decreases until 2005, consumption has now stabilized. Sales of fuel in 2011 were 11.3% lower than in 1999. Consumption through 2011 decreased 0.7% based on the 1991 level.

Decreases in the specific fuel consumption of motor vehicles have been partially offset by growing transport volumes – particularly road transport of goods – and by a trend toward larger and more powerful vehicles.

The most important reasons for the decreases in fuel consumption since 1999 include improved fuel efficiency of new automobiles as a result of optimizing engines and various vehicle technologies, along with a sharp increase in the number of diesel cars, which are relatively fuel efficient, among newly registered vehicles. A major factor in this success is the EU policy to reduce CO_2 emissions of new cars and new light commercial vehicles as set forth in the EU CO_2 Regulations (443/2009/EC and 510/2011/EC respectively). The German passenger car label for new vehicles, which was revised in 2011, provides information about a vehicle's energy efficiency and fuel consumption, thereby encouraging the purchase of more efficient cars. Environmental tax reform has contributed to the trend toward more fuel-efficient vehicles. It has also led to an increase in refuelling in other countries, which has reduced fuel sales in Germany.

The trends for sales of different types of fuel vary greatly. Sales of diesel fuel increased by 55% from 1991 to 2011, while petrol sales declined sharply, by 38%. Gaseous fuels have experienced strong growth over the past five years, but their share in fuel consumption is still relatively low (2011: 1.5%). Biofuels' share in road transport fuel in Germany in 2011 was around 5.5%. In contrast to the trend for fuels used for road, rail and inland waterway transport, consumption of aviation fuel (kerosene) increased by 23% from 1999 to 2011. Total sales of aviation fuel therefore increased by 81% between 1991 and 2011. Aviation fuel now accounts for 16% of total fuel sales, up from 9%.

[30] Road traffic, rail traffic, and inland waterways; does not include aviation.

1.7.4. Effects on greenhouse gas emissions

The trend for greenhouse gas emissions from transport (Table 9) is to a great extent determined by the trend for emissions for road transport. In the classification used by the U.N. Framework Convention on Climate Change, emissions by road traffic are responsible for more than 95% of transport emissions, because air transport includes only national aviation and shipping includes only inland waterways (the international components of air transport and shipping are recorded for purposes of information only). Railways are responsible for very few emissions. The CO_2 emissions that result from producing electric power for the railways (indirect emissions) are not included.

Changes in greenhouse gas emissions by road transport for the most part track changes in energy consumption (see 0), since CO_2 is the dominant greenhouse gas in the transport sector and CO_2 emissions are directly related to the consumption of fossil fuels. Greenhouse gas emissions by road transport increased 13% from 1991 to 1999. Energy consumption and therefore CO_2 emissions due to rail transport and shipping during the same period declined considerably and national air transport increased only slightly, so the increase in greenhouse gas emissions for all types of transport was somewhat less at 12%.

Greenhouse gas emissions from road transport declined considerably during the 1999-2009 period (-18%). The causes of this were a decrease in specific fuel consumption and increasing use of biofuels. The decrease was temporarily amplified by the 2008 economic crisis, when goods transport by road collapsed. Emissions rose again slightly after 2009 when more goods began to be transported by road again. In spite of the considerable increase of more than 60% in goods transport and more than 30% in passenger transport, greenhouse gas emissions from road transport were 4% lower in 2011 than in 1991, a major change in the trend.

The conversion of the railways from diesel to electric traction and technical and operational improvements in efficiency led to much greater reductions in emissions. Greenhouse gas emissions by rail transport declined by 59% from 1991 to 2011.

The decrease in emissions by inland waterways transport during the 1991-2011 period was similar to the decrease for rail transport (-63%). As was the case for rail traffic, the cause was improvements in efficiency and increased refuelling in other countries.

Overall, therefore, transport (not including international aviation and maritime shipping) was responsible for emissions of about 153 million tonnes of carbon dioxide equivalent (CDE) in 2011, 6% less than during base year 1991. Transport accounted for 17% of all greenhouse gas emissions.

Table 9: Trend for greenhouse gas emissions in 1,000 tonnes of CO_2 equivalent (1991-2011)

Year	Road transport	Rail transport(*)	Inland waterways	National air transport	Total	International air transport (**)
1991	156,269	2,603	2,097	2,144	163,113	12,054
1992	162,265	2,568	2,237	2,019	169,088	13,224
1993	166,839	2,573	2,283	1,903	173,598	14,206
1994	163,329	2,397	2,232	1,909	169,866	14,833
1995	167,477	2,322	1,764	1,947	173,510	15,406
1996	167,512	2,333	1,620	2,015	173,480	161,551
1997	168,392	2,158	1,282	2,172	174,004	16,692
1998	171,777	2,035	1,173	2,162	177,147	17,236
1999	177,218	1,923	957	2,226	182,325	18,587
2000	173,232	1,937	888	2,351	178,408	19,721
2001	169,669	1,772	854	2,219	174,514	19,289
2002	167,583	1,642	745	2,133	172,102	19,188
2003	161,255	1,608	777	2,098	165,737	19,548
2004	161,081	1,515	868	2,064	165,529	21,378
2005	152,981	1,350	959	2,173	157,462	23,315
2006	149,030	1,272	835	2,298	153,436	24,474
2007	145,941	1,245	833	2,363	150,382	25,382
2008	145,769	1,219	759	2,365	150,112	25,672
2009	145,499	1,067	829	2,242	149,637	24,969
2010	146,858	1,088	834	2,081	150,861	24,723
2011	149,354	1,069	773	1,858	153,054	23,792

(*) Not including emissions from electricity generated for railways
(**) For information

Development of greenhouse gas emissions in 1,000 t CO2 equivalents (1991-2011)
Source: UBA 2013c

1.8. Buildings sector – heating and cooling

1.8.1. Energy Saving Ordinance (EnEV)

The Energy Saving Ordinance (Energieeinsparverordnung - EnEV) replaced the Heat Insulation Regulation (Wärmeschutzverordnung – WSchV95) and the Heating Systems Regulation (Heizungsanlagenverordnung – HeizAnlV) in 2002 and for the first time combined requirements for building technologies and building services. The following changes were made in the amendment to the Energy Saving Ordinance that entered into force on 1 October 2009:

- To increase energy efficiency while ensuring economic viability, the requirements for annual primary energy consumption in new builds were made on average 30% stricter and the requirements for exterior building elements were on average 15% stricter. When making substantial changes to existing buildings, the maximum allowable U-values for exterior building elements became 30% stricter on average. It was also specified that when refurbishment involves more than 10% of the overall area of the building elements, the changed elements must comply with the new regulations.
- A new calculation method for residential buildings based on DIN V 18599 was introduced and can be used as an alternative to the existing method. The previous calculation based on the simplified method is replaced by a reference building method that is the same as the one used in the Renewable Energies Heat Act (Erneuerbare-Energien-Wärmegesetz – EEWärmeG). The maximum admissible primary energy requirement value for the building is determined individually based on a reference building having the same geometry, orientation, and usable floor space, assuming standardized components and building services.
- Individual requirements to upgrade insulation were expanded with respect to requirements for insulation quality. The requirement to insulate was extended to top-storey ceilings of buildings which are walkable and have not yet been insulated. Previously only non-insulated, non-walkable but accessible top-storey ceilings had to be insulated.

- Electric storage heating systems may no longer be used in residential buildings with more than five residential units if they are used solely to heat rooms. If the heating system was installed before 1990, the system must be taken out of service before the end of 2019. If the heating system was installed after 1990, it may not be used for more than 30 years. The same rules apply to non-residential buildings larger than 500 m^2. Refer to the 2013 amendment on this, as well.
- Documentation requirements for individuals, such as contractor declarations, were intensified to improve enforcement of the Energy Saving Ordinance. District chimney sweeps were given the task of inspecting heating systems (such as decommissioning heating boilers and installing insulation for heating systems).

Table 10: Comparison of maximum allowable heat transfer coefficients

Building element	**Heat Insulation Ordinance (WSch-VO95)** W/(m^2K)	**Energy Saving Ordi-nance (EnEV) 2002-2007** W/(m^2K)	**Energy Saving Ordi-nance (EnEV) 2009** W/(m^2K)
Exterior walls	0.50	0.45	0.24
	0.40	0.35	
Windows	1.80	1.70	1.30
Roofs and ceilings	0.30	0.30	0.24
		0.25	0.20
Basements	0.50	0.40	0.30
		0.50	

Sources: Hansen & Kleemann 2005; EnEV 2009, additional information by BMVBS

<u>The 2013 amendment</u>

The amendments to the Energy Saving Act (Energieeinsparungsgesetz – EnEG) and the Energy Saving Ordinance transpose the revised EU Buildings Directive and the cabinet decisions on the Energy Concept and the Energiewende where they relate to laws on conserving energy in buildings.

A fundamental obligation for new builds to comply with the minimum-energy buildings standard was enshrined in the Energy Saving Act (which entered into force on 13 July 2013). To transpose the EU Buildings Directive, the standard will apply to all new buildings in Germany starting in 2021 and to new public buildings starting in 2019. The lowest-energy building standard is for the most part the same as the standard for the climate-neutral building, which according to the federal government’s Energy Concept is to be introduced for new construction by 2020. Decommissioning electric night storage heaters was also rescinded.

The amendment to the Energy Saving Ordinance (EnEV 2013) was completed with the adoption of the cabinet resolution on 16 October 2013. It had not yet been promulgated at the time this document went to press. The version approved on 16 October 2013 contains the following changes:

- The 2013 Energy Saving Act provides for stricter efficiency standards for new buildings according to the criterion of economic viability by 1 January 2016: reducing the admissible annual primary energy consumption by an average of 25% and the admissible minimum thermal insulation value of the building envelope by an average of 20%.
- The standards for existing buildings will not be made stricter. The existing requirement to decommission old constant temperature heating boilers is expanded (previous requirement was to replace boilers installed before 1978, now boilers installed before 1985 or boilers that have been operated for 30 years must be replaced).

<u>Requirements for energy performance certificates and inspection reports for air conditioning systems</u>

- Introduction of efficiency classes for new energy performance certificates for residential buildings using a scale from A+ to H, similar to the one used for household products
- Introduction of the requirement to include energy indicators, including efficiency class, in real estate advertisements when selling and renting
- Clarification of the current requirement to present the energy performance certificate to potential buyers and tenants (energy performance certificate must be presented at the time of visits to the property being sold or rented)
- Introduction of the requirement to hand the energy performance certificate over to the buyer or new tenant

- Introduction of the requirement to display energy performance certificates in certain buildings with heavy use by the public that is not due to official use, if an energy performance certificate already exists (examples of buildings of this kind: large stores, hotels, department stores, restaurants, and banks)
- Expansion of the current requirement for public authorities to display energy performance certificates to smaller buildings with heavy use by the public for official purposes

<u>Enhanced enforcement of the Energy Saving Act</u>

- Introduction of an independent system of random checks of energy performance certificates and reports on the inspection of air conditioning systems

1.8.2. Funding energy modernization

The German government supports energy-efficient refurbishing and construction of housing and energy-related refurbishment of buildings used for municipal and social services infrastructure in the context of the funding programmes (Energy-Efficient Building and Refurbishment) of KfW, a government-owned development bank. New build and refurbishment projects in accordance with energy-efficiency standards that far exceed the minimum requirements of the Energy Saving Act are funded. The general principle is that better results in terms of energy consumption receive more funding.

Energy-efficiency work on some 3.1 million residences and more than 1,600 buildings at municipal level have received this type of support since 2006.

Programme funding totalling €1.5 billion annually is available from the Energy and Climate Fund (EKF) from 2012 to 2014 to finance the KfW Energy-Efficient Building and Energy-Efficient Refurbishment programmes. In addition, €300 million is available each year from 2013 to 2020 for direct grants as part of that programme.

KfW support has also been available since 2011 for refurbishment solutions going beyond individual buildings. This ensures that renewable energy sources can be used more extensively in urban neighbourhoods with many older buildings and gets other groups of investors involved in the refurbishment process. Neighbourhood concepts, the use of refurbishment managers, and measures to supply district heating to neighbourhoods are being funded.

1.8.3. Federal buildings

Long-term energy refurbishment plan for federal buildings

The German government uses some 2,300 properties for civilian and military purposes, which are under uniform property management by the Federal Real Estate Agency (BIMA). The total costs of heating and electricity in these properties are about €0.4 billion a year.

The objective according to the decision of 6 June 2011 concerning the Energiewende, Germany's transition to a new energy era, is for the federal government to serve as a role model in reducing energy consumption by its future new builds and its existing properties (Benchmark Paper on Energy Efficiency No. 3).

Data on buildings, consumption, and users is transferred to an evaluation system and reviewed on the basis of structural, energy-related and real estate management criteria to determine what refurbishment work is necessary and whether it is possible.

To reduce energy consumption, this integrated approach must take into account all work related to

- Refurbishment of the building envelope
- Use of renewable energy sources
- Modernization of building technology
- Improvement of operation

The long-term refurbishment plan is almost complete. It currently appears that investments of some €1.6 billion must be assumed in this sector alone up to 2020. The building envelope of about 80% of the properties and over 90% of the building services must be refurbished. If the refurbishment target is to be met, it will be necessary to stay at least 20% below the energy requirements of the Energy Saving Act.

1.9. Industry and trade, commerce and services

1.9.1. Structure

Gross value creation by the trade, commerce and services sector totalled €1,583.8 billion in 2011. It thus contributed 69% of Germany's total gross value creation, giving it by far the greatest share of macroeconomic performance. The share of the trade, commerce and service sector in total gross value creation has increased by 6% since 1991. This rising share of gross value creation is reflected in employment figures. In 2011, 73.7% of employment was in the trade, commerce and service sector (not including agriculture), up from only 60.9% in 1991.

Table 11: Employment and gross value creation in the trade, commerce and services sector by segment

	2000	2005	2010	2020	2030
	1,000 gainfully employed persons				
Agriculture, horticulture	936	850	830	735	594
Small industrial operations, crafts[1]	649	682	713	1232	1376
Construction	2769	2165	2142	2004	1883
Commerce	6078	5899	5924	5265	4529
Banks and insurance	1277	1244	1229	1245	1249
Transport, communication	2133	2108	2152	2319	2350
Other private services	8093	9028	9435	9601	9297
Healthcare	3668	4038	4143	4328	4467
Education	2150	2278	3215	2065	1788
Public administration, social insurance	2426	2300	2348	1958	1635
Defence	431	370	320	320	320
Total trade, commerce and services	30610	30962	31552	31072	29488
	Real gross value creation, 2005 = 100				
Agriculture, horticulture	102	100	104	113	113
Small industrial operations, crafts1	105	100	110	133	156
Construction	126	100	112	124	139
Commerce	98	100	111	119	126
Banks and insurance	115	100	107	128	154
Transport, communication	90	100	114	151	191
Other private services	92	100	111	135	158
Healthcare	86	100	110	139	176
Education	103	100	105	112	116
Public administration, social insurance	101	100	109	110	113
Defence	111	100	93	112	137
Total trade, commerce and services	98	100	110	130	151
[1]Calculated as residual value					

Source: UBA 2009a

1.9.2. Effects on greenhouse gas emissions

The great importance of the trade, commerce and services sector in gross value creation is accompanied by a relatively low level of CO_2 emissions. The sector was responsible for only 4% of total emissions in 2011, corresponding to emissions of 38 million tonnes of CO_2 equivalents (CDE). The sector has thus cut its emissions by more than half from some 81 million tonnes of CO_2 in 1990, and can point to the strongest relative reduction in emissions of any sector. Its CO_2 intensity was 0.024 tonnes CDE/€1,000 (gross value creation) in 2011. That is less than one-tenth of the CO_2 intensity of the industry sector, which was 0.274 tonnes CDE/€1,000 (gross value creation) for the same year.

1.10. Industrial processes

1.10.1. Structure

OECD surveys show that industry's share in gross value creation in Germany was 22% in 2011, twice as high as in France. It was as much as 36.5% in 1970, but has hovered around 20% since 2000. German industry is distinguished by its structure of specialization, including regional cluster structures of efficient SMEs, large companies and research institutions, and by the availability of highly-qualified skilled workers and engineers.

Industrial undertakings based in Germany have often focused in high-quality specialized and niche products such as technical textiles and special steels. They make relatively high expenditures for research and development to defend their top positions in many areas.

Many industrial products are exported. Between 1995 and 2011, mechanical engineering's share in exports rose from 42.7% to 61.4%, the share of the chemicals and pharmaceuticals industry rose from 41.6% to 60.2%, the share of the automotive industry rose from 47.7% to 63.4%, and the share of the electronics industry rose from 35.4% to 49.6%.

1.10.2. Effects on greenhouse gas emissions

Industrial processes influence emissions of greenhouse gases in many different ways: combustion processes cause emissions of CO_2 but also emissions of other greenhouse gases. Emissions by German industry have fallen by more than 30% since 1990, with considerable declines during the first few years after reunification. The causes of this were alterations to the German industrial structure and the decline of industry in the former East Germany, which was not competitive. Other measures were instituted after 2005, such as reduced use of clinker in concrete or increased use of recycled paper in paper production. The total level of emissions by the industry sector has hardly changed in recent years. Emissions in 2009 were at their lowest level since 1990 due to the economic crisis. This was followed by a slight rise in 2010.

Protecting the climate requires considerable willingness by German industry to change and adapt, but it also offers opportunities. German industry – particularly the fields of mechanical engineering, plant construction, measurement and control technology and electrotechnology – is a leader in the export of products related to the environment and climate protection.

There has been great progress in making industrial processes more environmentally sound since the first use of what are known as end-of-pipe technologies, such as catalytic converters and flue gas desulphurisation systems in the 1970s and 1980s. Increasing industry’s productivity and efficiency is essential in facing up to international competition, so many industrial processes have been – and are still being – optimized to reduce their consumption of energy and resources. It is understandable in business terms that this often happens when aging equipment and systems must be replaced in any event.

The German federal government is working to ensure that new acquisitions use technologies that are as environmentally friendly and climate conscious as possible. Environmental management systems such as EMAS and other standards offer support for an environmental orientation of industrial products. Economic instruments usually require a compromise between controlling environmental quality and maintaining companies’ international competitiveness.

1.11. Agriculture

1.11.1. Structure

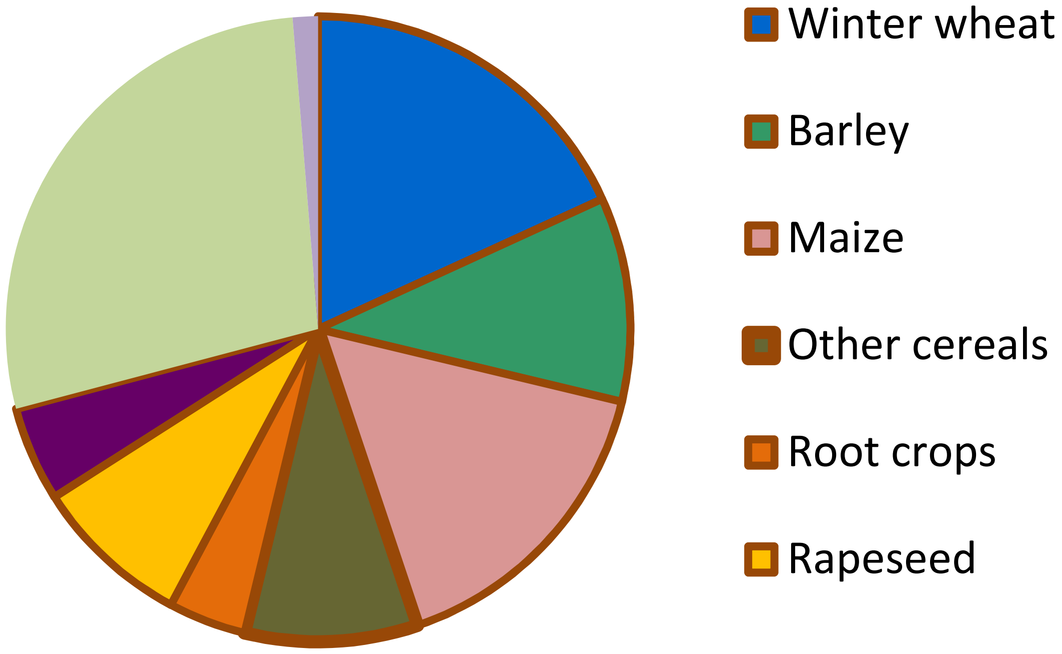
Some 299,000 farms managed about 16.7 million hectares of agricultural land in Germany in 2010.[31] Compared with the previous survey on agricultural structure in 2007, the number of farms decreased by about 2% and the land used for agriculture decreased by 0.2% annually. In 2011, each farm had an average of 56 hectares of land used for agriculture. Farms that include at least 100 hectares of land used for agriculture cultivated about 55% of it. The mean size of farms tends to decrease from east to west and from north to south. About 60% of the land is leased.

About 46% of farms are run as a secondary occupation. This partially explains why the 1.1 million people who work in agriculture are equivalent to only 0.5 million full-time equivalents.

In 2012, some 71% of land used for agriculture was cultivated and 28% was used as permanent grassland (Figure 8). Far more maize has been grown in the past few years. This is also due to increased cultivation of silo maize and its use as a fermentation substrate for biogas production. The installed electrical capacity of all German biogas plants was 2.9 TW in 2011,[32] more than double the amount in 2007 (1.2 TW). The land devoted to growing maize increased by almost 600,000 ha during the same period.

[31] Federal and Länder Statistical Offices 2011.
[32] Fachverband Biogas 2012.

Figure 8: Agricultural land use in Germany (2012)

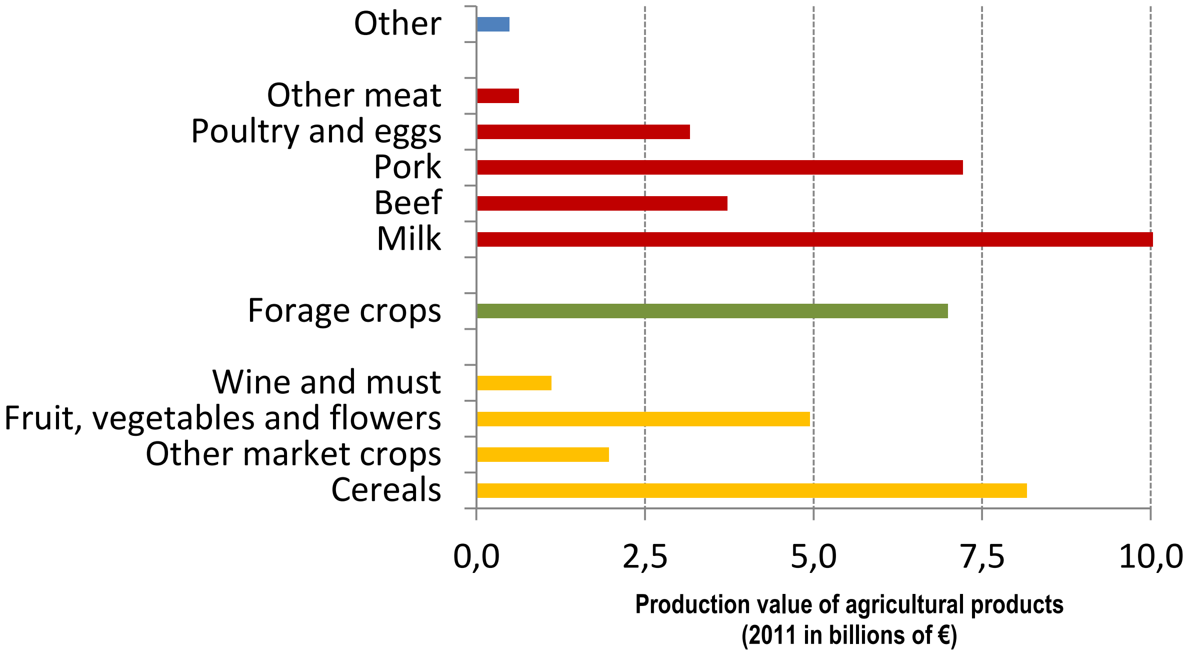


Source: BMELV 2013

The main types of livestock raising are cattle farming, particularly dairy cows, and pig farming. In 2011, 12.5 million cattle and 27.4 million pigs were kept on German firms. The cattle herd has been reduced by 1.2% annually over the past ten years, but the number of pigs has increased by 0.6% annually. Germany averaged 0.77 large animal units per hectare in 2010.

Figure 9 shows the economic importance of agricultural products based on their production value. About half of the €52 billion production value of German agriculture in 2011 came from plant crops or livestock raising. Milk alone accounted for 20% of total production. It should be noted for plant crops that forage crops are an internal input within the sector, because they are needed for livestock raising.

Figure 9: Production value of various agricultural products produced by German agriculture (2011)



Source: BMELV 2013

1.11.2. Effects on greenhouse gas emissions

Agriculture makes a considerable contribution to German greenhouse gas emissions.[33] Studies show that organic farming is generally more climate friendly than conventional agriculture based on land area. The reason for this is primarily the use of mineral fertilizers in the conventional sector, because they cause high levels of greenhouse gas emissions when they are manufactured and used. Conversely, organic farming requires more land and can cause higher greenhouse gas emissions than conventional agriculture, based on products. The use of drained bog lands has been shown to have serious climatic effects. Rewetting them would contribute enormously to climate protection. Bogs that have been drained subside over decades and release an average of 20 tonnes CO_2 per hectare per year. This corresponds to an annual subsidence rate of 1 cm, which has often been observed. Depletion of peat amounting to 2-4 cm per year has often been observed in heavily drained bogs.

[33] E.g., IÖW 2008.

Bog lands make up 4 to 5% of the area of Germany. Most bogs have been drained for decades and are being used for agriculture and forestry. The continuous depletion of peat releases considerable quantities of greenhouse gases in the form of carbon dioxide (CO_2) and nitrous oxide (N_2O). Drained bogs released approximately 5% of total German greenhouse gases in 2010, making them the largest single source outside of the energy sector – higher than the use of nitrogen fertilizer or livestock raising in agriculture. Emissions from drained bogs have actually increased in recent years because grasslands were ploughed for cultivation. Raising the water table (rewetting) immediately reduces greenhouse gas emissions.

Every form of rewetting offers immediate, reliable climate protection at the project or landscape level. Rewetting of all raised bogs and low-nutrient fens and most high-nutrient fens, even in small areas, has resulted in clearly measurable emission reductions. Restoring water levels that are close to those that occur in nature offers the best climate protection. Methane emissions can increase in isolated very wet areas in some cases, but they are equivalent to no more than 20% of the reduced CO_2 and N_2O emissions. Comprehensive multi-year scientific measurements and studies by the Thünen Institute have shown that rewetting drained bogs in Germany was – and continues to be – a reliable, efficient climate protection measure.

There have been few rewetting projects in locations with the highest area-based emissions, i.e., low drained agricultural land. This means there is still considerable potential for reducing emissions. Rewetting bog lands requires new forms of use for agriculture and forestry. They are already developing in the area of renewable raw materials and are being targeted for promotion and expansion.

1.11.3. Framework conditions

Greenhouse gas emissions by German agriculture are influenced by multiple factors, particularly the legal background conditions and funding instruments under the Common Agricultural Policy (CAP).

The requirements of the Fertilizer Ordinance (Düngeverordnung) should be mentioned when considering regulatory law. Many parts of the Fertilizer Ordinance in its current form influence the management of nutrients, particularly agricultural fertilizer. The Ordinance defines minimum storage capacities, admissible application methods, the time between application and incorporation of the agricultural fertilizer and restrictions on application. Limit values have been defined for both the maximum application of the nitrogen (N) that is bound up in agricultural fertilizer (170 kg per hectare) and the maximum admissible surplus N and P balances. The limits for the admissible surplus N balance have been constantly reduced since 2006. The implementing provisions of the German Länder for liquid manure were defined in 2010, and most Länder require liquid manure and dry poultry manure to be incorporated within four hours (except when applied to crops).

The Fertilizer Ordinance has been evaluated by a Federal-Länder working group. The group's report (autumn 2012) pointed out that the Ordinance should be amended; for example, the requirement for immediate incorporation should be uniform throughout Germany. The total N balance declined by at least 50 kg N per hectare of land used for agriculture to around 90 kg N per hectare between 1990 and 2010.[34] Most of that decrease took place in the early 1990s and is primarily the result of a reduction in the amount of nitrogen fertilizer. The nitrogen use efficiency (ratio of nitrogen removal to nitrogen application) increased from 30% to 50% during the same period.

Ploughing up grassland, which releases large amounts of greenhouse gases, also affects greenhouse gas emissions by agriculture. The share of grasslands in total land used for agriculture in Germany has declined continuously since 1993 and has stabilized at 27.8-27.9% since 2011[35] (see Table 12) The slight drop corresponds to the general decrease in the amount of land used for agriculture, primarily due to the use of land for transport and settlement projects.

Table 12: Share of permanent grassland in land used for agriculture 2010-2012

Excerpt from the conclusions of the land use survey (Bodennutzungshaupterhebung) 2012

Millions of hectares	2010	2011	2012	+/- 2012 vs. 2011
Permanent grassland	4,654	4,644	4,631	-0.30%
Land used for agriculture	16,704	16,721	16,667	-0.30%
Share of permanent grassland in land used for agriculture	27.86%	27.77%	27.79%	

Source: BMELV 2013

[34] Osterburg/Techen, 2012.
[35] BMELV 2013.

Some 50% of grassland that is ploughed is ultimately used for maize.[36] Direct payments under the first pillar of the Common Agricultural Policy (CAP) are subject to compliance with certain environmental standards (cross-compliance). Cross-compliance provisions also include the requirement to keep agricultural land in good agricultural and ecological condition (GAEC). This generally includes maintaining permanent grasslands, and the amount of grassland in relation to agricultural land may not be reduced by more than 5%. Bans on ploughing grasslands or conditions included in building permits have been adopted in Länder where those limits have been exceeded in recent years.

The Länder fund many different measures under the second pillar of the CAP, and they are having a positive influence on greenhouse gas emissions by the sector. They include advice on using fertilizer, subsidies for investments in covering liquid manure and digestion residue storage units, subsidies for certain liquid manure application methods, and compensation for limitations on cultivation methods (complete or partial abandonment of fertilizer use).

1.11.4. Effects of climate change on agriculture

This sector is also strongly influenced by the effects of climate change. The consequences of climate change for agriculture could be lower harvests due to excessively high temperatures and insufficient precipitation. An increase in climate variability can cause severe fluctuations in yields and failed harvests. But a moderate temperature increase, a longer vegetation period, and sufficient water supplies in certain regions also offer the potential for higher yields of certain crops. Arable crops generally do not use the full vegetation period. Yields of cereals increased for several decades, but harvests have stagnated for about ten years now. The reasons for this are unclear, but could be associated with the varieties and fertilizer that are used.

The extent to which climate change will affect future agricultural yields greatly depends on crops and water supplies. Heat and drought in the warmer, drier areas of eastern and south-west Germany are already limiting capabilities for agricultural production. A further decline in agricultural yields is to be expected there if irrigation is not used to counteract those effects. In contrast, regions in the Central German

[36] Osterburg, B. et al. 2009.

Uplands or northern Germany, which tend to be too cool or wet for agricultural use, could benefit from gradual warming and longer vegetation periods. In particular, it may be possible to grow crops limited by temperature – such as maize, fruit, wine grapes, and oil seeds – or winter cereal varieties that require a warmer regional climate. These cooler locations are currently used primarily as grassland. Converting them to agricultural land would lead to a serious loss of humus.

Agriculture can adjust relatively quickly to changing climate and weather conditions. It has done so in the past. Adapting to the potential effects of climate change will be possible primarily by growing the right varieties and new types of crops, as well as changing to cultivation methods that will protect soil and conserve water. Cultivation methods that protect the soil are progressively becoming more popular, primarily in eastern Germany. Agriculture is a main area of action of the German Strategy for Adaptation to Climate Change (DAS),[37] in which the federal government is pooling its adaptation efforts (see Chapter 5).

1.12. Forestry

1.12.1. Structure

The exploitation and use of wood are an important economic factor in Germany. Selling wood is the most important source of income for owners of forests. Forests in Germany are managed by around 160,000 private, state, and municipal forestry operations and over 4,200 forest operating groups. Germany has a total of 2 million private forest owners who are responsible for some 47% of forested areas. Municipal forests account for another 20%, while state forests make up about 33% of forested land. This range of ownership makes an important contribution to the diversity of forests, as do the different conditions in the various locations. Some 100,000 people who are employed in state, municipal, and private forestry operations are responsible for annual sales of €5 billion.

With 1.2 million employees and revenue of €168 billion (2009), the German forestry industry can offer the forestry and wood cluster a reliable source of raw materials if framework conditions are right. Value creation by the German wood industry is currently based primarily on softwood. Almost 20 million cubic meters of softwood

[37] UBA 2011a.

timber but only 1 million cubic meters of hardwood timber were produced in 2009. Sales of softwood are closely tied to use in the construction sector. Potential uses for hardwoods have not yet been fully utilized, primarily for technical reasons.

1.12.2. Effects of forestry on greenhouse gas emissions

Germany’s forests sequestered 1.23 billion tonnes of carbon (120 tonnes/hectare) in tree biomass, 81% in above-ground biomass and 19% in roots in 2008.

Total emissions from forests in 2011 were -32.657 Gg CO_2 equivalents (CDE). Of that, -21.378 Gg CO_2 was sequestered due to the growth of plant mass, -9.800 Gg CO_2 was sequestered in mineral soils, and -3.647 Gg CO_2 was sequestered in dead wood. The amount released from litter was 1.427 Gg CO_2.

It will be impossible to quantify changes in sequestered amounts without comparing two federal forest inventories. That will not be possible until 2014/2015, when the results of the third federal forest inventory for 2012 will be available and can be compared with the second federal forest inventory for 2002.

The sink performance of forests in Germany is trending downward because the use of wood is increasing and biomass growth and carbon sequestration in older stands slows down. But the forest floor still provides a high level of carbon sequestration.

1.12.3. Effects of climate change on forestry

The natural occurrence of tree species is determined by location as a complex of factors primarily comprising climate, soil and water. Forests have been influenced by human beings and their structure has been modified for almost 7,000 years. Forest ecosystems have constantly adapted to environmental conditions. But the extent, direction, and speed of current climate change now threaten to exceed the ability of forests to adapt. Forests may suffer from heat and drought stress as summer heat and the length of dry phases increase. Extreme weather events can cause early leaf drop and slow growth. The dry, warmer regions of eastern and south-west Germany, locations with a generally poor water supply, and stands that are not appropriate for other reasons are at particular risk. The hazard of wild fire may also increase. The risk of losses due to pests such as bark beetles will rise at the same time as stress increases. Mass propagation of pests such as nun moths and cockchafers may occur more frequently, and pests that have previously been unimportant or disregarded may increase.

Mountain forests in the Alps could be particularly affected by climate change. The effect of climate change could be stronger there than in the lowlands. The risk of natural hazards (heavy snowfall, mudslides, floods, and falling rock) could increase considerably. That could further increase the importance of forests for protecting settlements and infrastructure.

It will be necessary to adapt forests to climate change in sufficient time to reduce the increased risk of disasters and associated disruptions to the timber market and other forest functions. Forest owners should proceed with efforts to convert forests from pure stands to low-risk mixed stands that are suited to their location. Adapted wild stands will be an important prerequisite for this.

However, climate change is only one of the multiple stress factors faced by forests. Many stands are in poor condition due to air pollution, particularly today's high level of nitrogen inputs into the atmosphere. This phenomenon has been described as "new types of forest damage" since the 1970s. The consequences for soil and vegetation will persist over many years.

The shift in leaf unfolding to early times in the year and the resulting prolonged vegetation periods as a result of high temperatures, as well as the CO_2 fertilization effect (promotion of plant growth due to a high CO_2 concentration in the atmosphere), could increase wood production and the function of forests as CO_2 sinks if sufficient water and nutrients are available. The rate at which carbon accumulates in soil should also be considered in this context. Some 1.2 billion tonnes of carbon are currently sequestered in the above-ground and subterranean biomass of forested areas in Germany. In the medium term, the positive effects of this are probably negligible compared with climate-related stress factors.

Some fundamental assumptions about the conditions for growth and survival of individual tree species under changing climatic conditions can be derived. The growing conditions for spruce, in particular, could worsen in many places if, as expected, temperatures increase, more dry phases occur, and weather events are more frequent in Central Europe. Generally speaking, it is the interaction among various stress factors that does the most damage to forests. Complex damage to oak and Scotch pine has been observed. The lower growth limits for spruce in low mountain ranges will probably rise considerably, thereby reducing the areas in which spruce can be grown. The great plasticity of beech indicates that it will continue to be an important main and mixed tree species, even if its lower tolerance for drought will worsen conditions for growth in shallow or sandy soils and in the northern German lowlands. Whether oaks are “winners” in climate change will depend on controlling the heat-loving oak pests.

The German government and the Länder must remedy the lack of available information so that Germany’s two million forest owners can be convinced of the need to adapt to changes. Where silviculture is concerned, stands must be as stable and mixed as possible so they will be more resistant to adverse events (disasters) affecting large areas, such as storms or bark beetles, and so that they can adapt better to changing climatic conditions. When choosing tree species and varieties, it must be ensured that they are appropriate for the locations and any expected changes there. Due to the uncertainty of scenarios for climate change and their effects on forest production over the long term, forest owners should seek to spread the risk as widely as possible and make sure that a wide variety of options for action are available. The adaptation strategies followed by the individual Länder are very different. Some favour targeted, more active adaptation (such as forest conversion to replace sensitive tree species), while others favour a combination of forest conversion and/or continuation of existing silviculture systems and risk minimization strategies (mixed forest option).

The German government and the Länder are expanding the scientific basis for decisions about converting forests based on climate change. In the context of the joint task force on improving the agricultural structure and coastal protection (GAK), the German government and the Länder are funding various measures to promote the adaptation of forestry to climate change, such as the conversion of pure stands into stable deciduous and mixed stands. Silviculture that comes as close to nature as possible through the use of modified wild stands is also being supported since it is also desirable for purposes of nature conservation. Other measures are aimed at preventing and coping with natural disasters. The German government and the Länder are constantly improving an environmental monitoring system that includes the condition of forests so that any changes can be discovered in sufficient time for a response to be developed and measures taken. As part of the further development of the German Strategy for Adaptation to Climate Change, indicators to describe the impacts of climate change and the effectiveness of adaptation measures and to assess vulnerability are being developed for fields of action including forests, forestry, and biodiversity.

1.13. Waste management

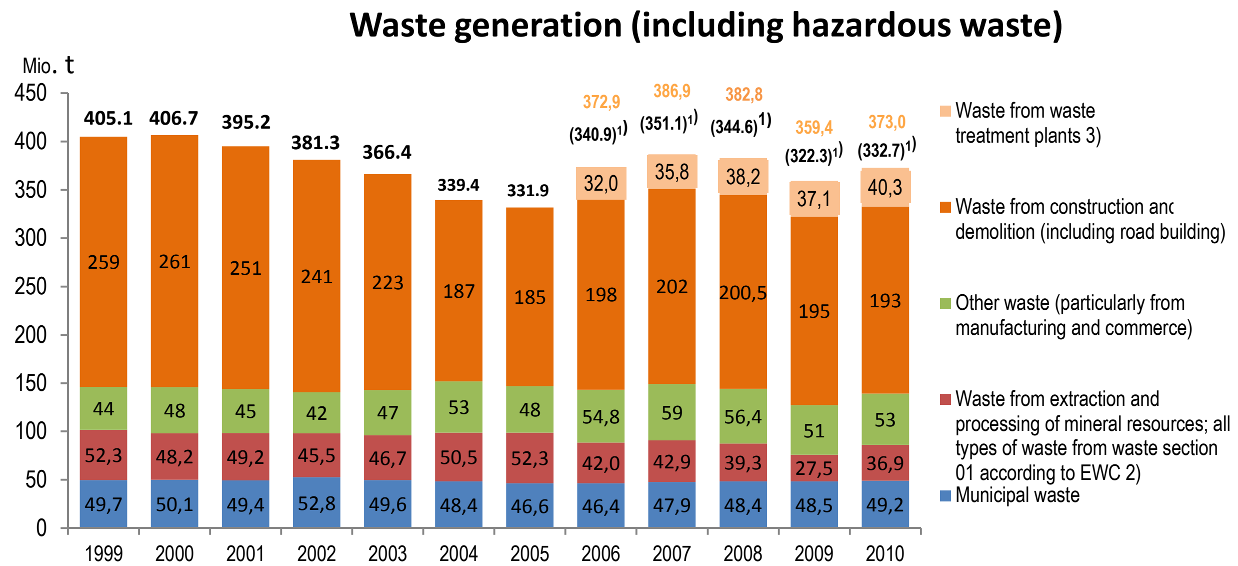
1.13.1. Waste generation

Germany generated 49.2 million tonnes of municipal waste in 2010.[38] Municipal waste includes household waste, commercial waste similar to household waste, and bulky waste, as well as various recyclable materials such as used paper, used glass, biowaste, garden waste and packaging which can be recycled using many different processes. The recovery rate for all municipal waste in 2010 was 78%, up 8% from 2006. The recycling rate for 2010 was 63%.

In addition to municipal waste, other types of waste were produced in the following quantities in 2010: 36.9 million tonnes of waste from extracting and processing natural resources, 193.3 million tonnes of construction and demolition waste, 53.3 million tonnes of other waste (particularly manufacturing and commercial waste), and 40.3 million tonnes of waste from waste treatment facilities (see graphic below).

[38] Federal Statistical Office 2012a.

Figure 10: Waste generation in Germany 1999-2010



1) Waste generation, not including waste from waste treatment plants; included as component of waste generation for the first time in 2006

2) Waste from the extraction and processing of mineral resources.

3) Not including waste from water treatment plants (EWC 1908), waste from the preparation of water intended for human consumption or water for industrial use (EWC 1909) and secondary waste in the form of raw materials/products resulting from the disposal process.

Note: The Environmental Statistics Act (Umweltstatistikgesetz) of 1994 is not oriented to direct recording of waste generation. The waste quantities input by the operators of waste disposal plants have for the most part been recorded since 1996.

Source: Federal Statistical Office, Waste Balance (Abfallbilanz) 2009, Wiesbaden 2011

A total of 332.7 million tonnes of waste was generated in 2010 (373 million tonnes minus double counting due to waste from waste treatment facilities). The recovery rate was 77%, and the recycling rate was 69%. Slightly less than 18% of this waste is sent to landfills.

1.13.2. Legal basis and objectives of waste management

The fundamental legislation governing waste management is the Closed Cycle Management Act (Kreislaufwirtschaftsgesetz – KrWG) of 24 February 2012.[39] Section 6 (1) of the Act specifies the following five-level hierarchy: avoidance, preparation for reuse, recycling, other recovery (particularly energy recovery and

[39] Federal Law Gazette (BGBl) I, page 212.

backfilling) and disposal. Various implementing regulations and laws on taking back individual product groups or materials (such as packaging, electronic devices or batteries) have been adopted with the objective of preventing and recovering certain waste fractions. The Landfill Ordinance (Deponieverordnung) of 27 April 2009[40] (successor to the Storage of Waste Ordinance (Abfallablagerungsverordnung) of February 2001), most recently amended by Article 5 (28) of the Act of 24 February 2012,[41] is very important for waste disposal. It abolished the storage of municipal waste that has not been pre-treated starting 1 June 2005, to avoid further emissions (landfill gas and polluted leachate) from landfills. Sending biodegradable waste and waste with a high calorific value to landfills was therefore prohibited from 1 June 2005; they must now go to waste incineration plants or mechanical-biological treatment plants.

1.13.3. Thermal treatment of waste and energy recovery

Seventy incineration facilities for household waste with a total capacity of about 19 million tonnes per year operated in Germany in 2011. The development of municipal waste incineration is shown in Table 13. Additional capacity is not planned at the moment.

Table 13: Development of household waste incineration 1990-2011

	Number of plants	Throughput/ Capacity in 1,000 t/a	Average throughput per plant in 1,000 t/a
1990	48	9 200	191
1992	50	9 500	190
1993	49	9 400	192
1995	52	10 900	210
1998	53	11 900	225
2000	61	14 000	230
2005	67	16 900	252
2011	70	19 000	271

Source: National Inventory Report 2013

[40] Federal Law Gazette. I, page 900.
[41] Federal Law Gazette I, page 212.

Thermal methods that use municipal waste or high-calorific-value fractions produced from it as substitute fuel have increasingly been used in the past few years. By the end of 2011, 30 substitute fuel power plants with a capacity of some 4.5 million tonnes per year were on line. Another three substitute fuel power plants with planned capacity of 1 million tonnes per year were under construction at that time. After completion of the plants, it is projected that annual capacity of 5.5 million tonnes will be available at substitute fuel power plants.

Substitute fuels from municipal waste (refuse-derived fuel or RDF) can also be used instead of fossil fuels in co-incineration in existing power plants and industrial systems. In 2011, approximately 0.9 million tonnes of RDF were used in coal-fired power plants and about 2 million tonnes were used in the cement industry. No significant changes in waste quantities as a result of co-incineration are expected over the next few years.

All waste incineration plants in Germany use the energy released by the waste. Most plants generate electricity and heat in combined cycle plants or produce steam for power plants or industrial operations. This replaces fossil fuels, thereby conserving fossil resources. This also avoids fossil CO_2 emissions, since residual waste on average contains about 50% non-fossil organic components. In 2011, 4,950 GWh of electricity and 7,600 GWh of heat were produced from the biogenic portion of waste in waste incineration plants; this avoided a total of 6 million tonnes CO_2 equivalents and was climate-neutral.[42]

All plants in which waste undergoes thermal treatment are subject to the Incineration and Coincineration of Waste Ordinance (Verordnung über die Verbrennung und Mitverbrennung von Abfällen – 17th BImSchV) and must comply with strict emissions limits and operating parameters to protect the environment.

1.13.4. Biomechanical waste treatment

Germany had 46 biomechanical waste treatment plants with annual capacity of about 5.0 million tonnes in 2011. Some 2.5 million tonnes of municipal waste were also treated in 30 mechanical waste treatment plants. When treating a total of 7.5 million tonnes of waste in the two types of plants, 4.5 million tonnes of high-calorific-value

[42] BMU 2012.

fraction were separated so it could be used as substitute fuel and 0.2 million tonnes of metals and 0.2 million tonnes of other recyclables were separated for recovery. Only about 1 million tonnes of waste that was pre-treated in these plants was stored in landfills. Biomechanical waste treatment achieves a net reduction in the climate footprint (adjusted for its own energy consumption) of 2.1 to 2.5 million tonnes CO_2 equivalents.[43]

Biomechanical waste treatment plants must fulfil the strict requirements of the Storage of Waste Ordinance (AbfAblV), which entered into force when the Landfill Act was amended in 2009. The same requirements are now contained in the Landfill Ordinance (Deponieverordnung). The operating requirements and air quality standards contained in the Biological Waste Treatment Plant Ordinance (Verordnung über Anlagen zur Biologischen Behandlung von Abfällen – 30th BImSchV) and in annex 23 to the Waste Water Ordinance (Abwasserverordnung – AbwV) also apply. They ensure low-emission waste treatment in biomechanical waste treatment plants and environmentally compatible landfill practices for the treatment residue.

1.13.5. Recovery of biowaste and green waste

Germany separately collects and recovers biowaste and green waste, so it has established its recovery of biodegradable waste at a very high level compared with other countries. An average of 111 kg of biowaste and green waste was separately collected for each inhabitant in 2011. Nationally, some 9.1 million tonnes of biowaste from different sources was generated, with an upward trend.[44] According to a current study,[45] German household waste alone contains 4 to 5 million tonnes of biowaste and green waste, and conservative estimates indicate that appropriate measures could access almost 2 million tonnes of it each year. The legal basis for this was created in the 2012 Closed Cycle Management Act. Separate collection of biowaste and green waste will be mandatory from 1 January 2015.

Composting plants for biowaste and green waste have been operated in Germany since the 1980s. The first digestion plants went on line shortly after that. As the price

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[43] ASA 2011.
[44] Federal Statistical Agency 2013b.
[45] Witzenhausen Institute 2011.

of wood used for energy has risen, efforts have begun over the past five years to separate more of the wood fraction from green waste for use as fuel.

Almost 1,000 large composting plants (each with annual capacity of over 1,000 tonnes) with total capacity of over 10 million tonnes were operated in Germany in 2011. Half of those plants process only green waste or a combination of biowaste and green waste. Ten million tonnes of processing capacity currently handles the aforementioned 9.1 million tonnes of collected biowaste and green waste, so there is available capacity for the additional quantities that will result from the expansion of the collection requirement.

There were also some 100 biowaste digestion plants in Germany in 2011 which used different methods, operating continuously or in batches. Appropriate biowaste will increasingly undergo digestion followed by composting. That will improve the use of biowaste to produce energy and allow recovery of the organic material and its components for use as soil conditioners. One requirement for this is to retrofit existing composting plants with a digestion module. Combining targeted downstream aeration of digestion residue with the capture and treatment of any exhaust that contains methane will meet strict emission standards. Depending on the quality of the input and the method used, each tonne of biowaste that is digested produces between 80 and 140 m^3 of biogases with a methane content of 50 to 65%. The energy it contains corresponds to 50 to 80 m^3 of natural gas. The digestion residue can be used directly in agriculture as a liquid digestion product or be sold as a solid digestion product after composting.

The biogas is usually converted directly into electricity (200 to 300 kilowatt hours per tonne [kWh/t] input) and heat (also about 200 to 300 kWh/t input) in a combined heat and power plant (CHP). If 20,000 tonnes of biowaste were generated each year, a CHP plant with capacity of 600 kW (electric) could produce sufficient electricity for 1,000 to 1,500 households. It is also possible to improve the quality of biogas so that it is of the same quality is natural gas (“biomethane”). In addition to expanding separate biowaste collection, the recovery of biowaste should be optimized. One way to do this is to use appropriate green waste to produce heat. Around one-third of green waste could be used in biomass power plants to generate electricity and heat.

1.13.6. Landfills

Sending waste containing large amounts of organic biodegradable material to landfills, which can contribute to the formation of methane and methane emissions, has been prohibited since June 2005. Only about 110 former household waste landfills were still operational in 2011 (see Table 14). A requirement for continued operation was compliance with all statutory requirements for liners and collection and treatment of leachate and landfill gas. According to the Landfill Ordinance, only waste containing less than 3 percent by weight total organic carbon (TOC) or that does not contribute to gas formation may be stored in those landfills.

Household waste landfills were shut down or remediated in compliance with statutory requirements. For the larger centralized landfills, this includes regular active landfill degasification with use of the energy. For smaller landfills with a low level of gas formation, oxidation of the methane usually takes place in the revegetation level.

The breakdown of biodegradable waste in the landfill (in situ stabilization) can be accelerated using the controlled addition of limited amounts of air and water. At the same time, the landfill body is converted from an anaerobic state with methane formation to an aerobic state with very little remaining methane formation. The accelerated organic breakdown also shortens the aftercare period. Investments in measures of this kind have been funded by the National Climate Initiative since early 2013.

No more biodegradable waste may be sent to landfills, and the biodegradation of the waste sent to landfills before 2005 is progressing, so methane emissions from landfills will continue to decrease from their current low level and then disappear over the next few years.

Table 14: Changes in quantities of biodegradable waste sent to landfills, including number of landfills and methane emissions

	1990	1993	1999	2003	2008	2011
Number of (former) landfills for house-hold waste	8 273	562	376	302	130	110

Waste with a higher biodegradable fraction [million t], such as household waste	44.3	27.8	15.5	11	0	0
Estimated methane emissions from landfills *) [million t]	1.84	1.86	1.24	0.99	0.67	0.53

Development of quantities of biodegradable waste sent to landfills, including number of landfills and methane emissions

Source: National Inventory Report 2013[46]

1.13.7. Effect on greenhouse gas emissions

Germany had a study done in 2008/2009 to determine the potential for climate protection offered by waste management.[47] According to it, emissions from waste management which are harmful to climate declined from 38 million tonnes CO_2 equivalents in 1990 by some 56 million tonnes to a net reduction of around 18 million tonnes CO_2 equivalents at the end of 2006. Recovery from all municipal waste is to be more consistent by 2020 as a result of further expanding separate collection with a preference for material recovery and by increasing the efficiency of recovery. Sending waste to landfills is to be avoided to the extent possible.

According to new calculations by the Federal Environment Agency (UBA), taking into account the actual collection of landfill gas and residual gas emissions from existing landfill sites, methane emissions from landfills fell by around 64%, from 1.84 million tonnes in 1990 to 0.67 million tonnes in 2008 and further to 0.53 million tonnes in 2011[48] (see section 2.9.6). This is equivalent to a total reduction of 27.5 million tonnes CO_2 equivalents up to 2011.

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[46] The source of the data on emissions is the National Inventory Report (NIR) 2013.*) Due to the requirements to use measurements instead of estimates for emission reporting, methane emissions from landfills are much higher than they were in the Fifth National Report. There was previously no complete data on the quantities of landfill gas collected. The collection rates for landfill gas in emission reporting were determined using qualified estimates. The Federal Statistical Office compiled data on total quantities of landfill gas collected from all landfills for the first time in 2012. The statistics show a much lower collection rate than previously indicated. The 2013 NIR therefore required back-calculations, which result in much higher methane emissions from landfills compared with levels in the Fifth National Report.

[47] ifeu/ Öko-Institut 2010.

[48] UBA 2013c.

Municipal waste incineration plants handle the largest quantities of residual municipal waste, approximately 19 million tonnes. The energy generated in 2009 was 7.7 TWh of electricity, and 14.2 TWh of heat was exported. Municipal waste incineration plants therefore achieved a net reduction in fossil CO_2 emissions of 3.9 million tonnes, taking into account energy purchased from external sources and metal recovered from incineration residues.

Digestion of biowaste from households offers additional potential for reducing CO_2 emissions. EFEU and Öko-Institut estimate that improving biowaste recovery can save as much as 2 million tonnes CO_2 equivalent by 2020.

1.14. Resource efficiency

Natural resources, particularly raw materials, are important production factors and therefore serve as the basis of our prosperity. Over 68 million tonnes of raw materials were used in 2009, about one-third more than in 2000, two-thirds more than in 1990, and about twice as much as in the late 1970s. Demand for raw materials continues to increase sharply, with the world population projected to exceed 9 billion people in 2050 and the emerging economies expected to enjoy rapid economic development. Per capita consumption of raw materials in the industrialized countries is currently about four times higher than in less developed countries. Using natural resources carefully and efficiently will therefore be a key competency in future societies. Germany is well equipped to proceed with an economic approach that uses resources efficiently as the world changes. An increase in resource efficiency can limit environmental pollution, increase the competitiveness of German industry, create new jobs, and promote employment. Back in 2002 the federal government included the goal of doubling the productivity of raw materials in Germany between 1994 and 2020 in its national sustainability strategy. The German resource efficiency programme that was adopted by the federal government on 29 February 2012 is intended to achieve that objective of the sustainability strategy.

1.14.1. Consumption and productivity of resources

The efficient use of resources can make an important contribution to climate protection. In 2002 Germany included in its national sustainability strategy the goal of doubling the productivity of raw materials in Germany between 1994 and 2020. The productivity of raw materials had risen 47% by 2010. Overall, this indicator has moved in the right direction, although the rate of increase over the past five years would not be sufficient to meet the target. Still, this indicator will have gone 82% of the way toward reaching the objective by 2020.

The average cost of raw materials and supplies accounted for at least 45% of the gross production value of companies in the manufacturing industry in 2008, more than twice as much as the percentage for wages, which was 18% in 2008. In sectors that are particularly dependent on raw materials prices, such as the automotive and mechanical engineering industries, material costs already make up over 50% of gross production value. Still, many companies have focused their attention on increasing the productivity of labour. While the productivity of materials increased by a factor of 2 in Germany from 1960 to 2005, labour productivity grew by a factor of 4 during the same period.

The use of biotic (renewable) raw materials can also help conserve abiotic raw materials. The use of renewable raw materials offers considerable opportunities for developing new technologies and products that use resources efficiently.

Germany can already point to some success in increasing resource efficiency. The concept of conserving resources is enshrined in laws on permitting facilities and plants. According to the Federal Pollution Control Act (Bundesimmissionsschutzgesetz), plants that are subject to permitting must be built and run so that state-of-the-art measures prevent harmful effects on the environment.

Waste management offers an important instrument for extracting and producing what are known as secondary raw materials. Internalizing disposal costs and imposing strict environmental requirements create incentives for waste avoidance, promote waste recovery, and reduce inputs of raw materials. Including general priority for avoidance and recovery along with product responsibility in laws on waste and prohibiting untreated municipal waste in landfills have considerably increased the collection and recovery rates for municipal waste since the 1990s (see section 1.13)

1.15. Municipal wastewater disposal

1.15.1. Municipal wastewater generation

In Germany, 95.7% of the population is connected to public wastewater treatment plants.[49] Seventy-nine percent of wastewater from the rest of the population is discharged into small treatment plants, and some 21% into septic tanks. The 9,900 municipal sewage treatment plants handle about 10 billion m^3 of municipal wastewater from homes and businesses. Half of the wastewater is used water and half is precipitation and infiltration water. In terms of population equivalents (PE), the wastewater has a load of approximately 125 million PE. One PE is equivalent to a chemical oxygen demand (COD) of 120 g. Approximately 1.1 billion m^3 of wastewater is treated in industrial sewage treatment plants.

1.15.2. Greenhouse gas emissions from municipal wastewater treatment plants and small private treatment systems

Municipal wastewater treatment in Germany normally takes place under aerobic conditions (municipal wastewater treatment plants and small private treatment systems), i.e., methane emissions are very low. Open digestion for sludge stabilization, which did cause methane emissions, was abolished in 1994. Sludge stabilization using anaerobic digestion can be economical for municipal wastewater treatment plants above 50,000 PE; the methane that is produced is collected and used to produce energy. However, uncontrolled anaerobic processes can cause methane to be produced in the septic tanks of homes that are not connected to the public sewer system or to small treatment plants. A total of 574,600 people were still discharging wastewater into septic tanks in 2010.[50] However, the organic load discharged into septic tanks has been drastically reduced since 1990, resulting in a strong downward trend for methane emissions (from 180 kt/a in 1990 to 13 kt/a in 2009[51]).

Nitrous oxide (N_2O) emissions can be a by-product of municipal wastewater treatment, particularly as a result of denitrification, during which gaseous end products (primarily molecular nitrogen) are produced from nitrate. The level of nitrous

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[49] Federal Statistical Office 2012b.
[50] Ibid.
[51] UBA 2011b.

oxide emissions in the wastewater sector depends on the per capita discharge of protein, so it is directly related to lifestyles and consumption patterns.

According to calculations done for the 2012 National Inventory Report,[52] 3,370 tonnes of methane (70,800 tonnes CDE) and 7,430 tonnes of nitrous oxide (2,303,300 tonnes CDE) were produced by municipal wastewater treatment plants in 2010, a total of almost 2.4 million tonnes CDE. Methane emissions from wastewater treatment have declined by 93.8% since 1990, while nitrous oxide emissions have risen 3.6%.

1.15.3. Energy consumption and electricity generation by municipal wastewater treatment plants

The energy consumption of municipal wastewater treatment plants decreased from 4,400 GWh per year to 4,200 GWh per year between 2005 and 2010. Larger plants consume less electricity per population equivalent (PE) per year. For example, plants in size class 1 (<1,000 PE) consume 75 kWh/PE/a, while plants with more than 100,000 PE consume only 32 kWh/PE/a.[53] Ninety percent of the population equivalents are treated in plants that treat more than 10,000 PE. Those plants consume 87% of the electricity consumed by wastewater treatment plants.

Electricity generation by wastewater treatment plants increased from 870 GWh per year in 2005 to 1,100 GWh per year in 2010. Approximately 92% of the electricity that was generated was used by the plants for their own power supply.

1.15.4. Legal basis

The version of the Water Management Act (Wasserhaushaltsgesetz) dated 05 December 2012 specifies that the energy efficiency of wastewater treatment plants is a criterion for establishing the state of the art.

[52] UBA 2012a.
[53] UBA 2009b.

2. Inventory of anthropogenic emissions of greenhouse gases

Germany submitted the National Inventory Report (NIR 2013), which describes the methods and data sources on which the calculations of German greenhouse gas emissions are based, on 15 April 2013 in accordance with decision 3/CP.5, along with the Greenhouse Gas Inventories covering the period from 1990 to 2011. The descriptions in this chapter are based on the 2013 National Inventory Report. Refer to the National Inventory Report for further details and for information on the determination and calculation of emission inventories.[54]

Information on the direct greenhouse gases carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) is provided below.

2.1. Presentation, determination and structure of emission data

Greenhouse gas emissions in Germany are presented for the years 1990 to 2011 in summary tables and tables showing trends for specific substances. To highlight changes in emissions, those trends are also presented in graphic form.

Detailed information on emissions is contained in inventories published annually in the Common Reporting Format (CRF). The data used in this report corresponds to the corrected emission data submitted to the UNFCCC on 15 April 2013.[55]

2.2. Accuracy of emission data

Emission inventories are fraught with uncertainty, and determining those uncertainties should serve as an aid for improving the precision of the inventories. Uncertainties are estimated when data is collected and therefore during the emissions reporting process under the heading of data collection. In contrast, the aggregation of such uncertainties cannot take place until the inventory is generated or following the emission reporting cycle.

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[54] The National Inventory Report is available at http://www.uba.de/uba-info-medien/4503.html.

[55] The CRF tables of the National Greenhouse Gas Inventories are available at http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/deu-2013-crf-11apr.zip.

When calculating and aggregating uncertainties, the uncertainties concerning activity rates and emission factors, which have generally been estimated by experts at the lowest level of the source groups in the ZSE (Central Emission System) database used to calculate emissions, are converted into uncertainties for emissions and aggregated. Aggregation of the uncertainties according to Tier 1 as specified in the IPCC Good Practice Guidance[56] is done once a year at the end of the reporting cycle for the current reporting year. Uncertainty is also estimated using the IPCC Tier 2 method every three years.

In the current NIR 2013, Germany reports uncertainties determined using the Tier 1 method. This involved having the experts from the specialized units at the Federal Environment Agency (UBA) who supplied the data and outside institutions estimate the individual uncertainties.

The total uncertainty of the Inventory for 2011 according to Tier 1 is 6.3% (level) or 6.5% (trend).

Total nitrous oxide emissions were a major contributor to the overall uncertainty, primarily due to nitrous oxide emissions from agricultural soils (CRF 4.D).

CO_2 emissions from the fuel combustion sector (CRF 1.A) also make a considerable contribution to the total uncertainty. Solid fuels from public electricity and heat production (CRF 1.A.1.a) and mobile sources (CRF 1.A.3) with an emphasis on road transport (CRF 1.A.3.b) and combustion by commercial/institutional activities and households (CRF 1.A.4.a/b) predominate.

Other major contributors are CO_2 sinks and sources from the LULUCF sector and methane emissions from solid waste disposal (CRF 6.A) and livestock raising (enteric fermentation, CRF 4.A).

Detailed information on uncertainties in this area can be found in NIR 2013 (chapters 1.7.2 and 18).

2.3. Greenhouse gas emissions 1990-2011

When the Kyoto Protocol entered into force in February 2005, the international community of nations promised to develop binding targets for action and

[56] IPCC 2000

implementation instruments for global climate protection. The European Community (which had 15 Member States at that time) made the commitment to reduce its greenhouse gas emission during the 2008-2012 period by 8% from the base year (1990 or 1995).[57] That commitment was divided among the participating Member States as part of burden sharing.[58] As a result, Germany made the commitment to reduce emissions by 21% from the base year, a considerable contribution to fulfilment of the EU commitment.

The commitment to reduce greenhouse gas emissions as part of EU burden sharing was fulfilled again in 2011 with a 25.6% reduction from the base year. The individual greenhouse gases contributed to the change in different ways. Emissions of the direct greenhouse gases that dominate in terms of quantity, primarily methane, were reduced considerably. The main causes of this are as follows:

- Change from the use of solid fuels to low-emission liquid and gaseous fuels since 1990
- Increased use of renewable energy sources and the associated substitution for fossil fuels
- More efficient plants and facilities
- Changes in livestock raising conditions and reduction of herd sizes
- Fulfilment of statutory provisions on waste management

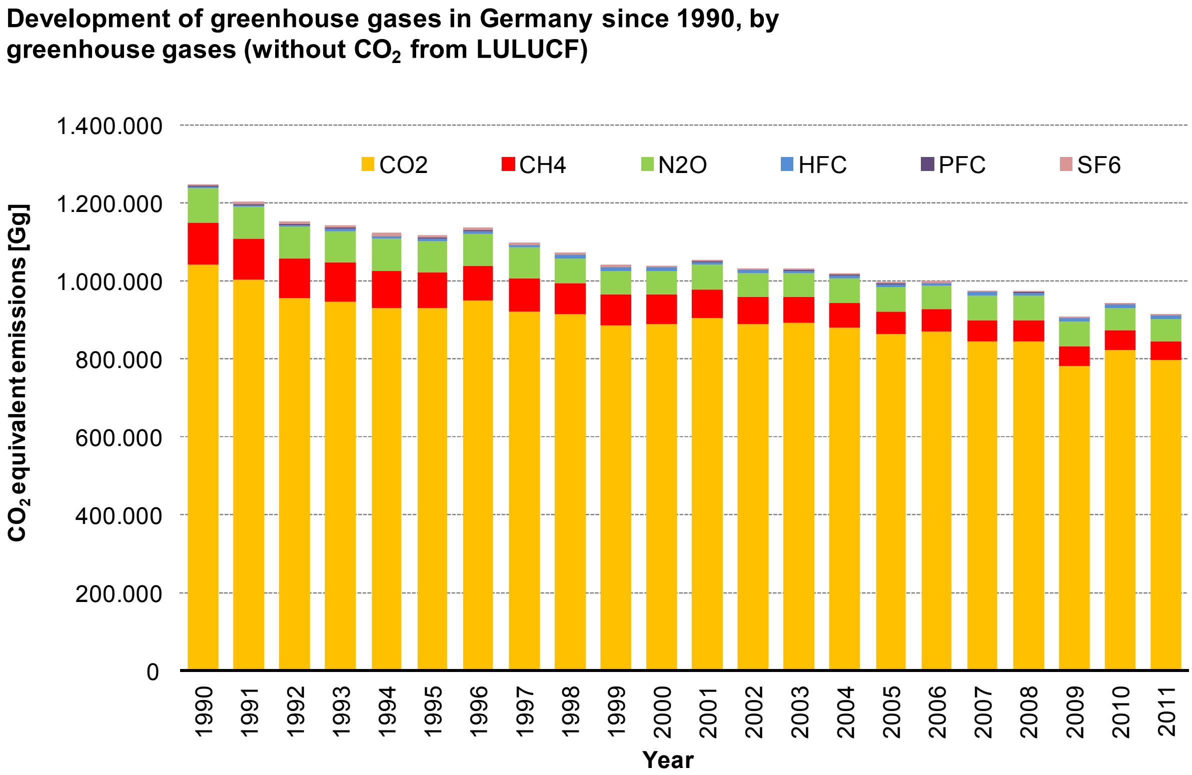
Changes in greenhouse gas emissions in Germany since 1990 are shown in Table 15 for the individual greenhouse gases and in Figure 11 as total CO_2 equivalents (CDE) in graphic form. Detailed tables are contained in NIR 2013, annex section 22.3. CO_2 emissions, at 87.1%, were the main cause of greenhouse gas emissions in 2011 as well. Most of them came from stationary and mobile combustion of fossil fuels. The relative share of CO_2 emissions in total greenhouse gas emissions has risen by 4 percentage points since the base year due to the disproportionate reduction in emissions of other greenhouse gases. Methane (CH_4) emissions, most of which are caused by livestock raising, fuel distribution, and landfills, accounted for

[57] For HFCs, PFCs and SF_6.

[58] Burden Sharing Agreement: Adopted in Council Decision 2002/358/EC of 25 April 2002 concerning the approval, on behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the joint fulfilment of commitments thereunder [Official Journal L 130 of 15 May 2002].

a 5.3% share in 2010. Most emissions of nitrous oxide (N_2O) came from agriculture, industrial processes, and the combustion of fossil fuels, contributing 6.2% of greenhouse gas emissions. Fluorinated gases (known as F-gases) contributed about 1.4% to total emissions. The distribution of greenhouse gas emissions in Germany is typical of a highly developed, industrialized country.

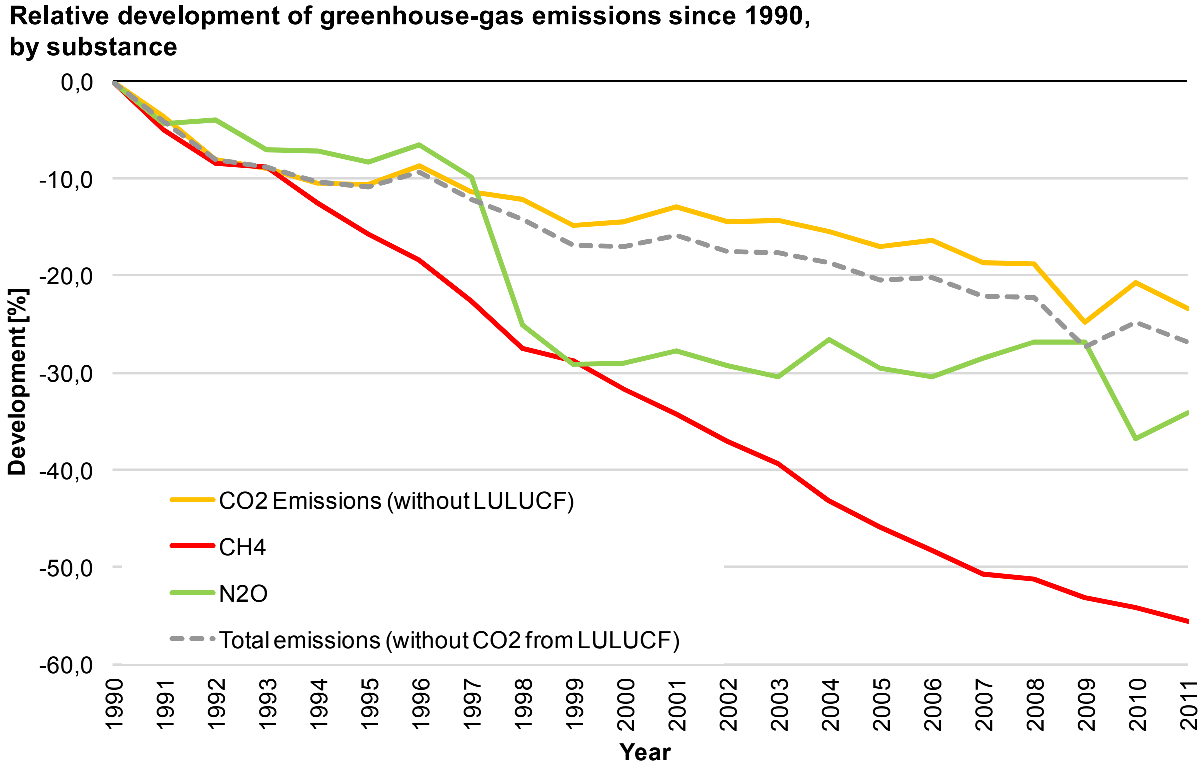
Figure 11: Development of greenhouse gases in Germany since 1990, by greenhouse gases



Source: UBA 2013c

The trend for these developments, based on 1990, is summarized in Table 14. Major reductions in the direct greenhouse gases that are present in the largest quantities were achieved during the period under consideration.

Figure 12: Relative development of greenhouse gas emissions since 1990

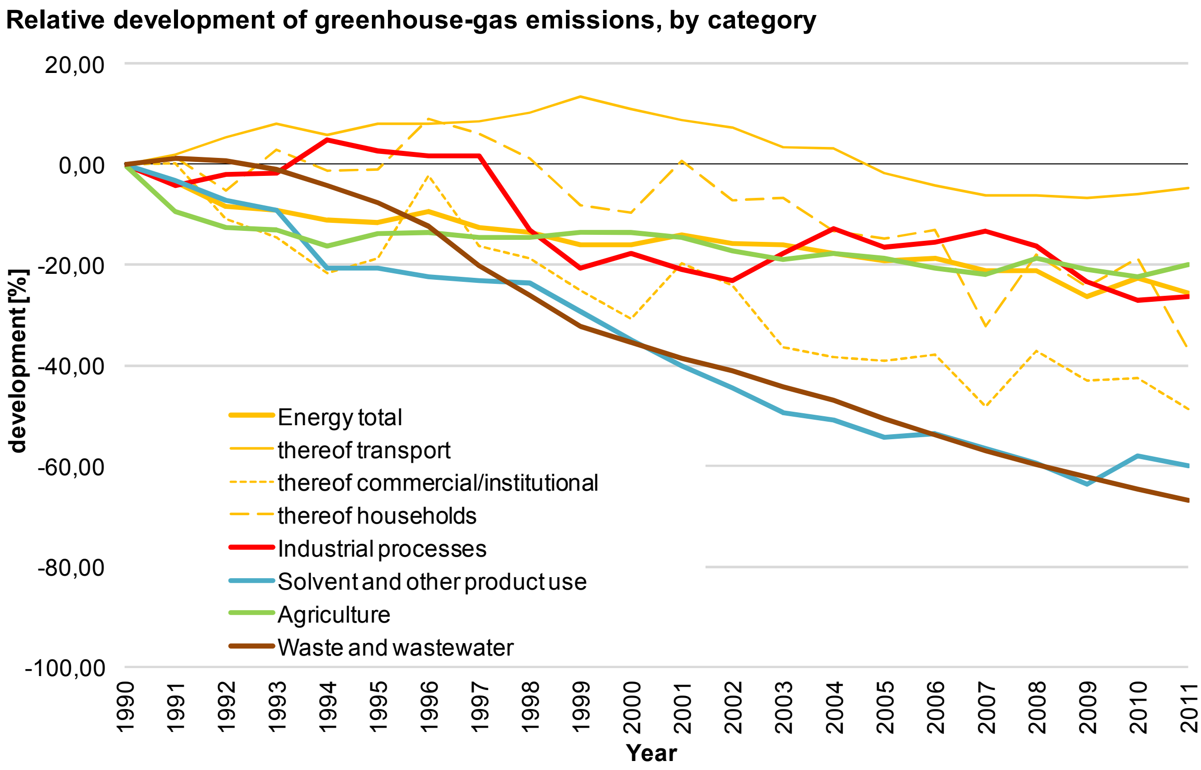


Source: UBA 2013c

Figure 11 shows the relative development of emissions by source group since 1990.

Overall, Germany is well on its way to fulfilling the commitments it made during the first commitment period of the Kyoto Protocol. Provisional estimates show that greenhouse gas emissions were some 25% less than their 1990 level in 2012, as well, which is much lower than the target for the 2008-2012 period.

Figure 13: Development of greenhouse gas emissions since 1990, by category



Source: UBA 2013c

Table 15: Emissions trends in Germany since 1990, by greenhouse gas

Emissions Trends	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
												(Gg)											
Net CO_2 emissions/removals[2]	1.005.890	1.005.890	968.485	921.476	912.499	896.650	895.151	916.031	887.270	879.696	852.522	856.337	866.438	897.213	899.439	888.002	871.823	877.524	854.680	853.256	791.974	834.511	807.118
CO_2 emissions (without LUCF)[2]	1.041.914	1.041.914	1.004.595	957.437	948.543	932.360	930.781	951.757	922.957	915.050	887.781	891.400	907.443	890.751	892.932	881.034	864.716	870.739	847.397	845.761	783.734	826.063	798.058
CH_4	5.236	5.236	4.972	4.796	4.773	4.580	4.411	4.272	4.052	3.798	3.727	3.576	3.442	3.295	3.173	2.972	2.833	2.709	2.582	2.553	2.453	2.399	2.326
N_2O	280	280	268	269	260	260	257	262	253	210	199	199	202	198	195	205	197	195	200	205	205	177	184
HFCs (CO_2 equivalent)	7.012	4.592	4.214	4.377	6.361	6.853	7.012	6.699	7.460	8.167	8.453	7.623	8.578	9.056	8.412	8.507	8.640	8.708	8.742	8.843	9.443	8.963	9.177
PFCs (CO_2 equivalent)	1.780	2.627	2.277	2.062	1.931	1.640	1.780	1.738	1.398	1.506	1.249	792	724	789	847	814	695	550	484	472	338	285	230
SF_6 (CO_2 equivalent)	6.779	4.642	4.975	5.491	6.262	6.551	6.779	6.460	6.404	6.173	4.497	4.269	3.933	3.236	3.181	3.400	3.480	3.398	3.334	3.115	3.065	3.194	3.316

Emissions Trends Changes compared to base year[1]	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
												(%)											
Net CO_2 emissions/removals[2]		0,0	-3,7	-8,4	-9,3	-10,9	-11,0	-8,9	-11,8	-12,5	-15,2	-14,9	-13,9	-10,8	-10,6	-11,7	-13,3	-12,8	-15,0	-15,2	-21,3	-17,0	-19,8
CO_2 emissions (without LUCF)[2]		0,0	-3,6	-8,1	-9,0	-10,5	-10,7	-8,7	-11,4	-12,2	-14,8	-14,4	-12,9	-14,5	-14,3	-15,4	-17,0	-16,4	-18,7	-18,8	-24,8	-20,7	-23,4
CH_4		0,0	-5,0	-8,4	-8,8	-12,5	-15,7	-18,4	-22,6	-27,5	-28,8	-31,7	-34,3	-37,1	-39,4	-43,2	-45,9	-48,3	-50,7	-51,2	-53,2	-54,2	-55,6
N_2O		0,0	-4,3	-4,0	-7,0	-7,1	-8,3	-6,5	-9,8	-25,1	-29,1	-29,0	-27,7	-29,3	-30,5	-26,6	-29,5	-30,5	-28,5	-26,9	-26,9	-36,8	-34,2
HFCs							0,0	-4,5	+6,4	+16,5	+20,5	+8,7	+22,3	+29,1	+20,0	+21,3	+23,2	+24,2	+24,7	+26,1	+34,7	+27,8	+30,9
PFCs							0,0	-2,4	-21,5	-15,4	-29,8	-55,5	-59,3	-55,7	-52,4	-54,3	-61,0	-69,1	-72,8	-73,5	-81,0	-84,0	-87,1
SF_6							0,0	-4,7	-5,5	-8,9	-33,7	-37,0	-42,0	-52,3	-53,1	-49,8	-48,7	-49,9	-50,8	-54,1	-54,8	-52,9	-51,1
Total GHG Emission and Removal trends																							
Total Emissions/Removals with LULUCF[2]	1.218.216	0,0	-4,2	-8,3	-9,0	-10,6	-11,1	-9,6	-12,5	-14,6	-17,4	-17,4	-16,7	-14,6	-14,7	-15,7	-17,5	-17,3	-19,3	-19,3	-24,5	-21,8	-24,0
Total Emissions without CO_2 from LULUCF[2]	1.254.239	0,0	-4,0	-8,0	-8,8	-10,4	-10,8	-9,3	-12,2	-14,2	-16,9	-17,0	-15,8	-17,5	-17,7	-18,7	-20,4	-20,2	-22,2	-22,2	-27,3	-24,8	-26,9
Total Emission wrt EU burden sharing	1.232.430	+1,5	-2,3	-6,4	-7,2	-8,8	-9,2	-7,7	-10,6	-12,7	-15,5	-15,5	-14,3	-16,1	-16,2	-17,2	-19,0	-18,8	-20,8	-20,9	-26,0	-23,4	-25,6

Emissions Trends Changes compared to previous year	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
												(%)											
Net CO_2 emissions/removals[2]		0,0	-3,7	-4,9	-1,0	-1,7	-0,2	+2,3	-3,1	-0,9	-3,1	+0,4	+1,2	+3,6	+0,2	-1,3	-1,8	+0,7	-2,6	-0,2	-7,2	+5,4	-3,3
CO_2 emissions (without LUCF)[2]		0,0	-3,6	-4,7	-0,9	-1,7	-0,2	+2,3	-3,0	-0,9	-3,0	+0,4	+1,8	-1,8	+0,2	-1,3	-1,9	+0,7	-2,7	-0,2	-7,3	+5,4	-3,4
CH_4		0,0	-5,0	-3,5	-0,5	-4,0	-3,7	-3,1	-5,2	-6,3	-1,9	-4,0	-3,8	-4,3	-3,7	-6,3	-4,7	-4,4	-4,7	-1,1	-3,9	-2,2	-3,1
N_2O		0,0	-4,3	+0,3	-3,1	-0,2	-1,2	+2,0	-3,5	-17,0	-5,3	+0,2	+1,7	-2,1	-1,7	+5,5	-3,9	-1,3	+2,8	+2,3	+0,1	-13,5	+4,1
HFCs		0,0	-8,2	+3,9	+45,3	+7,7	+2,3	-4,5	+11,3	+9,5	+3,5	-9,8	+12,5	+5,6	-7,1	+1,1	+1,6	+0,8	+0,4	+1,2	+6,8	-5,1	+2,4
PFCs		0,0	-13,3	-9,4	-6,4	-15,1	+8,5	-2,4	-19,6	+7,8	-17,1	-36,6	-8,5	+9,0	+7,2	-3,8	-14,7	-20,7	-12,1	-2,4	-28,5	-15,5	-19,5
SF_6		0,0	+7,2	+10,4	+14,0	+4,6	+3,5	-4,7	-0,9	-3,6	-27,2	-5,1	-7,9	-17,7	-1,7	+6,9	+2,4	-2,4	-1,9	-6,6	-1,6	+4,2	+3,8
Total GHG Emissions and Removal Trends																							
Total Emissions/Removals with LULUCF[2]		0,0	-3,9	-4,3	-0,8	-1,8	-0,5	+1,7	-3,3	-2,4	-3,2	-0,1	+0,9	+2,6	-0,2	-1,2	-2,1	+0,2	-2,4	-0,1	-6,4	+3,5	-2,8
Total Emissions without CO_2 from LULUCF[2]		0,0	-3,8	-4,2	-0,8	-1,7	-0,5	+1,7	-3,2	-2,4	-3,1	-0,1	+1,4	-2,0	-0,2	-1,2	-2,1	+0,2	-2,4	-0,1	-6,5	+3,5	-2,9

Source: UBA 2013c

2.3.1. Carbon dioxide (CO_2)

The reduction in CO_2 emissions is closely linked to trends in the energy sector. The sharp emissions reduction in this area seen in the early 1990s was primarily the result of restructuring in the new German Länder, including switching to cleaner fuels and decommissioning obsolete facilities. The subsequent decline since the mid-1990s is primarily attributable to the effect of climate change mitigation measures. The changes in the fuel mix have continued, to a somewhat lesser degree, up to the current report year.

Use of gases, primarily natural gas, as substitutes for solid and liquid fuels is also reflected in emissions trends for stationary combustion systems. While CO_2 emissions from liquid fuels decreased by about a quarter, with respect to their levels in 1990, and emissions from solid fuels decreased by almost half, emissions from gaseous fuels increased by nearly 50%.

When these emissions trends are viewed at the level of individual source categories, a highly consistent picture emerges. In comparison to 1990 levels, emissions in all source categories of energy-related emissions decreased by a total of nearly 236 million tonnes CO_2.

Comparable, but specific (when seen at the detailed level), developments took place in the transport sector. CO_2 emissions increased slightly from 1990 to 1999. Since then, they have fallen below their outset level, to just under 153 million tonnes in 2011, as a result of decreases in consumption, substitution of diesel fuel for petrol and increasing use of biodiesel. Consumers' shifting of fuel purchases to other countries has played a lesser role. Diesel fuel's share in total fuel consumption for road transport increased sharply throughout the entire period in question. In 1990, nearly two-thirds of all road traffic emissions were still being caused by petrol consumption. Now, the relationship is nearly reversed, and diesel emissions predominate.

2.3.2. Nitrous oxide (N_2O)

Since 1990, N_2O emissions have decreased by about 34.2%. The main emissions sources are the use of nitrogen-containing fertilisers in agriculture, the chemical industry, use of fossil fuels, and livestock raising. Smaller amounts of emissions are caused by wastewater treatment and product use of N_2O (for example, as an anaesthetic). Industry has had the greatest influence on emissions reductions, especially in the area of adipic acid production from 1997 to 2009. As a result of technological reduction measures, the chemical industry's emissions have been reduced by about 80%, with respect to 1990. Since 1999, emissions trends have been strongly influenced by economic trends in the chemical industry sector. Emissions from adipic acid production decreased drastically from 2009 to 2010 as a result of one producer's installation of a second redundant waste gas treatment system.

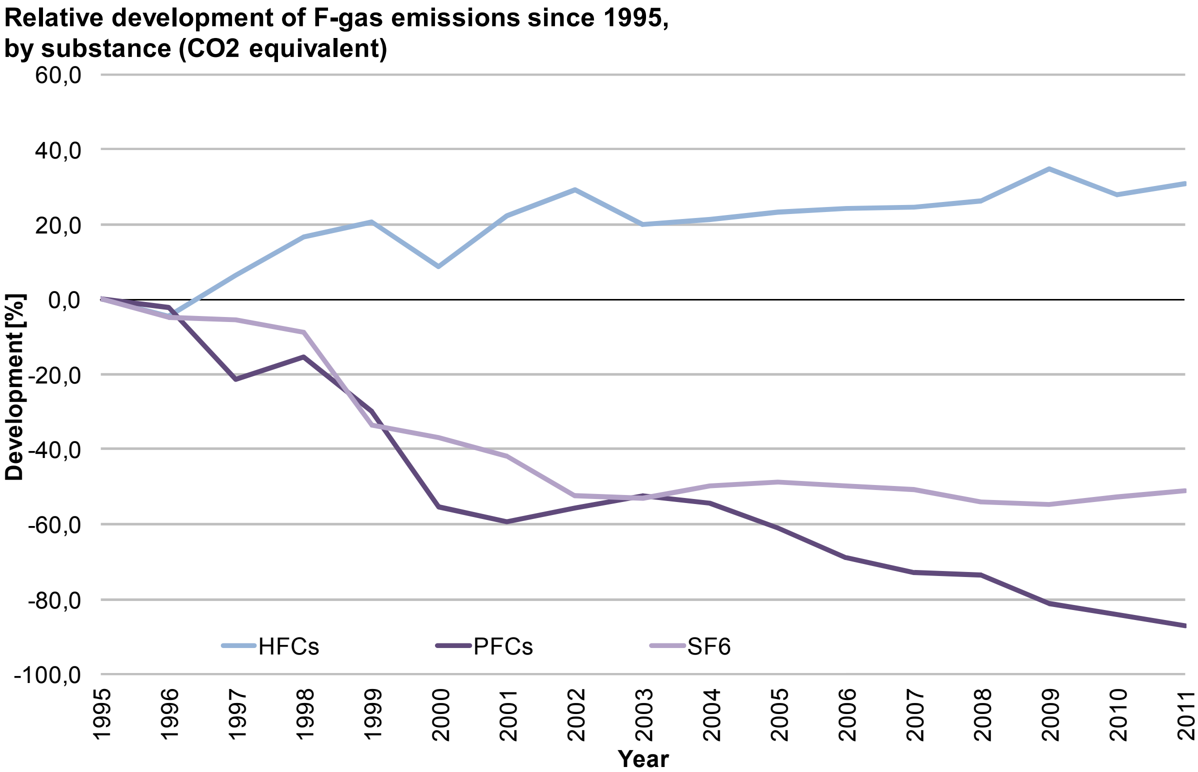
2.3.3. Methane (CH_4)

Methane emissions are caused mainly by animal husbandry in agriculture, waste landfilling and distribution of liquid and gaseous fuels. Energy-related and process-related emissions and emissions from wastewater treatment play an almost negligible role. Methane emissions have been reduced by 55.6% since 1990. This trend has been primarily the result of environmental policy measures (waste separation with intensified recycling and increasing energy recovery from waste) which have decreased landfilling of organic waste. A second important factor is that energy recovery from coal mine gas has increased, while overall production of such gas has decreased (due to the closure of coal mines). Emissions in this area have decreased by nearly 80% since 1990. Yet another reason for the emissions reductions is that livestock populations in the new Länder have been reduced, with reductions occurring especially in the first half of the 1990s. Repairs and modernisations of outdated gas distribution networks in that part of Germany, along with improvements in fuel distribution, have brought about further reductions in total emissions.

2.3.4. F-gases

Figure 14 shows emissions trends for F-gases for the period 1995-2011. HFC emissions increased primarily as a result of intensified use of HFCs as refrigerants in refrigeration systems and of increasing disposal of those systems. This more than offset emissions reductions resulting from their reduced use in PUR installation foams. The emissions reductions for PFCs were achieved primarily through efforts of primary aluminium producers and semiconductor manufacturers. The SF_6 emissions reduction until 2003 is due primarily to decreasing use of the gas in automobile tyres since the mid-1990s. In this area, efforts to increase environmental awareness have been successful, resulting in emissions reductions of over 100 tonnes and greenhouse gas reductions of 2.5 million tonnes of CO_2 equivalents. Similar success has been achieved with soundproof windows, for which production use of SF_6 has been reduced to nearly zero since 1995. The majority of current and future emissions of this substance will result from open disposal of old windows. Emissions from electricity transmission facilities have also decreased considerably. Important new emissions sources include welding, production of solar cells and production of glass fibre optics.

Figure 14: Relative development of F-gas emissions since 1995



Source: UBA 2013c

2.4. Description of the National System of Emissions Inventories

Article 5.1 of the Kyoto Protocol mandates the establishment of National Systems for preparation of greenhouse gas emissions inventories. The National System for Germany fulfils the requirements of the Guidelines for National Systems (UNFCCC

Decision 19/CMP.1), which are binding under the Kyoto Protocol and Decision 280/2004/EC.

The National System provides for the preparation of inventories conforming to the principles of transparency, consistency, comparability, completeness and accuracy.

Such conformance is achieved through extensive use of the methodological regulations from the IPCC Guidelines and the IPCC Good Practice Guidance, through ongoing quality management and through continuous inventory improvement.

The institutionalization of the National System was expanded up to 2011 based on an agreement among undersecretaries of the participating ministries in 2007. This was originally done by creating a national Co-ordination Committee and an in-house directive (Hausanordnung) for the Federal Environment Agency. Further institutionalization was achieved through agreements with other federal institutions, industrial associations or individual companies.

Institutionalization and operation of the National System in accordance with requirements has been confirmed by all previous reviews under the Kyoto protocol.

Single National Entity
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Emission Situation Department (I 2.6)
Federal Environment Agency (UBA)
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06844 Dessau
michael.strogies@uba.de
Tel. +49 340 2103-2088

The National System was primarily institutionalized on three levels: the ministerial level, the level of the Federal Environment Agency and the level outside of the federal administration.

In Germany, the National System has been established at ministerial level, under the leadership of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) based on an agreement between the undersecretaries of the participating ministries in a policy paper, “National Emissions Reporting System”, dated 5 June 2007. The System now incorporates other German ministries, including the Federal Ministry of the Interior (BMI), the Federal Ministry of Defence (BMVg), the Federal Ministry of Finance (BMF), the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV), so all of the key institutions that are in a position to make high-quality specialised contributions are now involved. The policy paper defines the responsibilities of the federal ministries and specifies that the national System will be based on existing data streams. Where the data streams are incomplete, the gaps are to be remedied by appropriate activities in the responsible ministries. The participating ministries created a National Co-ordinating Committee to support the reporting process. The Co-ordinating Committee is also responsible for approving inventories and the reports required by Articles 5, 7 and 8 of the Kyoto Protocol.

The “National Emissions Reporting System” policy paper also assigns the Federal Environment Agency the task of serving as the Single National Entity for Germany. The tasks incumbent on the Single National Entity include planning, generating, and archiving the inventories and the description of them in the inventory reports, as well as quality control and assurance for all steps in the process. The Single National Entity also serves as the central contact point, coordinates and informs all participants in the National System and integrates other specialised units at the level of the Federal Environment Agency into the National System. A working group on emissions inventories was established to coordinate relevant work within the Federal Environment Agency.

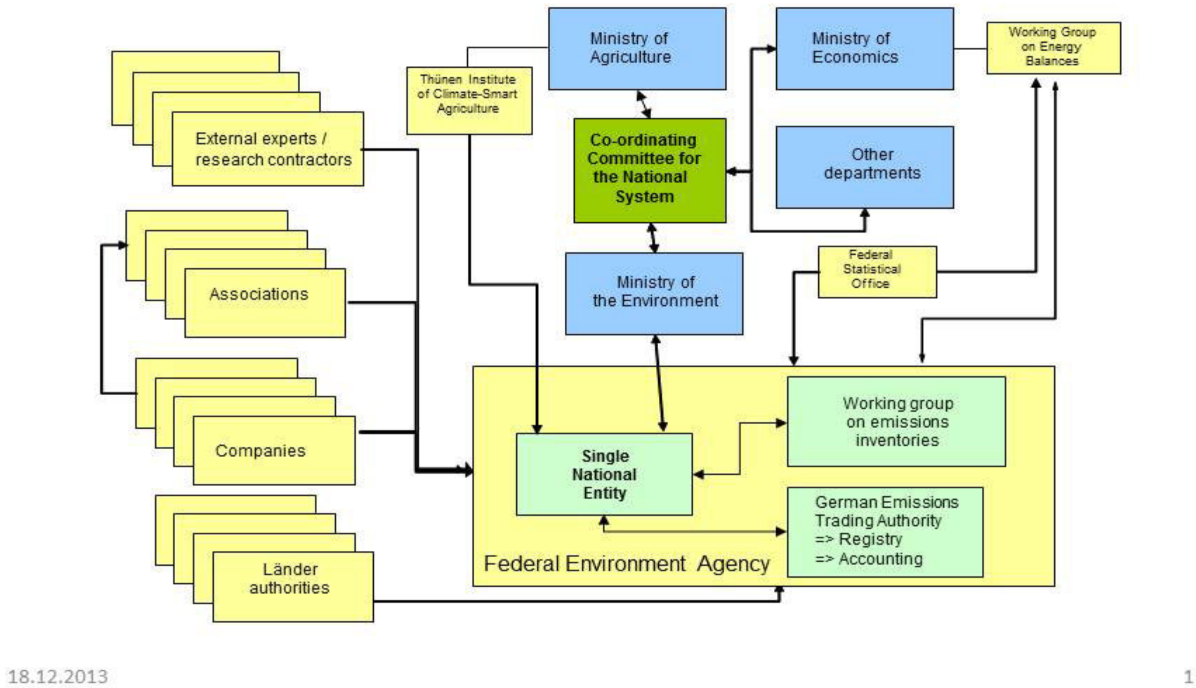
The instruments of the Single National Entity (national coordination agency) are described in detail in section 1.2.1.2 of NIR 2013.

Many institutions and non-governmental organisations are integrated into the National System (see NIR 2013, section 1.2.1.4).

Figure 15 provides an overview of the structure of the three levels of the National System of Emissions in Germany. A detailed description of the National System in Germany can be found in NIR 2013, section 1.2.1.

The “National System” policy paper on emissions reporting of 5 June 2007 is contained in the annex (section 22.1.1) of NIR 2013.

Figure 15: Structure of the National System of Emissions (NaSE)



Source: UBA 2013c

To implement the IPCC Good Practice Guidance on quality control and quality assurance within the Federal Environment Agency, an in-house directive containing a Quality System for Emissions was established in 2005 which applies throughout the emission reporting process. A detailed description of the Quality System for Emissions is contained in sections 1.3.3 and 1.6 of NIR 2013.

2.5. Description of the National Register

In June 2012, the previously existing decentralised registry architecture of the European Emissions Trading scheme was fundamentally changed. The Union Registry introduced an EU-wide standardisation and centralisation of the system, but user accounts are still administered by the Member States. Due to the fact that the Union Registry is developed and operated by the European Commission, most of the requested information on the national registry in accordance with paragraph 32 of the annex to decision 15/CMP.1 needs to be provided by the EU Commission. The contribution for the Sixth German National Communication was provided in the English language by the EU commission on 27 February 2013. The text was retained unchanged and starts in the next paragraph (the German version contains an informal translation into German).[59] The EU Commission pointed out that they have provided comprehensive documentation to the UNFCCC for the re-certification and therefore back up their answers to 15/ CMP.1 annex II.E paragraph 32. The answers to 15/CMP.1 annex II.E paragraph 32 (a), (g) and (h) were specified directly by the German registry.

Directive 2009/29/EC adopted in 2009, provides for the centralization of the EU ETS operations into a single European Union registry operated by the European Commission as well as for the inclusion of the aviation sector. At the same time, and with a view to increasing efficiency in the operations of their respective national registries, the EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway decided to operate their registries in a consolidated manner in accordance with all relevant decisions applicable to the establishment of Party registries - in particular Decision 13/CMP.1 and decision 24/CP.8.

With a view to complying with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011, in addition to implementing the platform shared by the consolidating Parties, the registry of EU has undergone a major re-development. The consolidated platform which implements the national registries in a consolidated manner (including the registry of EU) is called

[59] The original version provided by the Commission is used here.

Consolidated System of EU registries (CSEUR) and was developed together with the new EU registry on the basis the following modalities:

(1) Each Party retains its organization designated as its registry administrator to maintain the national registry of that Party and remains responsible for all the obligations of Parties that are to be fulfilled through registries;

(2) Each Kyoto unit issued by the Parties in such a consolidated system is issued by one of the constituent Parties and continues to carry the Party of origin identifier in its unique serial number;

(3) Each Party retains its own set of national accounts as required by paragraph 21 of the Annex to Decision 15/CMP.1. Each account within a national registry keeps a unique account number comprising the identifier of the Party and a unique number within the Party where the account is maintained;

(4) Kyoto transactions continue to be forwarded to and checked by the UNFCCC Independent Transaction Log (ITL), which remains responsible for verifying the accuracy and validity of those transactions;

(5) The transaction log and registries continue to reconcile their data with each other in order to ensure data consistency and facilitate the automated checks of the ITL;

(6) The requirements of paragraphs 44 to 48 of the Annex to Decision 13/CMP.1 concerning making non-confidential information accessible to the public would be fulfilled by each Party individually;

(7) All registries reside on a consolidated IT platform sharing the same infrastructure technologies. The chosen architecture implements modalities to ensure that the consolidated national registries are uniquely identifiable, protected and distinguishable from each other, notably:

(a) With regards to the data exchange, each national registry connects to the ITL directly and establishes a distinct and secure communication link through a consolidated communication channel (VPN tunnel);

(b) The ITL remains responsible for authenticating the national registries and takes the full and final record of all transactions involving Kyoto units and other administrative processes such that those actions cannot be disputed or repudiated;

(c) With regards to the data storage, the consolidated platform continues to guarantee that data is kept confidential and protected against unauthorized manipulation;

(d) The data storage architecture also ensures that the data pertaining to a national registry are distinguishable and uniquely identifiable from the data pertaining to other consolidated national registries;

(e) In addition, each consolidated national registry keeps a distinct user access entry point (URL) and a distinct set of authorisation and configuration rules.

Following the successful implementation of the CSEUR platform, the 28 national registries concerned were re-certified in June 2012 and switched over to their new national registry on 20 June 2012. During the go-live process, all relevant transaction and holdings data were migrated to the CSEUR platform and the individual connections to and from the ITL were re-established for each Party.

Table 16: Specifications to paragraph 32 of the annex to decision 15/CMP.1

Reporting Item	Description
15/CMP.1 annex II.E paragraph 32.(a) Name or contact	The German registry administration is located in the **German Emissions Trading Authority** (DEHSt) at the Federal Environment Agency. The DEHSt is the competent national authority to implement the market instruments of the Kyoto Protocol. The contact infor-

Reporting Item	Description
	mation is: Umweltbundesamt (UBA) Deutsche Emissionshandelsstelle (DEHSt) Bismarckplatz 1 14193 Berlin Germany The postal address is: Umweltbundesamt (UBA) Deutsche Emissionshandelsstelle (DEHSt) Postfach 33 00 22 14191 Berlin The registry section E 2.4, the central registry administration, consists of nine staff members. The head of section Dr. Thomas Schütz is the German registry administrator.
15/CMP.1 annex II.E paragraph 32.(b) Cooperation arrangement	The EU Member States who are also Parties to the Kyoto Protocol (25) plus Iceland, Liechtenstein and Norway have decided to operate their registries in a consolidated manner. The Consolidated System of EU registries was certified on 1 June 2012 and went to production on 20 June 2012. A complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. This description includes: • Readiness questionnaire • Application logging Change management procedure Disaster recovery • Manual Intervention • Operational Plan

Reporting Item	Description
	• Roles and responsibilities • Security Plan • Time Validation Plan • Version change Management The documents above are provided as an appendix to this document. A new central service desk was also set up to support the registry administrators of the consolidated system. The new service desk acts as 2nd level of support to the local support provided by the Parties. It also plays a key communication role with the ITL Service Desk with regards notably to connectivity or reconciliation issues.
15/CMP.1 annex II.E paragraph 32.(c) Database structure and the capacity of national registry	In 2012, the EU registry has undergone a major redevelopment with a view to comply with the new requirements of Commission Regulation 920/2010 and Commission Regulation 1193/2011 in addition to implementing the Consolidated System of EU registries (CSEUR). The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the Data Exchange Standard (DES). All tests were executed successfully and lead to successful certification on 1 June 2012.
15/CMP.1 annex II.E paragraph 32.(d) Conformance to technical standards	The overall change to a Consolidated System of EU Registries triggered changes the registry software and required new conformance testing. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The doc-

Reporting Item	Description
	umentation is annexed to this submission. During certification, the consolidated registry was notably subject to connectivity testing, connectivity reliability testing, distinctness testing and interoperability testing to demonstrate capacity and conformance to the DES. All tests were executed successfully and lead to successful certification on 1 June 2012.
15/CMP.1 annex II.E paragraph 32.(e) Discrepancies procedures	The overall change to a Consolidated System of EU Registries also triggered changes to discrepancies procedures, as reflected in the updated manual intervention document and the operational plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.[60]
15/CMP.1 annex II.E paragraph 32.(f) Security	The overall change to a Consolidated System of EU Registries also triggered changes to security, as reflected in the updated security plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.
15/CMP.1 annex II.E paragraph 32.(g) List of publicly available information	*1. 13/CMP.1 annex II paragraph 45: Account Information:* The data of all accounts can be viewed online at: http://ec.europa.eu/environment/ets/account.do?languageCode=en&account.registryCodes=DE&identifierInReg=&accountHolder=&search=Search&searchType=account&currentSortSettings= The data of operator holding accounts can be viewed online at: http://ec.europa.eu/environment/ets/oha.do?form=oha&languageCode=en&account.registryCodes=DE&accountHold-

[60] Those annexes were submitted when this information was originally provided to the UNFCCC and are not included here.

Reporting Item	Description
	er=&identifierInReg=&installationIdentifier=&installationName=&permitIdentifier=&mainActivityType=-1&complianceStatus=-1&search=Search&searchType=oha&currentSortSettings= *2. 13/CMP.1 annex II paragraph 46: Joint implementation project information* The complete documentation of the JI projects is presented in the German JI project database which is accessible at the following URL. The database also contains already registered but not yet approved JI projects. https://jicdm.dehst.de/promechg/pages/project1.aspx *3. 13/CMP.1 annex II paragraph 47: Unit holding and transaction information* The information requested in (a), (d), (f) and (l) is classified as confidential due to Article 83 paragraph 1 Registry Regulation No. 1193/2011 as well as national data protection law and therefore not publicly available. Transactions of units within the most recent five year period are also classified as confidential, therefore the transactions provided are only those completed more than five years in the past. The information requested in (b), (c), (e), (g), (h), (i), (j) and (k) is publicly available at: http://ec.europa.eu/environment/ets/transaction.do?languageCode=en&startDate=&endDate=&transactionStatus=4&fromCompletionDate=&toCompletionDate=&transactionID=&transactionType=-1&suppTransactionType=-1&originatingRegistry=DE&destinationRegistry=-1&originatingAccountType=-1&destinationAccountType=-1&originatingAccountNumber=&destinationAccountNumber=&originatingAccountIdentifier=&destinationAccountIdentifier=&originatingAccountHolder=&destinationAccountHolder=&search=Search&currentSortSettings=&resultList.currentPageNumber=1

<table>
<tr><th>Reporting Item</th><th>Description</th></tr>
<tr><td></td><td>4. 13/CMP.1 annex II paragraph 48: Authorized legal entities information
The following legal entities are authorized by Germany to hold Kyoto units:
<table><tr><td></td><td>Legal entities authorised by Germany to hold units</td></tr><tr><td>AAU</td><td>Federal Government only</td></tr><tr><td>ERU</td><td>Each account holder</td></tr><tr><td>CER</td><td>Each account holder</td></tr><tr><td>RMU</td><td>Federal Government only</td></tr><tr><td>tCER</td><td>Federal Government only</td></tr><tr><td>lCER</td><td>Federal Government only</td></tr></table></td></tr>
<tr><td>15/CMP.1 annex II.E paragraph 32.(h)
Internet address</td><td>The internet address of the German part of the Union registry is:

https://ets-registry.webgate.ec.europa.eu/euregistry/DE/index.xhtml.</td></tr>
<tr><td>15/CMP.1 annex II.E paragraph 32.(i)
Data integrity measures</td><td>The overall change to a Consolidated System of EU Registries also triggered changes to data integrity measures, as reflected in the updated disaster recovery plan. The complete description of the consolidated registry was provided in the common readiness documentation and specific readiness documentation for the national registry of EU and all consolidating national registries. The documentation is annexed to this submission.</td></tr>
<tr><td>15/CMP.1 annex II.E paragraph 32.(j)
Test results</td><td>On 2 October 2012 a new software release (called V4) including functionalities enabling the auctioning of phase 3 and aviation allowances, a new EU ETS account type (trading account) and a trusted account list went into Production. The trusted account list adds to the set of security measures available in the</td></tr>
</table>

Reporting Item	Description
	CSEUR. This measure prevents any transfer from a holding account to an account that is not trusted.

3. Policies and measures

Climate protection policies have been a prominent part of German politics for more than two decades. This is based on a comprehensive strategy that was initiated early on and has been constantly developed by the federal government.

Important strategies, policies and measures in the areas of energy and climate protection were adopted with the Integrated Energy and Climate Protection Programme of 2007 and the Energy Concept of 2010 and in the decisions on accelerating the Energiewende in summer 2011, known collectively as the “energy package”. Long-term energy and climate targets for Germany were also approved for the first time in the Energy Concept.

As part of analyses done for the German 2013 Projection Report, a research consortium commissioned by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) developed scenarios for the development of greenhouse gas emissions in Germany from 2005 to 2030:

- A “with-measures” scenario (WMS) based on the introduction of additional climate and energy policy measures and substantial changes to existing ones before October 2012
- A “with-additional-measures” (WAMS) scenario that also considers the effect of other conceivable climate and energy policy instruments (or corresponding targets) for the development of scenarios

The Projection Report is based on model calculations done by a consortium of German research institutes for the German federal government as part of a project to generate greenhouse gas emission scenarios as the basis of the 2013 Projection Report.

The 2013 Projection Report is based on model calculations done by a consortium of German research institutes for the German federal government. Some emission projections from other federal government research projects have been included in those model calculations. The results of the scenarios presented here for the development of greenhouse gas emissions in Germany have not been formally adopted by the federal Government.

The measures and instruments considered in the *with-measures scenario* in the 2013 Projection Report are discussed in greater detail below. This relates exclusively to the multi-sectoral and sector-based measures put in place by the federal government. Institutional measures and climate protection activities of the Länder and local authorities were not modelled or considered in the 2013 Projection Report.

Refer to the 2013 Projection Report for the results of the projections for *with-additional-measures scenarios*.[61]

3.1. General and political framework

3.1.1. Energy Concept and Energiewende

The federal government approved the Energy Concept in September 2010. It describes the orientation of Germany's energy policy up to 2050, particularly measures to expand the use of renewable energy sources and the grids and increase energy efficiency. In it, the federal government set itself the target, among others, of reducing greenhouse gas emissions in Germany by 40% by 2020, 55% by 2030, 70% by 2040 and 80 to 95% by 2050 (all in relation to base year 1990) (see Table 16).

The role of nuclear energy as presented in the Energy Concept was re-evaluated following the core meltdown of the Fukushima Daiichi nuclear power plant in Japan in March 2011. Germany's seven oldest nuclear power plants were permanently shut down, and Krümmel nuclear power plant was scheduled for shutdown. It was also decided that operation of the remaining nine nuclear power plants would be phased out by 2022. The "Energy Package" of 6 June 2011 was added to the measures contained in the Energy Concept, and implementation was accelerated. The Energy Concept and the decisions on the Energiewende, Germany's transition to a new energy system, provide for 166 specific measures, amendments to laws, and legislative proposals, most of which have already been implemented or are in progress. They have also been supplemented by additional measures.

61 [http://cdr.eionet.europa.eu/de/eu/ghgpro/envuucoda/130313_Projektionsbericht_DE_final.doc/manage_document]

Among the most important measures are ambitious legislation and funding programmes such as the following:

- The amendment to the Energy Industry Act (Energiewirtschaftsgesetz) and the Grid Expansion Acceleration Act (Netzausbaubeschleunigungsgesetz) with the objective of establishing the basis for coordinating grid planning, including connecting the grid to offshore wind farms and acceleration of planning and permitting procedures
- The amendment to the Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz) to improve the market and system integration of renewables
- The amendment to the Energy Saving Ordinance (Energieeinsparverordnung) and increased funding for the KfW Energy-Efficient Construction and Energy-Efficient Refurbishment programmes to promote energy-efficient construction
- The amendment to the Combined Heat and Power Act (Kraft-Wärme-Kopplungs-Gesetz) to increase the economic attractiveness of combined heat and power generation for power plants

Additional measures are described in the sections below.

Table 17: Summary view of status quo and quantitative targets of the Energiewende

	2011	**2012 (provisional AGEB data)**	**2020**	**2050**		
Greenhouse gas emissions						
Greenhouse gas emissions (compared with 1990)	-26.4%	- 25.5%	-40%	2030 -55%	2040 -70%	2050 -80% to -95%

Source: BMWi/BMU: 2012 Monitoring Report

3.1.2. Steering and coordinating the Energiewende

Because of the importance of the Energiewende, Germany's energy revolution, for society as a whole and for the economy, the federal government has created integrative structures and working processes for steering and coordination purposes. Solutions for various issues are discussed with major players in the Energiewende in forums that have been established for participation. The most important bodies are:

- Undersecretaries' Steering Group: federal government steering group at the undersecretary level, which reports on important projects related to the Energiewende, sets areas of emphasis, and coordinates new projects
- Energy talks: Semi-annual energy talks by the Chancellor and the responsible Federal Ministers with the heads of the Länder governments, along with regular technical and policy consultations with the Länder
- "Sustainable energy grids" platform, power plant forum, and renewable energies platform: dialogue with the relevant groups on key issues of the Energiewende

Table 18 provides a comprehensive summary of the participatory forums.

Table 18: Participatory forums on Energiewende

Forum	Place and participants	Subjects	Frequency
Chancellor with premiers of the Länder	Federal Chancellery	All issues related to the Energiewende, coordination of restructuring activities	Twice a year
Energy talks between Chancellor and representatives of business and civil society	Federal Chancellery	All issues related to the Energiewende, coordination of restructuring activities	Once a year
Undersecretaries' Steering Group	Federal Chancellery	All issues related to the Energiewende, coordination of restructuring activities	Twice a year
BMWi and BMU Monitoring Report	Ministries	Complete description of the status of the Energiewende	Annual data report Complete progress report every three years
Commission of four energy experts	No information	Support for the monitoring process, vote	Annually
Renewable Energies platform	BMU, BMWi, representatives of renewables sector, energy providers, public utilities, grid operators, Länder, municipalities	Reform of the EEG coordination of the expansion of renewables with the expansion of the grids, interaction of renewable and conventional energies	As needed, continuously
Future-oriented Grids (Zukunftsfähige Netze) platform	BMWi, BMU Ministries, power plant operators, grid operators	Taxation principles and market rules, coordination, generation, transmission, consumption	As needed, continuously
Power Plant Forum	BMWi, BMU	Security of supply, system stability	Twice a year

Forum	Place and participants	Subjects	Frequency
platform	Ferderal Network Agency, Länder, energy and environmental associations	for example, proposal for monitoring generation, expert opinion on electricity market design	
Energiewende Research Forum platform	BMF, BMWi, BMU, Ministries, Länder, academies, scientific organisations, universities, representatives of business and societal groups	Technological feasibility, economic and legal issues	No information

Source: federal government (2013)

3.1.3. Monitoring the Energiewende

The German government established a monitoring process entitled “Energy of the future” in autumn 2011. This process regularly reviews implementation of the measures set out in the Energy Concept and progress towards meeting its goal, focusing on achieving a secure energy supply that is both economically and environmentally sound. It is a long-term process. An annual Monitoring Report outlines the facts and status of implementation of measures. A detailed progress report will be published every three years, starting in 2014. The progress report will be based on a comprehensive data base compiled over several years. It will provide an opportunity for more detailed analyses, which may require special statistical processing. The Monitoring Reports will be jointly prepared by the Federal Economics Ministry and Federal Environment Ministry and approved by the federal cabinet. After approval by the cabinet they will be sent to the Bundestag (lower house of parliament) and Bundesrat (upper house).

The monitoring process has scientific support; an independent commission comprising four renowned energy experts advises officials and gives a scientific opinion of their reports. The members of the commission are Prof. Andreas Löschel (chair), Prof. Georg Erdmann, Prof. Frithjof Staiss and Dr Hans-Joachim Ziesing.

An office dealing with the monitoring process will also be set up at the Federal Network Agency (Bundesnetzagentur). It will support the federal government in preparing the reports. The annual reports and comments of the commission of experts are available on the Web site of the Federal Network Agency.[62]

3.2. Multi-sectoral measures at federal level

3.2.1. EU emissions trading

Emissions trading has been the main multi-sectoral measure for reducing CO_2 emissions in Germany since 2005. Emissions trading requires power generation plants and energy-intensive industries to surrender CO_2 allowances for their CO_2 emissions during the previous year. The third trading period of EU emissions trading began in early 2013 and runs until 2020. It includes many new rules to harmonize European emissions trading and centralize it in some areas:

- There has been only one EU-wide emissions trading budget since 2013. The emissions budget for those plants will be reduced by 1.74% annually from 2010. The result will be a 21% reduction in the emissions trading sector compared with 2005.
- The scope is being expanded to include aluminium production and chemicals plants. Additional greenhouse gases (nitrogen oxides and perfluorocarbons) have been included in emissions trading since early 2013.
- Emissions allowances for power generation have been auctioned since early 2013. This avoids windfall profits by electricity producers as a result of “pricing in” free allowances. Auctioning takes place throughout the EU using a common platform. However, Germany has exercised the special right to auction allowances through a national platform.
- As the third trading period begins, free allocation to industrial plants is determined by product-based benchmarks that are uniform throughout the EU. The benchmarks are oriented to the 10% of the most efficient plants of a sector in Europe, thereby rewarding the use of low-CO_2 technologies. Free allocation will be reduced from 80% to 30% from 2013 to 2020.

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[62] http://www.bundesnetzagentur.de/cln_1911/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/MonitoringEnergiederZukunft/monitoringenergiederzukunft-node.html

- Sectors with an increased risk of relocation of activities to third countries (carbon leakage) receive 100% free allocation according to the product-based benchmarks.
- Uniform rules for monitoring and reporting, accreditation, and verification have also been developed as part of the harmonization of emissions trading rules throughout the EU.
- The existing decentralized registry architecture run by the EU Member States was replaced by the Union registry in June 2012, thereby standardizing and centralizing registration throughout the EU. User accounts are still kept by the individual Member States, but the Commission is responsible for development and operation of the registry itself. Section 2.5 contains information from the EU Commission pursuant to paragraph 32 of Annex II.E of decision 15/CMP.1.

The new provisions ensure that emissions trading is far more ambitious, uniform conditions for competition are created in the EU, and the implementation of emissions trading is generally more efficient.

The federal government is of the view that well-functioning emissions trading is a key component of national and European climate protection policy and that it must remain so. Therefore, the federal government will participate actively in the discussion on the continued development of European emissions trading which has been initiated by the Commission.

The EU Exchange Trading Scheme (ETS) is included in the **with-measures scenario** in the following sectors as described below:

- Complete auctioning of emission right for electricity generation plants is projected to start in 2013. Heat generation will receive a free allocation of 80% of the heat benchmark in 2013, falling to 30% by 2020.
- The energy-intensive industry will include some new sectors, such as the aluminium industry, starting in 2013. It will receive a free allocation of 80% of the benchmark in 2013, falling to 30% in 2020. A free benchmark allocation of 100% is provided for any sector on the carbon leakage list. The individual eligible sectors will continue to receive electricity price compensation to offset indirect CO_2 costs.

- The electricity price including the CO_2 price will be used for all equipment and plants that consume electricity.
- Air transport was included in the Emissions Trading Scheme in 2012.

3.2.2. Special Energy and Climate Fund, Energy Efficiency Fund, and National Climate Initiative

The creation of the Special Energy and Climate Fund (EKF) pursuant to the Act dated 8 December 2010 (Federal Law Gazette I page 1807) was an important step in implementation of the Energy Concept. Following decisions by the federal government on 6 June 2011 to accelerate the Energiewende, Germany's transition to a new energy era, the EKF has received all proceeds from auctions of greenhouse gas allowances (after deducting the costs of the German Emissions Trading Authority). The proceeds are made available to promote an environmentally-friendly, reliable, affordable energy supply and for national and international climate and environmental protection measures.

The **with-measures scenario** includes the National Climate Initiative and the Energy Efficiency Fund:

The National Climate Initiative (NKI) of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) is an important part of the federal government's Integrated Energy and Climate Programme (Meseberg 2007) and its Energy Concept (2010). As part of the National Climate Initiative, programmes have been developed since 2008 to promote societal processes and technological innovations so that progress can be made towards achieving national climate targets throughout Germany. The Initiative follows a differentiated approach, addressing industry, consumers, and schools and educational facilities. It promotes the development and implementation of climate protection concepts, initiate incentive programmes and programmes to increase participation that invest in increasing the market penetration of climate protection technologies and supports innovative projects involving information, networking, and training. The National Climate Initiative received funding from the Energy and Climate Fund for the first time in 2011. The further development of the National Climate Initiative has been oriented to the “100% climate protection” model since 2010. Concepts for funding guidelines have already been developed.

Most of the resources for the National Climate Initiative come from emissions trading. A total of €899.7 million was spent on National Climate Initiative programmes and projects or used to increase the support funding for existing programmes from 2008 to 2011, with 21 projects and four funding guidelines receiving €193.3 million. Another €706.3 million was used to top up existing funding programmes of the Federal Ministry for the Environment (market incentive programme (MAP), environmental innovation programme (UIP) and funding for research into renewable energy sources.

The effects of the Energy Efficiency Fund, which was approved under the Creation of a Special Energy and Climate Fund Act (Gesetz zur Einrichtung eines Sondervermögens “Energie- und Klimafonds”, EKFG) of 8 December 2010 (BMF 2010), are also modelled in the with-measures scenario. The underlying financial assets of the Fund correspond to the financing contained in the Act Amending the Energy and Climate Fund (Änderungsgesetz zum Energie- und Klimafonds) of 6 June 2011 (BMF 2011) for 2011/2012: €90 million in 2011 and €89 million in 2012. Due to the income situation of the Energy and Climate Fund, the amounts that were originally estimated for the entire Energy Efficiency Fund in sequent years had to be corrected downward as follows: €232,464,000 in 2013, €202,986,000 in 2014, €213,885,000 in 2015 and €213,885,000 in 2016. The final amounts were set during the parliamentary procedure to prepare the overall budget for 2013 in autumn/winter 2012.

Within the context of this report, it is not possible to assess the quality of individual projects that are already being funded or are planned in the context of the Energy Efficiency Fund. Only a few large projects in the end consumer sectors construction (section 2.6.4), private households (section 2.6.5) and industry and trade, commerce and services (section 2.6.6) are included as supporting measures in the with-measures scenario.

3.2.3. Energy taxation

The First Step Toward an Environmental Tax Reform Act (Gesetz zum Einstieg in die ökologische Steuerreform) (“eco tax reform”) and subsequent changes to the taxation of energy products which are modelled in the with-measures scenario date back more than a decade, but their effects are still being felt in adjustments to different tax burdens for energy products. The First Step toward an Environmental Tax Reform Act of 24 March 1999 (Federal Law Gazette I page 378) increased energy taxes and – in subsequent reforms – changed laws on taxes to give them greater effects as incentives for environmental protection. The Electricity Tax Act (Stromsteuergesetz) is a new consumption tax with certain exemptions for the manufacturing industry and for renewable energy sources. The petroleum tax was graduated according to environmental criteria, with some uses receiving tax breaks and others being more expensive. The fuel tax was increased several times by the equivalent of about 3 euro cents/litre between 1999 and 2003. The Development of the Ecological Tax Reform Act (Gesetz zur Fortentwicklung der ökologischen Steuerreform) of 23 December 2002 (Federal Law Gazette I page 4602) initiated another increase in the petroleum tax which was graduated according to environmental effects. The Energy Tax Act (Energiesteuergesetz) of 15 July 2006 replaced the Petroleum Tax Act (Mineralölsteuergesetz, MinöStG) and integrated other fossil fuels in order to transpose the requirements of EU Directive 2003/96/EC restructuring the Community framework for the taxation of energy products and electricity. The Act now governs taxation of all fossil energy sources (petroleum, natural gas, liquefied natural gas and coal), as well as renewable energy products such as vegetable oil, biodiesel, bioethanol, and synthetic hydrocarbons from biomass that are used as heating or vehicle fuel in the Federal Republic of Germany.

3.2.4. Research and development

Another supporting pillar of the Energiewende, Germany’s energy transition, is the expansion of research and development in the areas of renewable energy and energy efficiency. In 2011, the German federal government’s Sixth Energy Research Programme, “Research for an environmentally sound, reliable and affordable energy supply”, established the broad outlines and areas of emphasis of its funding policy over the next few years. The programme is an important step in implementation of the Energy Concept of 28 September 2010, and the federal government intends to continue along that path into the age of renewable energy. Germany is to become one of the most energy efficient and environmentally sound national economies in the world. A complete presentation is contained in section 7.

3.3. Sector-based measures at the federal level

The sector-based measures and instruments (with-measures scenario) that were considered in the 2013 Projection Report are discussed in greater detail below. The descriptions of the measures are taken from the 2013 Projection Report.

The following measures are new since the Fifth National Communication:

- Amendment to the Combined Heat and Power Act (KWK-Gesetz) of June 2011 and July 2012
- Promotion of micro CHP units
- Amendment to the Renewable Energy Sources Act (EEG) of 2012, including the 2012 “photovoltaic”
- Decision to phase out nuclear power with amendment to the Nuclear Power Act (AtomG) of July 2011

3.3.1. Energy

3.3.1.1. Electricity generation from fossil fuels

Measures and instruments in the **“with-measures” scenario** include the following:

- Introduction of the EU Emissions Trading System (see section 3.2.1)
- Abolition of the natural gas tax for electricity generation: taxation of fuel inputs to generate electricity and for the co-generation of electricity and heat was modified by the Act on Reorganisation of Taxation of Energy Products and Amendments to the Electricity Tax Act (Gesetz zur Neuregelung der Besteuerung von Energieerzeugnissen und zur Änderungen des Stromsteuergesetz) of 15 July 2006 (Federal Law Gazette I No. 33, pages 1534-1561). As a result, natural gas is generally exempt from taxes as from 1 August 2006 if it is used for electricity generation in stationary installations with a rated electrical generating capacity of more than 2 megawatts or in stationary CHP installations with a monthly or annual utilisation rate of at least 70%. If the above requirements are fulfilled, natural gas

used for electricity production, in condensing power stations or in CHP plants is exempt from taxation (until July 2006, the exemption applied only to CHP plants with the above utilisation rate). This increases the attractiveness of natural-gas-based electricity production, which has low emissions compared with coal-fired electricity production.[63]

- Payment for avoiding use of the grid: the amendment to the Energy Industry Act (EnWG) and the associated Electricity Network Charges Ordinance (Stromnetzentgeltverordnung, StromNEV) in summer 2005 created the first statutory entitlement to reimbursement for the avoidance of grid use charges as a result of decentralized electricity feed-ins. In a grid or transformation level with decentralized feed-ins, the grid charges to be paid by the operator of that grid to the operator of the upstream grid level are lower, because less electricity must be taken from the upstream grid. The decentralized feed-in source receives the difference compared with the situation that would have existed without the decentralized feed-in for the grid service it has thus provided, which is referred to as “avoided grid charges”. They are calculated for every grid level, including transformation. Accordingly, the basis for calculating the avoided grid use of a plant feeding into the medium-voltage grid is the charge for drawing from high voltage/medium voltage transformation and not – as previously – the charge for drawing from high voltage. The charge calculation is contained in the Association Agreement on Criteria for Determining Grid Charges for Electric Energy and on Principles of Grid Use of 13 December 2001 (VV II plus).
- The 2002 Combined Heat and Power Act with amendments in 2008, 2011, and May 2012 and promotion of CHP in the Renewable Energy Sources Act: the Combined Heat and Power Act of 2002 (KWKG 2002) replaced the Preliminary CHP Act of 12 May 2000, which was primarily oriented to protection of existing CHP plants. The 2002 CHP Act was intended to help achieve the federal

[63] The legal situation fundamentally changed on 1 April 2012 as a result of the Act Amending the Energy and Electricity Tax Act and the Aviation Tax Act (Gesetz zur Änderung des Energiesteuer- und des Stromsteuergesetzes sowie zur Änderung des Luftverkehrsteuergesetzes, Energie/Strom/LuftVStGÄndG) of 5 December 2012 (Federal Law Gazette I 2012, pages 2436, 2725). Taxation of fuel inputs to generate electricity and for cogeneration of power and heat has been adapted to new EU requirements for subsidies. Natural gas is completely exempt from taxation if it is used to generate electricity in stationary installations with a rated electrical generating capacity of more than 2 megawatts or in high-efficiency stationary CHP plants with a monthly or annual efficiency of at least 70% which have not yet been written off.

government’s climate protection objectives by safeguarding and promoting the modernization of existing CHP plants subject to a time limit, expanding electricity production in small CHP systems, and launching fuel cells on the market. As a result of the 2008 amendment of the Combined Heat and Power Act, large new CHP plants with an installed electric capacity of more than 2 MW were eligible for support starting in 2009 if they are commissioned before 2016. Funding was limited to 30,000 hours or four years for industrial CHP plants and six years for district heating CHP plants. The operators of eligible CHP plants are paid a supplement for CHP electricity that is generated, based on the category of the plant. The (slight) amendment to the CHP Act on 30 July 2011 extended the validity period to include CHP plants commissioned up to 2020. The time limit was raised from four to six years. All in all, the amended Combined Heat and Power Act is the most important measure for promoting CHP plants in Germany. CHP also receives support in the context of power generation from renewables and through the heat benchmark of European Emissions Trading. The expansion of existing heat networks and construction of new ones also receive investment subsidies under the CHP Act. Because most feed-ins of heat into the network come from CHP plants, this indirectly increases or at least stabilizes the use of CHP. The amendment of the CHP Act in July 2012 increases payment rates for new plants that are commissioned starting in 2013 and for modernizing and upgrading existing plants. Heating/cooling networks and storage systems are also eligible for support. The funding limit of €750 million per year has been retained in the Act.

- Promotion of micro CHP systems: The Guidelines on the Promotion of CHP Systems up to 20 kWel of January 2012 are intended to supplement the extensive amendment to the Combined Heat and Power Act by further stimulating the widespread use of small CHP systems. Under this programme, new co-generation units up to 20 kWel installed in existing buildings can receive a one-time investment subsidy based on the electric capacity of the system. For example, micro systems up to 1kWel, which are suitable for single-family or two-family homes, will receive €1,500, while large systems with capacity of 19 kWel will receive €3,450.

These systems may not be used in areas with an available connection to district heating. They must also be serviced under maintenance contracts and are subject to strict efficiency requirements that exceed the requirements of the EU Cogeneration Directive for small-scale units. The primary energy saving must be at least 15% for systems smaller than 10 kWel and at least 20% for systems from 10 kWel to 20 kWel. Total efficiency must be at least 85%. Other requirements include the use of a heat storage unit with energy content of at least 1.6 kWh per installed kWth, control and regulation for heat-driven and electricity-driven operation, including smart heat storage management, and a system to measure current power consumption (smart meter) for systems above 3 kWel.[64]

3.3.1.2. Generating electricity from renewables

Measurements and instruments in the with-measures scenario include the following:

- The Renewable Energy Sources Act (EEG) is the key instrument for expanding the use of renewables. Pursuant to the amendment of the EEG in 2012, including the 2012 “photovoltaic amendment”, the new payment provisions shown in Table 19 apply to feed-ins of electricity from renewable energy sources. The discussion on fundamental reform of the EEG which began in 2013 is not included because there have been no political decisions on the terms of the reform.

Table 19: Development of payment for electricity from solar energy

	Installed capacity of roof-mounted systems.				**Standalone systems up to 10 MW**
	up to 10 kW	**up to 40 kW**	**up to 1 MW**	**up to 10 MW**	
Share of total electricity eligible for compensation*	**100%**	**90%**	**90%**	**100%**	**100%**
Commissioned					
after 01.04.2012	19.5	18.5	16.5	13.5	13.5
Degression	1%				
after 01.05.2012	19.31	18.32	16.34	13.37	13.37
Degression	1%				
after 01.06.2012	19.11	18.13	16.17	13.23	13.23
Degression	1%				
after 01.07.2012	18.92	17.95	16.01	13.1	13.1

64 http://www.bafa.de/bafa/de/energie/kraft_waerme_kopplung/mini_kwk_anlagen/index.html

	Installed capacity of roof-mounted systems.				Standalone systems up to 10 MW
	up to 10 kW	up to 40 kW	up to 1 MW	up to 10 MW	
Share of total electricity eligible for compensation*	**100%**	**90%**	**90%**	**100%**	**100%**
Degression	1%				
after 01.08.2012	18.73	17.77	15.85	12.97	12.97
Degression	1%				
after 01.09.2012	18.54	17.59	15.69	12.84	12.84
Degression	1%				
after 01.10.2012	18.36	17.42	15.53	12.71	12.71
Degression	As a function of capacity added in July, August and September 2012				
after 01.11.2012	Announced by the Federal Network Agency no later than 31 October 2012				

Source: BMU 2012

- The payment rates shown here apply to photovoltaic plants that are commissioned after 1 April 2012. The Federal Network Agency (Bundesnetzagentur) set new payment rates for the following three months (November, December 2012, January 2013) under the new flexible cap and published them for the first time in October 2012. This will be repeated every three months.

- The amendment to the EEG is backed by the decisions taken about the Energiewende on 6 June 2011. To improve the financing of offshore projects, the KfW offshore wind energy programme provides €5 billion in financial support for up to ten projects.

  Planning law has also been amended to facilitate the planning situation for photovoltaics and wind energy repowering projects. The expansion of the grid will also be improved by amendments to the Energy Industry Act in 2011 and 2012 and by the Grid Expansion Acceleration Act (Netzausbaubeschleunigungsgesetz – NABEG). This includes facilitating the construction of underground cables up to the 110-kV level, clustered connections for offshore wind farms and improvements to public participation and planning structures for transregional lines. Projections in the current National Renewable Energy Action Plan (NREAP) are used as a basis for projecting the development of renewable energies in the electricity sector up to 2020. The “long-term scenarios and strategies for the expansion of renewable energies in Germany taking into account the development in Europe and global development" scenario (update of the lead scenarios) of December 2010 and the long-term scenarios of 5 April 2012 will be used as a basis as work continues up to 2030.

Table 20: Measures to reduce emissions in the energy sector

Measure	**Target (quantitative)**	**Affected GHG**	**Type of instrument**	**Status of implementation (effect starts)**	**Reduction in millions of tonnes CO2 equivalents**		
					2010	2015	2020
Introduction of emission trading	Cost-effective CO_2 reduction	CO_2, N_2O, PFC	Economic	2005	No information	5	3
Abolition of natural gas tax	Increase the attractiveness of electricity from natural gas	CO_2	Fiscal	2006	No information	0	0
Payment for avoidance of grid use	Economic improvement for decentralized feed-ins	CO_2	Economic	2001	No information	0	0
CHP Act	Payment for CHP electricity generation a) Large plants b) Micro CHP systems	CO_2	Economic	2002, amendments 2008, 2011 and 2012	No information	a) 0 b) 1	a) 0 b) 3
Funding for micro CHP systems	Investment cost grant for small CHP systems	CO_2	Economic	2012	No information	0	1
Renewable Energy Sources Act	Minimum payments for electricity from renewables	CO_2	Regulatory Economic	2000, multiple amendments (most recently in 2012)	No information	7	14
Electricity conservation	Reduction in electricity consumption compared with without measures scenario	CO_2	Other	2012	No information	16	28

Source: Projection Report 2013

3.3.2. Transport

The following measures to reduce greenhouse gases in the transport sector which are included in the **multi-measure scenario** were approved before 30 July 2012 and have therefore entered into force or will soon enter into force:

- CO_2 emission standards for cars: EU Regulation 443/2009 specifies an average CO_2 emission target of 130 g CO_2/km for new cars that are registered in the EU in 2015. This emission target is to be achieved progressively by 2015. The Regulation specifies a target of 95 g CO_2/km for 2020; a process to determine the basis for calculating the final 2020 emission standard is currently in progress. It is assumed that this will not affect the target for 2020. CO_2 emission standards for light-duty vehicles: EU Regulation 510/2011 introduced an average CO_2 emission target of 175 g CO_2/km for new light-duty vehicles registered in the EU. This requirement is to be phased in by 2017. The Regulation sets a CO_2 emission target of 147 g CO_2/km by 2020, but a process to determine the final form of the Regulation for 2020 is currently in progress. It is assumed that this will not affect the target for 2020. Further development of the technology during the period beyond 2020 is assumed.
- Biofuels: the Biofuel Quota Act (Biokraftstoffquotengesetz) and the subsequent Act Amending Legislation on the Promotion of Biofuels (Gesetz zur Änderung der Förderung von Biokraftstoffen) transposed several EU directives (particularly EU Directive 2009/28/EC) and set quotas for biofuels and greenhouse gas reductions. At least 6.25% of the energy content of the total quantity of fuel is to be supplied by biofuels by 2014. A greenhouse gas reduction quota will be used starting in 2015, with 3% of greenhouse gas emissions to be reduced by using biofuels starting in 2015, 4.5% starting in 2017, and 7% starting in 2020.

  The Biofuel Sustainability Ordinance (Biokraftstoff-Nachhaltigkeitsverordnung) also includes the sustainability criteria from EU Directive 2009/28/EC, so inputs of biofuels must currently represent a 35% reduction in greenhouse gases compared with conventional fuels. That will rise to 50% in 2017, and plants commissioned after 2016 must be able to prove a 60% reduction in greenhouse gases starting in 2018. The evaluation of greenhouse gas reductions as a result of biofuels is currently being discussed; the Commission published a proposed Directive that would limit the amount of food-crop based biofuels that can be used to fulfil quotas and increased incentives for raw materials that appear to cause fewer effects due to indirect land use changes (ILUC) in October 2012 and negotiated it in early 2013.

- Increasing the efficiency of maritime traffic: forty-nine states in the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) made a commitment in mid-2011 to increase the efficiency of ships (Energy Efficiency Design Index – EEDI). The CO_2 emissions of new ships are to be reduced by 10% by 2019, 20% by the end of 2024, and at least 30% starting in 2025. The basis for comparison will be the average efficiency of new ships (by type) from 1999 to 2009. To increase the energy efficiency of all ships, a Ship Energy Efficiency Management Plan (SEEMP) is binding for all existing ships.
- Road tolls for heavy goods vehicles: a toll has been charged for vehicles heavier than 12 tonnes using the Autobahn motorway system since 2005. The new Act on Charging Route-Based Fees for the Use of Federal Motorways and Highways (Gesetz über die Erhebung von streckenbezogenen Gebühren für die Benutzung von Bundesautobahnen und Bundesstraßen), known for short as the Federal Trunk Road Toll Act (Bundesfernstrassenmautgesetz - BFStrMG) entered into force on 19 July 2011. It replaced the Autobahn Toll Act for Heavy Goods Vehicles (Autobahnmautgesetz für schwere Nutzfahrzeuge – ABMG). The content of both Acts is identical, except for substantial changes extending the toll for heavy goods vehicles to certain highways (criteria: must be built and maintained by the federal government, have direct connection to an Autobahn, be outside of an urban area, be at least 4 km long, and have at least two lanes in each direction with a structural barrier). The expansion of the toll will be implemented starting in August 2012. Depending on the pollutant class, tolls are currently €0.141/km to €0.274/km for heavy goods vehicles up to three axles and €0.155/km to €0.288/km for vehicles with more than three axles.

  Noise- and pollutant-related costs may be included in the toll for heavy goods vehicles in the context of EU Directive 62/1999, but this has not yet been a political objective. The Directive applies to heavy goods vehicles over 3.5 tonnes. Due to the high costs, Germany has applied an exemption and charges the toll for heavy goods vehicles whose total authorized weight is over 12 tonnes.

- Change in the motor vehicle tax: the amount of the vehicle tax for new cars has been based on specific CO_2 emissions and engine size instead of pollutant classes and engine size since July 2009. Diesel cars at the EURO 6 emission level which are registered for the first time from 2011 to 2013 are exempt from a maximum of €150 of the vehicle tax. The vehicle tax for all three- and four-wheeled light vehicles has been based on pollutant classes and engine size since 2010. Since December 2012 the tax exemption for electric vehicles has been expanded: it includes at present every type of all-electric vehicle and has been extended from five to ten years.
- Air traffic: an air traffic tax has been charged on legal transactions (usually the purchase of a ticket) that entitle a passenger to depart from a German airport. The amount of the tax is determined by categories based on the distance between the place of departure in Germany and the destination. For the sake of simplicity, the distance is always the distance from the largest passenger airport in the individual country of destination and Frankfurt am Main as the largest German passenger airport. The tax rates per passenger which are standardized in the Air Traffic Tax Act (Luftverkehrsteuergesetz) are divided into three distance classes and since early 2012 have been €7.50 (2011: €8.00), €23.43 (2011: €25.00) and €42.18 (2011: €45.00).
- Emissions trading for aviation: All flights taking off and landing in the EU have been included in the European Emissions Trading Scheme for greenhouse gases since 2012. The basis for determining the number of allowances is average annual emissions from 2004 to 2006. The allocated emission quantities were limited to 97% of that amount in 2012 and will be limited to 95% of that amount starting in 2013. Eighty-five percent of the emissions allowances are allocated free of charge, and 15% are auctioned. Enforcement for non-European flights was temporarily suspended on 25 April 2013. In essence, this “stop-the-clock” decision specifies that EU Member States will

refrain from imposing sanctions for non-fulfilment of reporting and payment requirements for all flights between Europe and non-EU countries between 2010 and 2012. Requirements for flights within the EU and other territories (such as overseas territories, accession states, and Switzerland) are not affected by the decision. The intention was to send a good-will signal to the ICAO negotiations. In light of the results of the ICAO assembly from 25 September to 4 October 2013, it will have to be determined whether emissions trading should be modified and, if so, how. This provision is not taken into account in section 5.6.2.1 due to the cut-off date for the definition of measures.

- Promotion of electromobility: It is aim of the federal government to develop Germany into a leading market for electromobility and a leading supplier of electromobility. The goal is to have one million electric vehicles on Germany's roads by 2020, rising to six million by 2030. Measures to achieve this are currently being implemented under the government electromobility programme of May 2011.
- Increasing the efficiency of aviation: The International Civil Aviation Organization (ICAO) adopted a plan to reduce emissions from aviation at its 37th General Assembly in 2010. Subject to a voluntary commitment, the efficiency of aircraft is to be increased by 2% annually based on fuel volumes. Absolute greenhouse gas emissions are also to be kept constant after 2020, primarily by using alternative fuels.

Table 21: Measures to reduce emissions in the transport sector

Measure	**Target (quantitative)**	**Affected greenhouse gas (GHG)**	**Type of instrument**	**Status (implemented, approved, planned)**	**Reduction in millions of tonnes of CO2 equivalent**		
					2010	**2015**	**2020**
CO_2 emission standard for cars	2012-2019: 130g CO_2/km; after 2020: 95g CO_2/km	CO_2	Regulatory	Implemented	0.1	1.1	2.5
CO_2 emission standard for light commercial vehicles	2014-2019: 175g CO_2/km; after 2020: 147g CO_2/km	CO_2	Regulatory	Implemented	0	0	0.1

Measure	Target (quantitative)	Affected greenhouse gas (GHG)	Type of instrument	Status (implemented, approved, planned)	Reduction in millions of tonnes of CO2 equivalent		
					2010	2015	2020
Biofuel blending	GHG reduction quotas: 3% from 2015, 4.5% from 2017, 7% after 2020 (=12% blending)	CO_2	Regulatory	Implemented	1.9	2.8	5.1
Increased efficiency of ships	a) CO2 reduction: 10% by 2019 20% by 2024 30% from 2025 b)Management plan for energy efficiency	CO2	Voluntary commitment	Implemented	0.3	0.9	1.6
Toll for heavy goods vehicles	Increase in toll to €0.141/km-€0.274/km and expansion to federal highways	CO_2	Economic	Implemented	1.4	1.3	1.2
Change in vehicle tax	Benchmark CO_2 emissions and engine size	CO_2	Fiscal	Implemented	0.6	0.8	0.8
Air traffic tax	Flights departing from Germany, 2012: €7.50-€42.18/ticket	CO_2	Fiscal	Implemented	0	0.6	0.5
Emissions trading for aviation	GHG emissions limited to 97% of 2004-06 average for 2012 and 95% from 2013	CO_2	Economic	Approved			
Promotion of electromobility	1 million electric vehicles by 2020 and 6 million by 2030	CO_2	Research	Implemented	0	0	0
Increased efficiency in aviation	a) Efficiency increase 2%/year b) GHG = constant due to alternative fuels	CO_2	Voluntary commitment in ICAO context	Approved a) Effective as of 2010 b) After 2020	0	1.6	3.3

Source: Projection Report 2013

3.3.3. Buildings sector – heating and cooling

This section describes the instruments for the buildings sector as a whole; the effectiveness of the individual instruments is quantified separately for the private household sector and for the trade, commerce and services sector. Quantifying individual instruments often involves great uncertainty, since multiple instruments (administrative law, subsidies and information-based instruments) generally interact.

In addition to the multi-sectoral policies presented in section 3.2 above, several funding measures specifically affect the buildings sector. The measures covered in this section reflect political instruments as they existed up to 30 April 2012. The main instruments in the **with-measures scenario** are presented below.

KfW programmes for Energy-Efficient Refurbishment and Construction (CO_2 building refurbishment programme)

The Energy-Efficient Refurbishment programme of Kreditanstalt für Wiederaufbau (KfW), which was created as part of the CO_2 building refurbishment programme, supports the refurbishment of existing buildings for which the application for a building permit was submitted before 1 January 1995 to conserve energy through low-interest loans or grants. The programme promotes refurbishment to meet the standard for the KfW Efficiency House and individual measures to improve the efficiency of the building or technical building systems. The amount of the funding depends on the level of efficiency that is achieved.

Five categories – KfW EH 55, KfW EH 70, KfW EH 85, KfW EH 100, and KfW EH 115 – have been defined for funding under the KfW Efficiency House scheme. They are based on annual primary energy consumption and the transmission heat loss through exposed surfaces of the building based on the reference values of the Energy Saving Ordinance (Energieeinsparverordnung - EnEV).[65] The KfW funding unit KfW EH Monument promotes the refurbishment of buildings that are particularly worthy of conservation. A portion of the loan is forgiven when documentation of compliance with the KfW Efficiency House standard is submitted (repayment grant).

Individual measures are also subject to certain minimum funding requirements. Individual measures include heat insulation of exterior walls, the roof, and floors and replacement of windows and exterior doors. When replacing technical building systems, funding is available for ventilation systems, condensing boilers that use heating oil or natural gas as a fuel, heat-driven CHP systems and heat transfer

[65] A KfW Efficiency House 70 standard is fulfilled, for example, if the building does not consume more than 70% of the primary energy consumed by equivalent new construction according to the EnEV. Based solely on the building envelope requirement (Ht‘), each value is 15% higher – for KfW 70, for example, a maximum of 85% of the specific transmission heat coefficient in the EnEV.

stations for connection to a district heating network. Heat generators that use renewable energy sources are funded only as supplements to the aforementioned systems.

Systems that include heat generators that use renewable energy are also funded by the KfW Energy-Efficient Refurbishment programme in the case of extensive refurbishments to meet the Efficiency House standard. Funding for individual measures is also possible through the Market Incentive Programme (MAP) of the Federal Office of Economics and Export Control (BAFA) (see below). Combining funding programs for individual measures is not allowed.

In contrast, the KfW Energy-Efficient Construction program, which is also financed by the CO_2 buildings programme, supports energy-efficient new construction. The construction, production, or first-time purchase of KfW Efficiency Houses is promoted through low-interest loans. The options are KfW EH 40, KfW EH 55 and KfW EH 70. A portion of the debt is also forgiven (repayment grant) if documentation of compliance with the KfW EH 40 or 55 standard is submitted. The level of efficiency is calculated in the same way as for KfW Efficiency Houses in existing buildings.

A total of €1.8 million annually is available for the Energy-Efficient Construction and Energy-Efficient Refurbishment programme from the Energy and Climate Fund (EKF) up to 2014.

The results of the annual evaluations of the KfW Energy-Efficient Refurbishment and Energy-Efficient Construction programmes can be viewed at the following link:

http://kfw.de/kfw/de/I/II/Download_Center/Fachthemen/Research/Studien_und_Materialien/Evaluationen_Energieeffizient_Bauen_und_Sanieren.jsp

Energy-efficient refurbishment of municipal and social infrastructure

In the area of municipal buildings, the KfW IKK/IKU energy-efficient urban refurbishment programmes support municipalities, municipal enterprises, associations of local authorities, and charitable organisations by offering low-interest loans. Buildings erected before 1995 receive low-interest loans so they can be refurbished to the KfW EH55, KfW EH70, KfW EH85, KfW EH 100 or KfW EH Monument standard or to finance individual measures. A portion of the loan is forgiven (repayment grant) upon submission of evidence of compliance with the KfW-Efficiency House level.

Energy-efficient urban refurbishment – grants for integrated neighbourhood concepts and refurbishment managers programme and energy-efficient urban refurbishment – energy-efficient neighbourhood utilities programme

KfW's energy-efficient urban refurbishment funding programme encourages measures to improve the energy efficiency of buildings and infrastructure in neighbourhoods (a component of the federal government's Energy Concept of 28 September 2010). Aims include creating more opportunities for using renewable energies in urban districts with many old buildings and involving additional groups of investors in the refurbishment process.

New funding elements have been added so that refurbishment managers can develop concepts and support implementation and to allow investments in neighbourhood heating solutions under the energy-efficient urban refurbishment – grants for integrated neighbourhood concepts and refurbishment managers programme and the energy-efficient urban refurbishment – energy-efficient neighbourhood utilities programme.

This instrument takes up the problem of a heterogeneous ownership and heating structure by getting many owner groups, particularly private landlords, more involved in the refurbishment process. Carefully weighing the need for energy refurbishment measures against concerns about culturally important buildings is particularly important for densely-built urban districts with many older buildings that are worthy of protection. Another aspect influencing the process is that there may be different cycles of measures; for example, heating systems may have been replaced recently.

Market Incentive Programme (MAP)

MAP promotes the installation of heating/cooling generation systems, heat storage units and heating networks for (partial) use of renewable energy sources in residential and non-residential buildings, for commercial purposes and for feed-ins into local/district heating networks.

Systems with more than 100 kW thermal output (for solar thermal systems, more than 40 m²) are funded through repayment grants for early partial repayment of low-interest loans in the KfW portion of the MAP (KfW Renewable Energies programme, premium variant). Smaller renewable energy heating systems receive investment grants from the BAFA portion of the MAP through the Federal Office of Economics and Export Control (BAFA) which are equivalent to 8 to 18% of acquisition costs. The KfW portion finances larger decentralized renewable energy heat generation units, heating networks and large heat storage units, lines to transport unprocessed biogas if the biogas is to be provided for use in a CHP system or as a fuel, and (ending 31 December 2012) systems to process biogas for feed-in into the natural gas network (loans and repayment grants).

Funding from the MAP is subject to fulfilment of minimum requirements for specific technologies relating to system efficiency and product quality (such as the Solar Keymark quality label). An efficiency bonus is granted in the BAFA portion for all systems (solar, biomass, and heat pumps) that are installed in particularly efficient buildings. The reason for this is that the economic efficiency of renewable energy systems decreases as the need for heating decreases, which means that they offer fewer cost savings compared with fossil-based utilities). A bonus (boiler replacement bonus) is also offered for simultaneous installation of a condensation boiler and a solar thermal system that is eligible for funding (boiler replacement bonus), for simultaneous installation of solar and biomass systems or solar thermal and heat pump systems (including in combination with solar systems used only to heat water), and for connecting the solar system to a heating network.

Systems in new builds (with application for building permit submitted after 1 January 2009) are not funded in the BAFA portion, with the exception of funding for innovations. The usage requirement (see below) required by the Renewable Energies Heat Act (EEWärmeG) applies to new builds.

Promotion by the MAP is not cumulative with other public funding programmes. The funding of individual measures under the KfW Energy-Efficient Refurbishment programme is an exception to this.

The federal budget for 2012 provides €317.81 million in Title 686 24 section 1602 pursuant to the decision of 21 March 2012. Of that amount, approximately €250 million is available for the MAP, with another €68 million for the National Climate Initiative (NKI). The amount contained in that title can be increased to as much as

€366 million from federal budget funds. Funding rates for investments under the MAP were also increased starting 15 August 2012 (BMU 2012). Those new provisions for the MAP starting on 15 August 2012 are already reflected in the with-measures scenario.

Energy Saving Act/Energy Saving Ordinance

The Energy Saving Ordinance (Energieeinsparverordnung – EnEV), an implementing regulation enshrined in the Energy Saving Act (Energieeinsparungsgesetz – EnEG), governs minimum energy requirements for new construction and for existing buildings undergoing major refurbishment. The regulatory requirements apply to both residential and non-residential buildings if they are regularly heated or cooled. The current implementing regulation is EnEV 2009 (amendment of 29 April 2009, entry into force 1 October 2009). The procedure for amending EnEV 2014 was completed with the cabinet decision on 16 October 2013. It is anticipated that the amendment will enter into force on 1 May 2014.

The Energy Saving Ordinance sets specific limits for annual primary energy consumption of heating, hot water, ventilation, and cooling in new buildings. It also limits primary energy consumption for lighting non-residential buildings and specifies minimum quality requirements for building envelopes.

The calculation uses a reference building method that specifies the energy performance of the building elements (wall, exterior wall, base of the building, window, etc.) in the reference building and also contains a reference for the technical building system. The primary energy factors of the energy sources that are used, which are defined in DIN V 18599: 2011-02 or DIN V 4701-10: 2003-08, are included in the calculation.

The calculation determines the maximum admissible annual primary energy consumption of a corresponding new building having the same geometry, floor space, and orientation. The reference buildings are divided into residential and non-residential building in the Energy Saving Ordinance.

The minimum quality of the envelope of residential buildings is also specified in the form of limits for specific transmission heat loss, which differ according to the type and size of the building (detached or terraced). The minimum quality of the envelope of non-residential buildings is governed by limits to the average heat transfer coefficient of the heat-transmitting envelope surface.

The Energy Saving Ordinance contains minimum requirements for the quality (U value) of exterior building elements used as replacements when refurbishing existing buildings.

As an alternative to what is known as the building element method, the requirements for existing buildings being modified, extended, or expanded are considered to have been fulfilled if the annual primary energy requirement calculated using the reference building method and the maximum limits of the requirements for the building envelope of an equivalent new building are not exceeded by more than 40%.

The requirements for existing buildings apply only to renovation or restoration of the building or certain individual building elements. The Energy Saving Ordinance thus establishes only a conditional obligation to refurbish, not an unconditional obligation. All provisions of the Ordinance are also subject to the strict requirement for economic efficiency contained in the Energy Saving Act.

Renewable Energies Heat Act (EEWärmeG)

The Renewable Energies Heat Act (Erneuerbare-Energien-Wärmegesetz – EEWärmeG) specifies that a portion of the energy consumption for heating and cooling by new buildings for which the building permit application was filed after 1 January 2009 must be supplied by renewable energy sources (primary obligation). This applies to both residential and non-residential buildings. The most recent amendment of the Act in 2011 also extended the requirement to use renewable energies to existing public buildings (which serve as a role model). Fifteen percent of the energy used for heating and cooling must be covered by renewables in buildings that have undergone extensive renovation (25% if gaseous biomass is used).

Specific minimum percentages of individual renewable energy sources are required for fulfilment of the obligation to use renewable energies in new construction.

Minimum requirements are also imposed for the quality and efficiency of the technologies that are used. A series of alternative measures accompanies the primary obligation. For example, the requirements of the Act can be fulfilled by staying 15% below the energy standards for primary energy and the building envelope under the Energy Saving Ordinance. The Act is also considered to have been fulfilled if at least 50% of the heating and cooling requirements are met by a CHP system or if heating is supplied by a heating network that is 50% powered by renewable energy or CHP systems. Another alternative measure is the use of waste heat.

Table 22: Measures that fulfil the primary obligation (to use renewable energy sources) under the Renewable Energies Heat Act (EEWärmeG)

	Minimum percentage	**Specific requirements for the technology**
Solar thermal	At least 15% of heating and cooling energy demand Requirement is met if in residential buildings with max. 2 units: solar collectors have at least 0.04 m^2 aperture surface per m^2 floor space > 2 units: solar collectors have at least 0.03 m2 per m2 floor space	Solar Keymark (liquid heat transfer mediums)
Gaseous biomass	At least 30% of heating and cooling energy demand	Used in high-efficiency CHP systems (requirements for CHP systems according to Annex V) Environmental requirements for processed biogas (production and processing) with regard to methane emissions, electricity consumption and inputs of process heat; use of mass balancing systems for biomethane
Liquid biomass	At least 50% of heating and cooling energy demand	Used in state-of-the-art boiler (currently condensation boiler) Requirements for bio-oil: Compliance with sustainability criteria under BioSt-NachV
Solid biomass	At least 50% of heating and cooling energy demand	Environmental requirements based on requirements of the Small Combustion Plant Ordinance (Kleinfeuerungsanlagen-Verordnung) and capacity-based efficiency requirements for the boiler
Geothermal with ambient heat	At least 50% of heating and cooling energy demand	Minimum requirements for annual performance coefficient (based on the technology used) Heat pump has a heat and electricity meter whose measured values allow calculation of the annual performance coefficient. Minimum requirements for determining annual performance coefficient Awarded the EU Flower, Blue Angel or European Quality Label for Heat Pumps (Version 1.3) or comparable quality seal

Source: Bürger, et al. 2012

An evaluation of the Renewable Energies Heat Act is available in the first report on the experience of the federal government with the Renewable Energies Heat Act, which was approved by the federal cabinet on 19 December 2012. The regulatory and financial funding instruments described in the sections above also contain information whose importance should not be underestimated. The effect of political instruments can therefore generally not be viewed in isolation.

Energy performance certificate

The energy performance certificate is an important measure for providing information in the buildings sector. As an integral part of the Energy Saving Ordinance, it comes under regulatory law. The 2002 Energy Saving Ordinance required an energy performance certificate for new builds. The 2007 Energy Saving Ordinance introduced a requirement for energy performance certificates when existing buildings are sold or rented. The performance certificate must be showed to potential buyers or tenants at the time of sale or rental. The aim of the energy performance certificate is to make the key indicators for energy requirements or consumption in buildings transparent and to raise awareness of them. A total of 1.87 million energy performance certificates had already been issued by May 2009, still in the initial phase of the requirement for energy performance certificates at the time of selling or renting (BBSR 2010). However, comparability of the key indicators shown in the energy performance certificate is not always provided in individual cases, because the issuance or the underlying calculation can be oriented either to consumption (calculation based on real consumption) or requirements (calculation according to a standard).

Information services of the German Energy Agency

The German Energy Agency (dena) has been informing private households and companies about measures and the background of efficient, rational use of energy and electricity in buildings, the possibilities for using renewable energies, electromobility, and efficient energy systems since the year 2000. Its website keeps people informed by offering numerous studies, brochures, and information, and it holds events and carries out projects on the aforementioned subjects. Since the agency was founded, it has offered stakeholders all over Germany a centralized, constantly growing source of information on the possibilities for efficient use of energy and renewable energy sources.

On-site energy advice

An on-site energy advice scheme funds refurbishment concepts provided by qualified independent specialists. A bonus is also paid for supporting thermography and recommendations on reducing electricity consumption.

Since 1 July 2012, grants have been increased, requirements for the qualifications of specialists are stricter, and the results of the advice that is given are oriented towards the energy-efficient building refurbishment funded.

Specific measures are recommended which together will result in an Efficiency House that is eligible for funding under KfW's Energy-Efficient Refurbishment programme. Appropriate analyses of economic efficiency must also be included in the report. The KfW funding is included in the calculations of economic efficiency.

A list of experts for federal funding programmes in the residential buildings sector was published in late 2011 to ensure the quality of on-site energy advice and the planning of KfW-funded Efficiency Houses and support while they are built. There are strict requirements for qualifications, and regular continuous professional development is a prerequisite.

Evaluations have shown that on-site advice has led to an average of 20% more investment in energy efficiency measures than was previously planned. Overall, the programme has achieved total annual savings on the order of 70 GWh and 2,400 GWh[66] over the life of the measure.

Energy advice for private households

The nationwide project at the Federation of German Consumer Organizations (vzbv), which is funded by the federal government, also initiates measures every year under which qualified energy advice conserves some 2,000 GWh[67] over their lifespan. Most of the advice is provided in the buildings sector. Personal advice is offered at 650

[66] ifeu 2008.
[67] ifeu 2005.

locations, by e-mail and by telephone. Energy checks during which the energy advisor visits homes or buildings have also been available since October 2012.

Table 23: Measures to reduce emissions in the buildings sector

Measure	**Target (quantitative)**	**Affected GHG**	**Type of instrument**	**Status (implemented, approved, planned)**	**Reduction in millions of tonnes of CO2 equivalents**		
					2010	**2015**	**2020**
KfW programmes	Increase energy efficiency in existing buildings, new builds, and municipal infrastructure	CO2	Funding	Implemented	No information	0.41	0.29
MAP	Installation of heating/cooling generators, heat storage units and heat networks	CO2	Funding	Approved	No information	0.07	0.06
2009 Energy Saving Ordinance	Minimum energy requirements for new builds and for existing buildings undergoing major refurbishment	CO2	Regulatory	Approved	No information	0.18	0.1
Renewable Energies Heat Act	Use of renewables to cover some heating and cooling requirements or certain alternative measures	CO2	Regulatory	Approved	No information	0.01	0.05
Supporting measures such as energy performance certificate	Information for stakeholders	CO2	Regulatory and voluntary	Approved	No information	0.09	0.13

Source: Projection report 2013

3.3.4. Private households - electricity

Measures and instruments in the **with-measures scenario** in this sector include the following:

Energy Consumption Labelling Act (Energieverbrauchskennzeichnungsgesetz – EnVKG) and Energy Consumption Labelling Ordinance (Energieverbrauchskenn-zeichnungsverordnung – EnVKV)

The Energy Consumption Labelling Act[68] governs how the energy consumption of energy-related products, cars, and tyres is labelled. For the sector of energy-related products, this is supplemented by the associated implementing regulation, the Energy Consumption Labelling Ordinance.[69] The Act and the Ordinance transpose the EU Directive on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products (Directive 2010/30/EU) into national legislation. The scope of the national provisions has been matched to the European standard. Energy-related products that themselves do not consume energy but that have a major influence on energy consumption are now eligible for the EU energy label. Other provisions of the Energy Consumption Labelling Act relate to responsibilities in Germany, market surveillance, and the ability of the responsible market surveillance authorities in the Länder to impose sanctions. The Federal Institute for Materials Research and Testing (BAM) has now been named as an additional authority that will be responsible for important tasks related to information and coordination. The Energy Consumption Labelling Ordinance governs the specific configuration of the labelling obligation and administrative offences in the event of a violation.

Individual product groups are determined by the EU Commission in delegated acts that supplement the Framework Directive.[70] The with-measures scenario includes all product groups for which labelling is mandatory under the delegated act. The effect of this instrument is also quantified.

[68] Current version dated 10 May 2012 (Federal Law Gazette I 2012, page 1070).
[69] Current version of 30 October 1997, most recently amended on 10 May 2012 (Federal Law Gazette I, page 1070).
[70] It should also be noted that in some cases implementing directives entered into force under old Directive 92/75/EC and will remain in force until they are replaced by new delegated acts. This relates in particular to electric ovens.

Article 14 of Directive 2010/30/EU specifies that the Commission will review the effectiveness of the Directive and its delegated acts no later than 13 December 2014. This process was initiated in spring 2013 by ordering a complete study to be done. The initial interim results are not expected before January 2014.

Minimum efficiency standards

Minimum efficiency standards under the EU Ecodesign Directive are defined and configured similarly to those for the industry sector and the trade, commerce and services sectors (see section 1.9) and include groups of appliances which are relevant to the household sector.

Introduction of smart meters to measure electricity consumption (new construction)

The amendment to the Energy Industry Act (Energiewirtschaftsgesetz – EnWG) on liberalisation of metrology, which entered into force in 2010, allowed and promoted innovative methods for metering electricity, as well as load-based, time-of-use tariffs. The amendment is based on the Directive on energy end-use efficiency and energy services (Directive 2006/32/EC – Energy Services Directive), which calls for individual consumption-based recording of and billing for energy consumption. According to Article 13 (1) of the Energy Services Directive, in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, Member States must ensure that all final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively-priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use.

Against that background, section 21b of the Energy Industry Act was revised and section 40 (3) was added. As a result, at the time of new construction or major refurbishments, or when the final consumer so requests, electronic electricity meters must be installed which reflect the actual energy consumption and time of consumption for the user of the connection (section 21b (3a) of the Energy Industry Act). To distinguish between the with-measures scenario and the without-measures scenario, the with-measures scenario initially modelled only the use of smart meters in new buildings and their effects on electricity consumption. Previous estimates for Germany[71] anticipated savings of 5 to 6% of the annual electricity consumption by a private household as a result of using smart meters. However, empirical data has not confirmed those estimates for Germany. It is likely that in coming months pilot projects being conducted by many energy suppliers that have installed smart meters in private households will improve the empirical data to be used as a basis for estimating energy savings as a result of smart metering methods. The initial conclusions based on metering results for 600 households are already available,[72] and they substantially confirm the order of magnitude of the above estimates.

Supporting instruments

Supporting instruments include voluntary labelling such as Energy Star, the Blue Angel or the EU Ecolabel. They are particularly relevant for consumer electronics and office equipment at present; the Blue Angel is used for a large number of appliances in Germany. It is difficult to quantify the influence of these instruments on electricity consumption by home appliances, because it is almost impossible to separate their effects from general technical progress in conserving energy and other measures.

Table 24: Measures to reduce emissions in the private household sector

Measure	**Target (quantitative)**	**Affected GHG**	**Type of instrument**	**Status (implemented, approved, planned)**	**Reduction in millions of tonnes of CO2 equivalents**

[71] UBA 2012b. Prognos/Öko-Institut 2009; BMU/Jochem, et al. 2008; KEMA 2009.
[72] Schleich, et al. 2011.

Energy Consumption Labelling Ordinance (EnVKV)	Mandatory labelling showing consumption of energy and other resources by electrical appliances and some household lamps	CO2	Regulatory	Implemented			
Minimum standards I (EU Ecodesign Directive)	Minimum standards for energy-relevant products based on implementing measures or lowest lifecycle costs	CO2	Regulatory	Implemented			
Smart metering after amendment of Energy Industry Act (EnWG)	Introduction of smart meters to measure electricity consumption in new builds	CO2	Regulatory	Implemented			

Data on GHG reduction is not available.

Source: 2013 Projection Report

3.3.5. Industry and trade, commerce and services

Measures and instruments under the **with-measures scenario** in this sector include the following:

3.3.5.1. Process heat/steam measures

EU Emissions Trading Scheme[73]

Emissions trading for industry primarily affects energy-intensive sectors such as metal production and processing, cement production, and glass and paper making. During the phase between 2013 and 2020, the scope will be expanded to include additional sectors (primarily the chemical industry and the non-ferrous metals industry), to include the greenhouse gas N_2O in some cases (such as adipic acid and nitric acid production), and to include the perfluorocarbons used in aluminium production. Free allowances are allocated for most industrial emissions on the basis of benchmarking and for the remaining emissions using a fallback approach (heat benchmark, fuel benchmark or process emission benchmark). Emissions that exceed the benchmarks must be covered by buying additional allowances. The cap for the ETS and therefore the cap for the industry sector is reduced by 1.74% annually. Free allocation based on benchmarks in sectors that are not classified as being at risk

[73] See section 3.2 on overarching instruments.

for carbon leakage will be reduced from 80% in 2013 to 30% in 2020, followed by a linear reduction to zero. Sectors at risk for carbon leakage receive a free allocation of 100% of the benchmark. Banking between the second and third phases of the EU ETS is allowed, meaning that surpluses from the second phase (2008-2012), for example due to the effects of the financial and economic crisis) can be carried forward to the subsequent period.

Tax capping under the Energy and Electricity Tax Act

The Act Amending the Energy and Electricity Tax Act and the Aviation Tax Act (Gesetz zur Änderung des Energiesteuer- und des Stromsteuergesetzes sowie zur Änderung des Luftverkehrsteuergesetz) of 5 December 2012 (Federal Law Gazette I No. 57 pages 2436-2445) entered into force on 1 January 2013. It specified that what is known as the tax capping scheme would be extended beyond 2012 over the next ten years. The initial eligibility requirements for tax capping (such as the minimum amount) remain unchanged from the previous model. The federal government therefore assumes that more than 20,000 companies can continue to benefit from the tax capping scheme and that the total extent of tax capping will be about €2.3 billion per year.

The ability to use tax capping was previously tied to achieving emission reduction targets under the climate agreement, which expired in late 2012. Starting in 2013, tax capping is subject to fulfilment of two new requirements. First, the recipient company must prove that it has introduced an energy management or eco-management system according to EMAS or alternative systems for SMEs no later than 2015. Second, the energy intensity of the manufacturing industry in Germany as a whole must be reduced by a statutory target value from the average for 2007-2012. That target value is 1.3% per year for reference years 2013-2015 and 1.35% per year for 2016-2022. The Act specifies that the target values for application years 2019 to 2022 (reference years 2017-2020) must be reviewed as part of an evaluation in 2017.

Energy advice for small and medium-size enterprises (SMEs)

Funding is available for SMEs to obtain skilled, independent advice on energy. Qualified experts identify potential for energy conservation and prepare specific proposals on measures to be taken. A short initial session and more comprehensive detailed advice are funded with a grant to cover the fee for advisory services. KfW then offers low-interest loans for investments in improving energy efficiency as part of its energy efficiency programme.

Minimum efficiency standards

Ecodesign Framework Directive 2009/125/EC (formerly Directive 2005/32/EC) is the legal framework that specifies minimum efficiency standards for certain energy-related products in the European internal market. Directive 2009/125/EC was transposed into German law by the Energy-Related Products Act (Energieverbrauchsrelevante-Produkte-Gesetz – EVPG). Minimum efficiency standards are not established by the Directive itself but rather by implementing measures based on it, generally EU regulations, which have binding legal force in the Member States. The European Commission can also recognize voluntary agreements by industry as an alternative to regulatory measures. These requirements must be fulfilled if the product is to carry the CE marking that will allow it to be placed in circulation or operated in the EU. The requirements are based on a technical, economic and environmental analysis. A preliminary study that includes a market analysis, a technical analysis of products, and standard scenarios with multiple variants is done for each product group. Seventeen regulations are currently in force, and another 18 product groups are being dealt with by the consultation forum or regulatory committee. Eleven preliminary studies are currently in progress (as of 15 October 2012). Product groups currently fall into three categories, all of which are supposed to be included in the multi-measure scenario, with different assumptions for each of them.

- Product groups for which there were implementing measures when modelling began. This applies to the following devices (some of which are classified only in the private household sector): simple set-top boxes, television sets, standby and off-mode losses, external power supplies, air conditioners, comfort fans, household refrigerators and freezers, non-directional household lamps, glandless standalone circulators, road and office lighting, electric motors, water pumps, fans, household washing machines, household dishwashers and household tumble driers. A regulation on some standby losses also applies to multiple device groups. The savings for these product groups in the with-measures scenario are calculated using the requirements or requirement levels that were determined in the implementing measure.

- Product groups for which at least one preliminary study is in progress or has been completed or for which there is already a draft Regulation are modelled in the with-measures scenario based on the least life cycle cost (LLCC) shown in the preliminary studies, in some cases at the draft stage. The LLCC standard is the one that is most likely to be implemented with the final implementing measure.
- Product groups for which no preliminary study has begun. Assumptions about the anticipated minimum standard that corresponds to the LLCC variant (expert estimate) must be made for these products in the with-measures scenario.

Public procurement of energy-efficient products

As part of its decisions on the Energiewende on 6 June 2011, the federal cabinet confirmed the announcement that the requirement for high-efficiency criteria in public procurement contracts which is contained in the Energy Concept of 28 September 2010 would be made legally binding. The first step is to amend the Regulation on the Award of Public Contracts (Vergabeordnung – VgV) accordingly.[74] As a matter of principle, the products and services that are procured must offer the highest level of performance with respect to their energy efficiency and belong to the highest efficiency class.

Promotion of energy-efficient cross-cutting technologies

A programme that offers grants to promote energy-efficient cross-cutting technologies in SMEs as part of the Energy and Climate Fund (see section 3.2.2) entered into force on 1 October 2012 and was published in the Federal Gazette (Bundesanzeiger) on 19 September 2012. The programme promotes investments to increase energy efficiency through the use of high-efficiency cross-cutting technologies that are available on the market, such as electric motors and drives, pumps, ventilation and air conditioning systems, pressurized air systems, systems for heat recovery and the utilization of waste heat, and lighting. Both individual measures and measures for systematic optimization of partial or entire processes, including detailed advice on projects, are eligible for funding. The funding programme is run by BAFA.

3.3.5.2. Supporting instruments

Amendments to the Energy Tax Act

[74] Draft of a Fourth Regulation Amending the Regulation on the Award of Public Contracts (Vierte Verordnung zur Änderung der Verordnung über die Vergabe öffentlicher Aufträge) 6 June 2011 version (http://bmwi.de/BMWi/Navigation/energie,did=405004.html).

Amendments to the Energy and Electricity Tax Act (including a reduction in general tax relief and what is known as tax capping) entered into force on 1 January 2011.

Electronic electricity meters

The 2009 amendment to the Energy Industry Act (Energiewirtschaftsgesetz – EnWG) on liberalization of metrology allows and promotes innovative methods for metering electricity as well as load-based rates that vary over time.

KfW programmes to promote energy efficiency in industry and trade, commerce and services

These include the KfW Environment Programme, the KfW Energy-Efficiency Programme, and the programme of the Federal Ministry for the Environment (BMU) to promote demonstration projects. Particularly noteworthy is the KfW Energy-Efficiency Programme, under which advice to medium-sized enterprises is followed by low-interest loans so that investments can be made in energy conservation.

To supplement the funding guidelines for high-efficiency cross-cutting technologies, the Energy and Climate Fund also includes a programme to fund energy-efficient and climate-friendly production processes. Corresponding funding guidelines are in preparation. As things now stand, funding is to be tied in particular to reaching a certain level of additional costs for investments in energy efficiency and for minimum requirements for the amount of energy saved and the reduction in CO_2 that is achieved.

Voluntary product labelling for energy-driven products (Blue Angel, Energy Star, EU Flower): Climate protection has been an area of emphasis for the Blue Angel ecolabel since 2009. Criteria now exist for more than 40 product groups, ranging from refrigerators to computers to coffee-makers. The Energy Star programme comes from the United States and covers only office equipment in the EU. Neither system distinguishes according to efficiency classes. Instead, each label is issued for all devices that fulfil a minimum standard.

Table 25: Measures to reduce emissions in the trade, commerce and services sector

Measure	Target (quantitative)	Affected GHG	Type of instrument	Status (implemented, approved, planned)	Reduction in millions of tonnes of CO2 equivalents		
					2010	2015	2020
Emissions trading	Cap and trade particularly for energy-intensive industries	CO2	Economic	Implemented	No information	0.83	1.62
Special energy-efficiency fund for SMEs	Subsidized energy advice linked to low-interest investment credits for SMEs	CO2	Funding	Implemented	No information	1.23	2.02
Minimum standards I (EU Ecodesign Directive)	Minimum standards for energy-relevant products	CO2	Regulatory	Implemented	No information	0.39	1.24
Changes in energy taxation	Reductions in the energy tax are tied to energy management and voluntary agreement to increase efficiency	CO2	Voluntary agreement	Implemented	No information	0.02	0.05
Funding programme for cross-cutting technologies in SMEs	Support for investments in cross-cutting technologies (pumps, motors, waste heat, etc.)	CO2	Funding	Implemented	No information	0.02	0.05
Procurement of energy-efficient products (federal government)	Procurement of energy-efficient products and services for the federal government	CO2	Voluntary agreement	Implemented	No information	-	-

Source: 2013 Projection Report

3.3.6. Industrial processes (CO_2, CH_4- and N_2O emissions)

Measures and instruments under the **with-measures scenario** in this sector include the following:

Inclusion of selected N_2O point sources in the EU ETS

A series of N_2O point sources (adipic and nitric acid production, production of glyoxal and glyoxylic acid) will be included in the European Emissions Trading Scheme starting in 2013. The corresponding (additional) emission reduction measures are compared with the EUA price, and their implementation is modelled accordingly. The specific allocation model for these source areas does not have much influence on this modelling, because the economic efficiency of emission reduction measures is based on the opportunity costs of any free emission allowances that are allocated.

Table 26: Measures to reduce emissions from industrial processes

Measure	**Target (quantitative)**	**Affected GHG**	**Type of instrument**	**Status (implemented, approved, planned)**	**Reduction in millions of tonnes of CO2 equivalents**		
					2010	**2015**	**2020**
a) Inclusion in the EU Emissions Trading Scheme and	Economic incentives for equipping production facilities with N2O reduction systems	N2O	Economic	a) starting 2013	Based on current experience from the joint implementation projects, a 50% reduction in emissions from 2009 levels is used for nitric acid production and a 90% reduction is used for adipic acid production.		
b) Possibility of joint implementation projects for adipic and nitric acid production				b) starting 2008			

Source: Projection Report 2013

3.3.7. Industrial processes – use of products (fluorinated greenhouse gases)

The following measures in addition to the measures to reduce PFCs, HFCs, and SF_6 which are already described in the Fifth National Communication are also taken into account in the with-measures scenario:

- Maintenance requirement/leakage checks for fixed air conditioners, heat pumps, and fire protection systems containing more than 3 kg of fluorinated greenhouse gases according to Regulation (EC) 842/2006 (F-gas Regulation)
- Maintenance requirement/leakage checks for mobile systems containing more than 3 kg fluorinated greenhouse gases which are used to cool goods during transport, according to the Chemicals and Climate Protection Regulation (Chemikalien-Klimaschutzverordnung –ChemKlimaschutzV)
- Prohibition on use according to Regulation (EC) 842/2006 for synthetic greenhouse gases in the following products/systems: noise insulation panels, fire protection systems (HFCs) and fire extinguishers (HFCs)

- Inclusion of F-gas emissions from the primary aluminium industry in the European Emissions Trading Scheme
- Replacement of HFCs by coolants having a GWP ≤ 150 and improvement of the air-tightness of mobile air conditioning systems for selected vehicle classes (cars and light commercial vehicles according to Directive 2006/40/EC (MAC Directive)). This applies to new vehicle types after 2001 and all vehicles in the class after 2017.
- Funding for measures that result in early replacement of HFCs by coolants having a GWP ≤ 150 in car air conditioners (Meseberg decision 23). This has not yet been implemented.

Table 27: Measures to reduce emissions from the use of products.

Measure	Target (quantitative)	Affected GHG	Type of instrument	Status (implemented, approved, planned)	Reduction in millions of tonnes of CO2 equivalents		
					2010	2015	2020
Miscellaneous measures: maintenance requirements, compliance with limits for leaks, substitution	Minimizing the release of fluorinated greenhouse gases	Fluorinated greenhouse gases	Regulatory and voluntary agreement		18% reduction in emissions from 2010 levels by 2020 based on CO2 equivalents (2.7 million tonnes)		

Source: Projection Report 2013

3.3.8. Agriculture

The 2013 Projection Report considers only a **with-measures scenario** in the agriculture sector. Most of the political regulations that apply to agriculture are determined at EU level as part of the Common Agricultural Policy (CAP). According to the Projection Report, there have been considerable effects from implementation of the Health Check decisions to reform the CAP during the period from 2003 to 2013, abolition of the arable set-aside starting in 2009[75] and the phase-out of milk quotas in 2015.

The following reforms are among the most important measures and instruments of the CAP:

[75]European Commission 2009.

- Cross compliance – Aid to farmers is linked to adherence to certain environmental requirements (good agricultural and environmental practice – GAEP). Farmers who do not respect the rules face cuts or the cancellation of direct payments. Premium payments have been linked to fulfilment of environmental standards (cross compliance) since 2005. For example, the use of nitrogen fertilizers is governed by the EU Nitrates Directive, which was transposed in Germany in the 2009 Fertilizer Act (Düngegesetz) and the Fertilizer Ordinance (Düngemittel-verordnung).
- Rural development – Extensification of agriculture is to be promoted by the regional agri-environmental measures of the CAP. Regulation (EC) 1698/2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) was adopted to that end. The Member States can develop national and regional agri-environmental measures that are then co-financed by the EU. Organic production methods, limited use of fertilizer, and environmentally sound livestock raising that respects animal welfare are eligible for funding.
- Health Check decisions – The Health Check decisions (decoupling livestock premiums), which also restructure the milk sector, have had considerable effects on livestock numbers since they were adopted in 2008.

In June 2013, the EU Commission adopted a new CAP reform package for the period from 2014 to 2020. The key points of the reform are linking direct payments more closely to environmental aspects and climate protection and funding for the development of rural areas. Five percent of the arable area of most farms can be allowed to return to nature, for example as fallow land or green strips, after 2015. Meadows and pastures are to be retained, and farmers are to rotate their crops. Thirty percent of direct payments to farmers are subject to respecting agricultural practices that are beneficial for the environment. Additional payments may be made for environmentally sensitive areas and areas with natural constraints. The EU agreement in principle is still subject to final approval by the European Parliament. The 2013 Projection Report does not yet include the reform of the CAP for the period after 2014.

Table 28: Measures to reduce emissions from industrial processes

Measure	Target (quantitative)	Affected GHG	Type of instrument	Status (implemented, approved, planned)	Reduction in millions of tonnes of CO2 equivalents
CAP: cross-compliance, EAFRD, Health Check	Good agricultural and environmental practice, extensification, restructuring of the dairy sector	CH4, N2O	Regulatory and economic	Approved	Emissions increase by 0.282 million tonnes of CO2 equivalents up to 2020 and decrease by 1.7 million tonnes of CO2 equivalents up to 2030 compared with 2010 levels

Source: Projection Report 2013

3.3.9. Waste management

The 2013 Projection Report contains only a **with-measures scenario** for the waste management sector. The key regulatory framework for waste management consists of the Technical Instructions on Municipal Waste (TA Siedlungsabfall – TASi) and, starting in 2001, the Storage of Waste Ordinance (Abfallablagerungsverordnung – AbfAblV) and the Closed Cycle Management Act/Waste Management Act (Kreislaufwirtschafts- und Abfallgesetz – KrW/AbfG). The requirements of the Technical Instructions on Municipal Waste/Storage of Waste Ordinance and the Recovery at Landfills Ordinance (Deponieverwertungsverordnung) were integrated into the Landfill Ordinance (Deponieverordnung) in 2009 and therefore continue to apply. Landfilling of biodegradable waste with corresponding landfill gas emissions is and remains permanently prohibited.

Additional regulatory instruments are the Biological Waste Treatment Plants Ordinance (Verordnung über Anlagen zur biologischen Behandlung von Abfällen – 30th BImSchV) and the amendment to the Incineration and Co-incineration of Waste Ordinance (Verordnung über die Verbrennung und die Mitverbrennung von Abfällen – 17th BImSchV), which effectively limit emissions from the treatment of residual waste and the landfilling of mechanically and biologically treated residual waste. At the same time, other types of disposal, including incineration and biomechanical waste treatment, make it possible to reduce the amount of waste that is generated. On the one hand, the composition of waste and the methane formation at existing landfills which results from the different half-lives of the waste components are important factors (influence of methane formation on input quantities). On the other hand, the collection and use of landfill gases also influences the level of residual methane emissions (in this case influence of the technical method on methane formation).

The federal government approved the amendment to the Closed Cycle Management Act on 30 March 2011. The Act entered into force on 1 June 2012. Recycling is accorded more importance than energy recovery; at least 65% of all municipal waste is to be recycled by 2020.

The declining population is also reflected in the calculation methods, which are based on population. Consequently, wastewater treatment and the resulting methane emissions are another controlling variable. Wastewater treatment in municipal treatment plants and small treatment systems is done under aerobic conditions, so there are no methane emissions.

Table 29: Measures to reduce emissions from waste management

Measure	Target (quantitative)	Affected GHG	Type of instrument	Status (implemented, approved, planned)	Reduction in millions of tonnes of CO2 equivalents
Various legal provisions		CH4, N2O	Regulatory	Approved	Total GHG emissions in the waste management sector decrease by approximately 11 million tonnes CO2 equivalents during the 2005-2030 period and are around 8.4 million tonnes of CO2 equivalents in 2020 in the with-measures scenario.

Source: Projection Report 2013

3.3.10. Forestry

The measures in this section are not reflected in the 2013 Projection Report. The federal government is examining whether future Projection Reports should be expanded to include them and, if so, how this should be done.

Forests are valuable ecosystems and carbon sinks, while simultaneously serving as areas for recreation and supplying raw materials. They make a major contribution to climate protection and help to reduce greenhouse gases thanks to conservation and propagation of forests, sustainable forest management, and the substitution of wood for energy-intensive materials with adverse carbon footprints and lifecycle assessments.

By sequestering CO_2 and serving as carbon sinks, forests and wood play an important role in achieving the federal government's climate targets. Carbon sequestration in forests, the replacement of fossil raw materials by the use of wood as a material and an energy source, and the sequestration of carbon in long-lived wood products decreases the amount of greenhouse gases released into the atmosphere by more than 120 million tonnes CO_2 (as of 2008) each year in Germany alone.[76] The contribution of forests and wood to climate protection should therefore be further expanded with due regard for all forest functions, including maintaining biodiversity in the context of proper sustainable forest management.

The federal government has implemented the following measures over the past few years to increase the climate protection offered by forestry:

The Forest Climate Fund (Waldklimafonds) was created on 1 July 2013 under the joint sponsorship of the Federal Ministry for Food, Agriculture and Consumer Protection (BMELV) and the Federal Environment Ministry (BMU). Funding from the Forest Climate Fund will be devoted to further expansion of the contribution of forests and wood to climate protection with due regard to all forest functions, including maintaining biological diversity in the context of proper sustainable forest management, and to promotion of the necessary adaptation of German forests to climate change. The targets and substantial orientation of the funding guidelines, which have been approved by the European Commission, were developed by both ministries with the involvement of the relevant associations and experts from the forestry, wood industry, environmental, and nature conservation sectors, along with participation by the Länder.

Funding will focus on the following targets:

- Improving the ability of forests to adapt to climate change while in particular maintaining their functions that favour biodiversity and as CO_2 sinks and safeguarding the potential of forests and wood products to lower CO_2 levels
- Safeguarding and increasing the ability of forests to offer sequestration and serve as sinks, as well as avoiding greenhouse gas emissions

[76] vTI 2011.

- Increasing the sequestration offered by wood products and increasing the share of wood products offering prolonged carbon sequestration

Research, monitoring, information and communication measures will also be funded.

3.4. Institutional measures and instruments under the Kyoto Protocol

3.4.1. National system for emissions reporting

Article 5 of the Kyoto Protocol requires every Party included in Annex B to create a national system for emissions reporting, which must include the information that is available nationally in the preparation of the greenhouse gas inventory. This requirement was implemented in Germany on the basis of a decision on 5 June 2007 by the undersecretaries of the ministries involved in providing the data. To discuss all questions that must be clarified within the context of the national system, particularly problems in data flows, and for official approval of the inventories and the reports required under Articles 5, 7 and 8 of the Kyoto Protocol, a coordinating committee of all ministries involved in reporting was created to provide support for the emissions reporting process. It is headed by the Federal Ministry for the Environment (BMU).

The Federal Environment Agency, department I 2.6 “Emissions Situation”, has been designated as the Single National Entity for reporting under the U.N. Framework Convention on Climate Change and the Kyoto Protocol.

The Single National Entity is responsible for planning and generating the national inventory, for quality control and quality assurance at each relevant step in the process, constant improvements to the inventory, and preparatory work for the co-ordinating committee’s decisions. The Single National Entity also serves as the central contact and coordinates and provides information to everyone involved in the national system.

3.4.2. Working Group on Emissions Trading as a Means to Combat the Impacts of Greenhouse Gases (AGE)

The federal cabinet created the Working Group on Emissions Trading as a Means to Combat the Impacts of Greenhouse Gases (AGE) under the sponsorship of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) as part of the National Climate Programme on 18 October 2000. The federal cabinet expressly welcomed the consultations of the AGE and extended its remit in the 2005 Climate Protection Programme. It is the working group’s task to review questions that arise in connection with the use of emissions trading in bundles of climate-related measures and to make recommendations on the configuration of new types of instruments. The background to the consultations of AGE are discussions at international level (Framework Convention on Climate Change, Kyoto Protocol) about the use of flexible mechanisms (such as the Clean Development Mechanism (CDM), Joint Implementation (JI) and international emissions trading) and the process of shaping and implementing the European Climate Change Programme (ECCP).

3.4.3. German Emissions Trading Authority (DEHSt)

The German Emissions Trading Authority (DEHSt) at the Federal Environment Agency is the national authority responsible for implementation of market-based climate protection instruments in the area of emissions trading, as well as project-based mechanisms under the Kyoto Protocol. It performs a wide range of duties, the details of which are defined in the EU Emissions Trading Directive, the Greenhouse Gas Emissions Trading Act (Treibhausgas-Emissionshandelsgesetz – TEHG), the Allocation Ordinance (Zuteilungsverordnung – ZuV 2020) and the Project Mechanisms Act (Projektmechanismengesetz – ProMechG).

The German Emissions Trading Authority actively supports plant operators, airlines, and specialized agencies in the proper implementation of requirements related to emissions trading, verifying this with corresponding controls. The Authority is also the contact point for the Federal Environment Ministry, the Länder, and the responsible pollution control agencies in the Länder.

3.4.4. Joint Implementation Coordination Office (JIKO)

The Federal Ministry for the Environment (BMU) created the Joint Implementation Coordination Office (JIKO) in 1995 to promote, approve, and monitor the joint implementation (JI) and clean development (CDM) projects specified in Articles 6 and 12 of the Kyoto Protocol. JIKO’s overarching objectives will continue during the second commitment period of the Kyoto Protocol, with the addition of new tasks related to the carbon market. Goals continue to be to create appropriate background conditions for cooperation between Germany and third countries which will promote and implement specific CDM/JI projects with an emphasis on the least developed countries, and to support the reform processes for CDM and JI. JIKO also supports the development of new market mechanisms (NMMs) with a view to keeping up with perspectives for long-term international cooperation in the carbon market.

The German Emissions Trading Authority at the Federal Environment Agency is responsible for the formal participation that is necessary for CDM and JI projects due to international requirements, i.e., approval of and consent to individual projects.

3.4.5. National Focal Point for Education on Climate Protection

As part of implementation of Article 6 of the U.N. Framework Convention on Climate Change, the National Focal Point for Education on Climate Protection (climate-education@bmu.bund.de) was created to make the multiplicity of educational activities in the area of climate protection more visible as an essential subsector of sustainable development, thereby creating a basis for further development. The Focal Point is used as a platform for public and private players in the educational sector. The many different governmental and non-governmental players in the educational field and their diverse educational activities are to be networked more within the context of Germany’s federal system. An intensive exchange will make it possible to better harness synergies.

3.4.6. Coordination of German Strategies for Adaptation to Climate Change and Competence Centre on Climate Impacts and Adaptation (KomPass)

In its decision on the German Strategy for Adaptation to Climate Change, the federal government created an interministerial working group on adaptation to climate change headed by the Federal Ministry for the Environment (BMU) and instructed it to coordinate the implementation and further development of the strategy. At the same time, the Conference of Federal and Länder Environment Ministers decided to create a committee on adaptation to climate change.

BMU created a Competence Centre on Climate impacts and Adaptation (KomPass) at the Federal Environment Agency to support the preparation and further development of a national strategy for adapting to climate change.

KomPass provided – and continues to provide – a technical and conceptual basis for creation of the strategy and in 2011 contributed to preparation of the Action Plan for Adaptation to Climate Change.

KomPass offers an information platform for technical knowledge about climate impacts, adaptation, and adaptation activities in Germany. KomPass promotes communication and cooperation with and among the decision-makers who are involved in the adaptation process.

3.4.7. Bilateral Standing Working Groups on the Environment and Energy

The federal government participates in bilateral working groups in Russia and Ukraine based on bilateral government agreements in the environmental sector. In addition to cooperation and advice to governments on general issues of climate policy, the tasks of the working groups are primarily project-based cooperation and the creation of capacities in the coal market (use of flexible Kyoto mechanisms or development of emissions trading systems).

3.5. Climate-protection activities of the Länder and municipalities

3.5.1. Länder

All 16 German Länder (states) have climate-protection concepts, programmes and/or plans (see Table 29). They are frequently tied to the subject of energy supply, and in some cases they are integrated concepts that include both mitigation and adaptation to climate change.

Only two Länder, North Rhine-Westphalia and Baden-Württemberg, have Climate Protection Acts so far. Rhineland-Palatinate also intends to adopt a Climate Protection Act. Berlin is planning an Energiewende Act. Hesse has made the reduction of greenhouse gases a requirement for funding under its Energy Future Act.

Only Bavaria, Hesse, and Saxony-Anhalt have strategies for adapting to climate change, while Lower Saxony has recommendations. In North Rhine-Westphalia, adaptation to climate change is a target of equal value under the Climate Protection Act. Therefore, adaptation strategies are also being developed under the Climate Protection Plan. Rhineland-Palatinate is currently developing an action programme for climate change for selected sectors. Hesse wants its administration to be carbon-neutral and is running a project to that end which calls for minimizing energy consumption and converting to low-greenhouse-gas energy sources and then completely offsetting the remaining CO_2 by 2030. Baden-Württemberg is having the Land administration itself audited with respect to energy use and environmental orientation. Energy conservation in Land-owned buildings is also on the agenda in Lower Saxony, Schleswig-Holstein, Rhineland-Palatinate and North Rhine-Westphalia.

Climate protection receives institutional support in several Länder, for example by combining responsibilities for climate protection and energy (in Hesse, Baden-Württemberg and Schleswig-Holstein) or by creating energy agencies and networks (in Baden-Württemberg, Rhineland-Palatinate and Saxony-Anhalt). Rhineland-Palatinate created its Competence Centre for the Impacts of Climate Change as the primary Land institution for dealing with issues related to adapting to the impacts of climate change in 2010.

Table 30: Climate protection activities in the Länder

	Laws, audits, institutionalisation	**Concepts, plans, programmes, studies, etc.**
Baden-Württemberg	Act Promoting Climate Protection in Baden-Württemberg (Gesetz zur Förderung des Klimaschutzes in Baden-Württemberg) Baden-Württemberg Sustainability Strategy Amendment of the Land (state) Planning Act (Landesplanungsgesetz) to expand wind energy Energy auditing of the Land (state) Ministries up to the end of 2013 and eco-auditing up to the end of 2014, eco-auditing of the entire Land administration Funding for implementation of a certified EMAS environmental management system Support for participation of municipalities in the European Energy Award Update of the Baden-Württemberg Renewable Heating Act (Erneuerbare-Wärme-Gesetz – EWärmeG) (planned)	Integrated Energy and Climate Protection Concept (IEKK) (draft) with participation of citizens and the public ECOfit environmental programme – advisory programme to increase environmental and climate protection in companies KlimaschutzPlus funding programme for municipalities and small- and medium-sized enterprises (SMEs) and associations Low-interest loans for energy-efficient building refurbishment by individuals and to increase energy efficiency in SMEs Bioenergy villages (Bioenergiedörfer) funding programme ECO Plus und ECO fit environmental programmes Future of old buildings (Zukunft Altbau) Launch of a contracting campaign Improvement in advisory services on energy Development of a renewable energies potential atlas
Bavaria	Bavaria 2020 Climate Programme (CO_2	Bavarian Climate Alliance and Bavarian Climate Week

	Laws, audits, institutionalisation	Concepts, plans, programmes, studies, etc.
	reduction, adaptation, research) Bavarian Climate Adaptation Strategy (BayKLAS) Bavarian Energy Concept "Energie Innovativ"	International cooperation in The Climate Group Virtual Alps Observatory at the Schneefernerhaus climate research station (Zugspitze) Bavarian Energy Atlas
Berlin	Berlin Energy Saving Act (Energiespargesetz) of 1990 A Berlin Energiewende Act (Energiewendegesetz) (Climate Protection Act – Klimaschutzgesetz) is being developed to replace the Berlin Energy Saving Act. Implementing regulation to the Renewable Energies Heat Act (EEWärmeG) is being developed. Climate protection agreements with companies including specific CO_2 reduction targets CHP model city E-mobility showcase	Land (state) Energy Concept 2020 (decision in 2010) Urban Development Plan for Climate (decision in 2010) A feasibility study on Climate-Neutral Berlin 2050 is to be done by the end of 2013 for development of an integrated strategic Energy and Climate Protection Concept (projected for 2014) Development of monitoring for the effects of climate change is planned. Energy saving partnerships (contracting) in public buildings to reduce energy consumption and increase energy efficiency
Brandenburg	Energy Strategy 2030 (2012) Energy Strategy 2030 – List of strategic measures (2012) Biomass Strategy (2010)	Sustainability strategy
Bremen	Act Promoting Economical and Environmentally Sound Energy Supplies and Energy Use in Bremen (Bremen Energy Act) (Gesetz zur Förderung der sparsamen und umweltverträglichen Energieversorgung und Energienutzung im Lande Bremen, Bremisches Energiegesetz – BremEG) of 17 September 1991 A supplemental plan to the Bremen Land Use Plan, "Development potential for adaptation to climate change", is being prepared.	Land (state) Energy Programme (1994), updates in 1996, 2001 und 2005 Action Programme on Climate Protection 2010 Climate Protection and Energy Programme 2020 Funding programme for heat insulation in existing residential buildings Funding programme for the replacement of electric heaters Funding programme for rational energy use in trade and industry CO_2 monitoring Climate protection management Technical concept: Climate change in Bremen – impacts and adaptation Study on the effects of climate change on species and biotopes in Bremen Expert report: Climate analysis for the Bremen urban area KLAS project: Climate adaptation strategy for extreme rain events Adaptation to climate change in the General Coastal Protection Plan for Lower Saxony/Bremen Second Regional Conference of the German government and the northern German Länder on climate adaptation in the coastal region (2012)
Hamburg	Hamburg Climate Protection Ordinance (Klimaschutzverordnung) (2007) Hamburg Climate Protection Concept 2007-2012 Climate Protection Master Plan (2013- 2020) First Action Plan: Requirements for Climate Change (2013)	Hamburg funding programmes include: Funding programme for resource conservation in companies with sub-programmes for specific areas such as heating network, WärmeCheck heating check-up, LichtCheck lighting check-up and cooling efficiency network Funding programme for energy-efficient improvements to heating systems in commercial and multi-family residential buildings Funding programme for heat insulation in existing buildings Funding programme for the Hamburg energy performance certificate Funding programme for renewable heating

	Laws, audits, institutionalisation	Concepts, plans, programmes, studies, etc.
		Funding programme for CHP initiatives Hamburg solar potential analysis European Environmental Capital 2011 Regional Conference of the German government and the northern German Länder on climate adaptation in the coastal region (2011)
Hesse	Hesse Strategy for Adaptation to Climate Change (2012) Hesse Future of Energy Act (Energiezukunftsgesetz) (2012)	Hesse Climate Protection Concept 2012 (2007) Action Plan for Climate Protection (2007) Hesse energy summit – Implementation concept for the Hesse Land (state) government (2012) Hesse Biomass Action Plan 2020 (2011) Integrated Energy and Climate Protection Concept (preparation 2013/2014) Hesse Action Plan on Adaptation to Climate Change (preparation 2013/2014)
Mecklenburg-Western Pomerania	Continuous updating of climate protection targets and measures since 1997 (Climate Protection Concept → Action Plan for Climate Protection)	Study on the impacts of climate change in Mecklenburg-Western Pomerania 2008 "Energy Land 2020" concept Mecklenburg-Western Pomerania Action Plan for Climate Protection 2010 Land (state) Renewable Energies Atlas for Mecklenburg-Western Pomerania, analysis of the potential for using renewable energy sources Regional conference of the northern German Länder on the subject of climate adaptation in the coastal region Bog protection programme/funding for sustainable development of surface waters and wetlands; emission reductions for the period to 2008 as a result implementing the concept were estimated at 300,000 tonnes CO_2 equivalents annually.
Lower Saxony	Implementation of recommendations by the Government Commission on Climate Protection (Regierungskommission Klimaschutz) for a Lower Saxony climate strategy and for a Lower Saxony strategy for adaptation to the impacts of climate change	Development of a Land (state) Climate Protection Act (Landesklimaschutzgesetz) with specific climate protection and energy efficiency targets for Lower Saxony Creation of a Lower Saxony Climate and Energy Agency (KEAN) Expansion of the Lower Saxony Sustainability Alliance (Allianz für Nachhaltigkeit)
North Rhine-Westphalia	Climate Protection Act (Klimaschutzgesetz) Climate Protection Plan Climate protection strategies and measures Measures for adapting to climate change	The climate protection targets of the North Rhine-Westphalia (NRW) state government are as follows: Expansion of renewable energies Increased energy efficiency Improved energy conservation The targets are to be achieved with the following instruments: North Rhine-Westphalia Energy Agency (EnergieAgentur.NRW) European Energy Award Leading market competitions Guidelines on the granting of aid from the programme for the rational use of energy, renewable energies and energy conservation – progres.nrw CHP programme area (funding for CHP systems and CHP-based measures); NRW/EU CHP investment credit CHP stimulus programme Guidelines on the granting of aid from the programme for the rational use of energy, renewable energies and energy conservation – progres.nrw Innovation programme area (progres.nrw - Innovation)

	Laws, audits, institutionalisation	Concepts, plans, programmes, studies, etc.
		Guidelines on the granting of aid from the programme for the rational use of energy, renewable energies and energy conservation – progres.nrw Market Launch programme area (district and local heating) NRW Efficiency Agency (Effizienzagentur) NRW.Bank efficiency credits Approximately 40 projects for adaptation to climate change (basic research on climate change, agriculture, soil, forestry, water management, cities and conurbations, plant safety, biodiversity, nature conservation and overarching activities such as training initiatives) Determination and discussion of operations for action and measures to adapt to climate change in the follow-up to the Climate Protection Plan Klimaplus campaign: The Klimaplus – NRW-Klimakommunen der Zukunft (NRW climate municipalities of the future) campaign (since 2008) pinpoints how cities and communities in North Rhine-Westphalia can connect climate protection and adaptation to the impacts of climate change
Rhineland-Palatinate	Land (state) Energy Agency created in July 2012. A network of regional offices of the Land Energy Agency will follow in 2013. Creation of Landesnetzwerk Bürgerenergiegenossenschaften Rhineland-Palatinate e.V., a network of energy cooperatives (www.laneg.de) (to achieve the Energiewende from the grassroots) Creation of the Rhineland-Palatinate Competence Centre for the Impacts of Climate Change (Kompetenzzentrum für Klimawandelfolgen) (www.klimawandel-rlp.de) in 2010	Partial update on renewable energies in Land (state) Development Programme IV in May 2013 Preparation for the tenth Energy Report for the 2010-2011 period Rhineland-Palatinate Wind Atlas submitted in July 2013 Analysis and evaluation of climate change by the Commission of Inquiry on Climate Change (Enquete-Kommission Klimawandel) of the Rhineland-Palatinate Landtag (state parliament) (see http://www.landtag.rlp.de/landtag/drucksachen/3600- for final report) Creation of the "kwis-rlp" climate change information system for Rhineland-Palatinate (www.kwis-rlp.de) in 2011 Creation of Web-based platform for free access to climate and weather data (www.wetter.rlp.de) www.klimlandrp.de Funding programme for investments in the area of energy efficiency and energy supplies (interest subsidy programme) Initiatives for combined heat and power (CHP) in Rhineland-Palatinate
Saarland		Climate Protection Concept 2008-2013 Analyses of potential for photovoltaics, wind, biomass and geothermal Energy Master Plan "Klima Plus Saar" funding programme E-Mobil Saar
Saxony	Saxony Energy and Climate Programme of 12 March 2013 Sachsen hat Zukunft (Future of Saxony) for the Free State of Saxony Climate impact monitoring in Saxony – indicators for the observation of climate impacts	Saxony/Saxony-Anhalt/Thuringia Regional Climate Information System (ReKIS) launched in January 2012 Successful completion of EU Structural Fund period in the area of energy efficiency and climate protection with the Funding Guidelines for Energy and Climate Protection/ 2007 Completion of first climate check in Land (state) planning; climate check ensures that the Land development plan supports future Land development when adapting to the impacts of climate change and in the area of climate protection. Successful completion of INTERREG IVC project

	Laws, audits, institutionalisation	Concepts, plans, programmes, studies, etc.
		EnercitEE and presentation of results in Brussels Vulnerability study for Saxony Integration of climate protection into schools
Saxony-Anhalt	Land (state) strategy for adaptation to climate change 2010, currently first revision Saxony-Anhalt Energy Agency 2013	Energy Concept 2007-2020 for Saxony-Anhalt (September 2007) Climate Protection Programme 2020 for Saxony-Anhalt (August 2010) First report on Climate Protection Programme (December 2011) Study on the impacts of climate change in Saxony-Anhalt 2012 Study on the costs of adapting to climate change – An economic analysis of selected sectors in Saxony-Anhalt Vulnerability study 2009
Schleswig-Holstein	Energy conservation in Land (state) properties, including through the creation of a special fund for energy-efficient refurbishment and development and implementation of a green ICT strategy Creation of an Energiewende and climate protection priority in funding programmes (40% share in funding for EAFRD and ERDF from 2014) Acceleration and acceptance of expansion of the power grids Expansion of wind energy in Schleswig-Holstein (including by designating suitable wind areas) Energiewende heating market (including through the Klimapakt Wohnen (residential climate pact) and measures for energy-efficient refurbishment of residential buildings and neighbourhood refurbishment) Support for community climate protection, including through an advisory services initiative Climate protection in agriculture and rural areas through funding of measures to reduce greenhouse gases in the context of EAFRD funding/CAP starting in 2014, Grasslands Protection Act (Grünlanderhaltungsgesetz) and protection for bogs	The Schleswig-Holstein Land (state) government submits a Climate Protection Programme during every legislative period. An Integrated Energy and Climate Protection Concept was submitted in 2011. Responsibilities for energy and climate protection policies were combined in one ministry for the first time when the new Land government was formed in June 2012. The Schleswig-Holstein Ministry for the Energiewende, Agriculture and Rural Areas (MELUR) will submit a priority programme and an indicator-based monitoring programme in mid- 2013. For additional information, see http://www.schleswig-holstein.de/Energie/DE/Energiewende/Klimaschutz/klimaschutz_node.html
Thuringia	Land (state) development programme 2025 Thuringia Climate and Adaptation Programme (2009) Thuringia Climate Agency (ThKA/2011) Thuringia Energy Concept 2020: New Energy for Thuringia (2012) Thuringia Energy and Green Tech Agency (ThEGA/2010)	Thuringia Climate and Adaptation Programme (2009) Integrated Programme of Measures to Adapt to the Impacts of Climate Change in the Free State of Thuringia (2013) Participation in ReKIS regional climate information system of the states of Saxony, Saxony-Anhalt, and Thuringia Land (state) development programme 2025 (in process) Energy summit 2011: New Energy for Thuringia (setting climate targets for 2020 by increasing the share of renewable energies in net electricity consumption and total energy consumption) European Energy Award – Funding for implementation-oriented climate protection in the municipalities of Thuringia Regular reports on the expansion of renewable energy sources included in annual economic report

Source: BMU based on information from the Länder

Many Länder have set their own climate targets. Additional targets relate to increases in energy efficiency and greater use of renewables (see Table 31). The Länder also have numerous funding programmes related to climate protection. A current summary is available at http://www.energiefoerderung.info, where the public can view the funding programmes that apply to the places they live. Lower Saxony specifically funds PPP climate protection projects by local authorities.

The Länder also finance specific research on climate and adaptation, for example, climatic changes and their territorial and sectoral impacts in Thuringia. Other topics include ecosystems, adaptation to climate change in the city, health, environmental technology, and energy and resource efficiency in Bavaria. In Rhineland-Palatinate, the Climate and Landscape Changes in Rhineland-Palatinate (KlimLandRP) project (www.klimlandrp.de) includes the specific effects of climate change on environmental resources (soil and water), land use (agriculture, forestry and viticulture) and biodiversity/nature conservation. The project has identified the risks and opportunities for Rhineland-Palatinate that are associated with climate change and – with the participation of stakeholders – developed important, extensive knowledge for determining specific options for adaptation by the region and pinpointed further needs for information and research. Hamburg hopes to further develop scientific excellence in research on and teaching of climate research, as well as research on climate impacts. The Lower Saxony innovation programme covers research and development in the area of new technologies related to renewable energy sources, energy conservation, and fuel cells. Research in Thuringia is focused on energy efficiency: the necessary research and educational infrastructure is being established as part of the "E hoch 4" (E to the power of 4) initiative, with research particularly devoted to energy efficiency in the area of mobility (environmentally-sensitive traffic management research project and boat-bike-rail model project). Hesse created the Hesse Climate Change Centre at the Hesse Environment and Geology Agency (HLUG) in 2008, which focuses on determining the effect of climate change on Hesse and conducts climate research.

All Länder accord great importance to improving communication with the public, with some of them emphasizing participation. For example, Baden-Württemberg is testing new approaches to citizen participation in its Integrated Energy and Climate Protection Concept in the hope of developing new ideas and approaches to effective climate protection measures. North Rhine-Westphalia is developing a climate protection plan as part of a broad dialogue and participation process. Rhineland-Palatinate is using various Web-based platforms, such as the Rhineland-Palatinate climate change information system (www.kwis-rlp.de). Saxony is adopting a similar approach, providing online climate data based on past measurements along with data on regional climate models for the future at www.rekis.org. The Climate Monitor of the Hesse Environment and Geology Agency offers current information on climate policies, research into climate and climate impacts and greenhouse gas balances, and also provides basic information, descriptions of organisations, and links. Several Länder are integrating the subject of climate change into school curricula and support services in that field.

Table 31: Climate protection and energy policy targets of the Länder

	Targets
Baden-Württemberg	Reduce greenhouse gases in Baden-Württemberg to 25% below 1990 levels by 2020 and to 90% below 1990 levels by 2050.
Bayern	Bavaria's CO_2 reduction target by 2020: well below 6 tonnes/year per inhabitant. Expansion of renewable energies: 50% coverage of electricity consumption by 2021.
Berlin	Reduce CO_2 emissions to 40% below 1990 levels by 2020 and climate neutrality by 2050.
Brandenburg	Increase the share of renewable energies in primary energy consumption to 32% by 2030. Reduce energy-based CO_2 emissions by the state of Brandenburg to 40% below 1990 levels by 2020 and to 72% below 1990 levels by 2030.
Bremen	Reduce CO_2 emissions (state of Bremen not including the steel industry) to at least 40% below 1990 levels by 2020.
Hamburg	Reduce CO_2 emissions by 2 million tonnes during the 2007-2012 period. Reduce CO_2 emission by 2 million tonnes during the 2013-2020 period. Reduce CO_2 emissions by 80% during the 1990 – 2050 period.
Hesse	Meet energy demand in Hesse (electricity and heating) using as close as possible to 100% renewables by 2050.
North Rhine-Westphalia	Under the new Climate Protection Act (Klimaschutzgesetz), total emissions of greenhouse gases that are harmful to the climate are to be reduced to at least 25% below 1990 levels (of total emissions) by 2020 and at least 80% below 1990 levels by 2020.
Lower Saxony	An Energiewende scenario that contains binding targets and specific measures up to 2020 and target planning up to 2050 are being developed for Lower Saxony. Specific climate protection and energy-efficiency targets for Lower Saxony are contained in the Land (state) Climate Protection Act (Landeklimaschutzgesetz) that is being prepared.
Rhineland-Palatinate	Greenhouse gas emissions in Rhineland-Palatinate are to be reduced to 40% below 1990 levels by 2020 and to 90% below 1990 levels by 2050. Rhineland-Palatinate will notionally meet 100% of its electricity demand with renewables by 2030. Electricity generation from wind is to be increased five-fold from base year 2010 to 2020, and electricity generation from photovoltaics is to be increased to 2 TWh. Research and development in the area of adaptation to the impacts of climate change. Creation of a climate change network with partners or specialised institutions at the regional, state and national levels.
Saarland	Twenty percent of electricity consumption from renewable energy sources by 2020.

	Targets
Saxony	Reduction of CO_2 emissions from the non-emission-trading sector (trade, commerce and services, transport and households) to 25% below 2009 levels by 2020. Increase the share of renewable energies in gross electricity consumption to 28% in the next ten years.
Saxony-Anhalt	Reduce greenhouse gas emissions to 40% below 1990 levels by 2020. Reduce greenhouse gas emissions by 7.6 million tonnes CO_2 equivalents from 2005 levels (for example, 3.0 million tonnes by using renewables, 1.4 million tonnes in the non-energy sector, 1.1 million tonnes by increasing energy efficiency, 2.1 million tonnes through energy conservations measures).
Schleswig-Holstein	Support all climate-related and energy-related targets at the EU and federal government levels and also meet them in Schleswig-Holstein. The aim is also a calculated share of renewables in electricity generation equivalent to 300-400% of electricity consumption.
Thuringia	The share of renewables in net electricity consumption is to rise to 45% and the share of renewables in final energy consumption is to rise to 30% by 2020.

Source: BMU based on information from the Länder

3.5.2. Local authorities

Local authorities make a significant contribution to implementation of climate protection measures in Germany because most emissions by transport, industry and consumers fall under their jurisdiction. Many local authorities are already committed to climate protection and are taking measures to improve energy efficiency, for example in the areas of refurbishing buildings, transport and street lighting. There are also networks at national and international levels (Climate Alliance, Covenant of Mayors, and Go 100% Renewable Energy regions). Many local authorities make voluntary agreements to earn certification (such as the European Energy Award and the Climate Alliance voluntary commitment). Their activities receive support from federal and Länder programmes. For example, funding has gone to local authority climate protection managers and investment projects in areas such as retrofitting to make street lighting more energy efficient and refurbishment of buildings to reduce energy consumption. Such funding is complemented by services offered by the Länder and the federal government (energy agencies and Service And Competence Centre on Municipal Climate Protection.

Based on legislation in the Länder, local authorities will be required to step up their climate protection activities (see Climate Protection Acts in North-Rhine Westphalia and Baden-Württemberg).

3.6. Policies and measures pursuant to Article 2 of the Kyoto Protocol

3.6.1. Activities aimed at promoting decisions by the ICAO and IMO in favour of emissions reductions

The Parties to the Kyoto Protocol have made the commitment to continuing their efforts to limit or reduce emissions from air and sea transport in the responsible UN organisations, the International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO). Germany has supported different developments in the two organisations.

3.6.1.1. International Maritime Organisation (IMO)

Germany is among the Member States of the IMO that have provided decisive support for air quality and the reduction of greenhouse gases and regularly make proposals on those subjects. Germany is involved in the negotiations through two federal ministries, the Federal Ministry of Transport, Building and Urban Development (BMVBS) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), along with the Federal Environment Agency (UBA) and other specialised organisations (such as the Federal Maritime and Hydrographic Agency (BSH) and Germanischer Lloyd). The Maritime Environmental Protection Committee is responsible for the subject of greenhouse gas emissions at the IMO.

Over the past few years, Germany has worked tirelessly for the introduction of an Energy Efficient Design Index (EEDI) and a mandatory Ship Energy Efficiency Management Plan (SEEMP), both of which were adopted by the IMO in 2011. The EEDI requires progressive reductions in CO_2 emissions by new ships based on the type of ship and its capacity (10% by the end of 2019, up to 20% by the end of 2024, and up to 30% from 2025) compared with a baseline. Germany also played an important role in developing an Energy Efficiency Operational Indicator (EEOI) for ships, which can be used as a voluntary measure under the SEEMP.

Germany is also working to promote worldwide market-based measures, including by submitting a proposal for a global emissions trading scheme for shipping jointly with France, Norway and Great Britain. Additional papers on this subject have been submitted. However, negotiations on market-based measures in the IMO have been blocked by massive resistance on the part of larger developing countries since MEPC 62. It cannot be assumed at present that it will be possible to adopt a market-based measure in coming years.

It must therefore be examined how progress can be made at the IMO toward additional technical and operational measures to reduce CO_2 emissions and toward monitoring of emissions. Germany is playing a major role in this work.

At the European level, the Council decided in 2009 that the Commission should be asked for a proposal on inclusion of emissions from maritime shipping in the Community's reduction obligations in case the IMO had not adopted sufficiently effective measures by the end of 2011. As a first step, the Commission made a proposal on reporting of CO_2 emissions by the shipping sector in summer 2013. Germany supports that work with constructive criticism and has already had several studies on this subject done or arranged to have them done.

3.6.1.2. International Civil Aviation Organisation (ICAO)

The International Civil Aviation Organisation (ICAO) considers environmental aspects within the framework of its Committee on Aviation Environmental Protection (CAEP), which comprises a range of different working groups. To deal with greenhouse gas issues, ICAO has also established some high-ranking working groups, such as the Group on International Aviation and Climate Change (GIACC), to resolve important political issues related to the introduction of climate protection instruments. Based on the work of that group, in which Germany participated, the 2010 ICAO Assembly approved a plan of measures that included an annual 2% increase in technical efficiency, technical and operational measures, and market-based instruments. The introduction of biofuels is also to receive support.

In spite of intensive work, none of these aspects has led to introduction of a mandatory measure. The Committee on Aviation Environmental Protection (CAEP) has been working intensively since 2010 on development of a CO_2 standard for aircraft, but has so far been able to agree only on a metrics system and on certification procedures. Adoption of a standard, which would most likely apply only to new aircraft, will be possible at the earliest at the 2016 ICAO Assembly. Germany submitted a series of technical proposals in support of this work.

After ICAO Secretary General Raymond Benjamin announced in 2011 that a proposal on a market-based measure to be adopted by the 2013 ICAO Assembly would be submitted before the end of 2012, a group of Council members, with the support of two experts' groups, submitted the following proposed measures to the Council:

- Offset measure without revenue generation (purchase of outside allowances by airlines or central organisations)
- Offset measure with revenue generation (as above but revenue generated by a transaction fee, for example, which could be used for climate protection)
- Global market-based measure

The 38th ICAO Assembly decided in its resolution to introduce a global market-based measure (MBM) to limit CO_2 emissions from air transport, about which a decision is to be made at the 29th ICAO Assembly in 2016 and which is to enter into force in 2020. There was broad support by ICAO Member States and the aviation industry for a measure of this kind. The type of instrument has not yet been defined. In addition to a cap and trade system, an offsetting measure is also on the short list at ICAO. Because technical measures and measures based on flight operations on their own are far from adequate, the MBM measure is intended to ensure achievement of the objective of CO_2-neutral growth starting in 2020, which has also been adopted by the ICAO. With regard to regional measures, the EU was unable to convince the BRICS countries (Brazil, Russia, India, China and South Africa) that the text of the resolution should contain a passage governing the MBMs of individual countries or groups of countries (regional measures) in greater detail. In this context, most non-European countries want agreement to be reached about the inclusion of third country carriers in national airspace as well. Because this is a matter of national sovereignty, the EU entered a reservation against this part of the resolution. Under Directive 2008/101/EC, aviation activity has been included in EU emissions trading since 2012, but enforcement for non-EU airlines was suspended in the decision of 25 April 2013. This “stop-the-clock” decision basically states that EU Member States will waive sanctions for non-fulfilment of reporting and payment requirements from 2010 up to 2012 for all flights between European and third countries. Obligations for flights within the EU and other territories (overseas territories, accession states, and Switzerland) are not affected by the decision.

3.6.2. Information on the implementation of policies and measures to minimize adverse effects (including adverse effects of climate change) in developing countries

3.6.2.1. Bioenergy

In 2011, bioenergy met 6.1% of Germany's total electricity requirements, 10.1% of its total heating requirements and 5.5% of its total fuel requirements. It thus provided a total of

8.4% of the country's final energy consumption of 2,415 TWh.

In the decisions to accelerate the Energiewende – Germany’s energy transformation – in 2011, the federal government set the target of having most of Germany’s energy supply come from renewables by 2050. Biomass is currently the main renewable energy source in Germany; almost three-quarters of final energy produced using renewable sources came from biomass in 2011. Even if that level declines in the future in favour of wind and solar energy, bioenergy will continue to be important for achieving the energy transformation.

Ensuring sustainable production of the biomass used to produce energy in the Federal Republic of Germany is an important objective for the federal government. Since January 2011, the use of biomass to produce energy in the biofuels and bioliquids sector has been subject to European sustainability criteria, particularly requirements to protect land with a high nature value (HNV), land with high carbon levels and peatlands and to reduce greenhouse gas emissions by at least 35% compared with fossil fuels. The sustainability criteria also apply to domestic and imported biofuels and bioliquids. The federal government is working toward the extension of sustainability criteria to include solid and gaseous biofuels in the electricity and heating sector at the EU level.

The Renewable Energies Directive and the Fuel Quality Directive do not contain conclusive provisions in some areas related to sustainability criteria, including indirect land-use changes (ILUCs). Indirect land-use changes occur when biomass to produce energy is produced on land that was previously used to produce biomass for other purposes (such as food or animal feedstuffs) and production is as a result at least partially pushed to areas with a high carbon content (such as forests or bogs) or a high level of biodiversity. In this way, the use of bioenergy could indirectly cause greenhouse gas emissions and threaten ecologically valuable areas. The discussion on ILUCs in the biofuel sector has previously not taken into account that land as a scarce resource all over the world faces sharply rising demand for agricultural raw materials for all applications. Effective, climate-friendly land use should therefore apply not only to bioenergy but also to agricultural production of food and animal feedstuffs and use of biomass material. The European Commission proposed amendments to these Directives containing numerous modifications, particularly about avoiding ILUCs, on 17 October 2012. The proposal is currently in the co-decision procedure with the Council and the European Parliament.

The federal government is working for the expansion of sustainable use of bioenergy within the Global Bioenergy Partnership (GBEP). A total of 23 countries and 14 international organisations are partners in GBEP, while many others are observers. One area of emphasis of the initiatives is to expand capacity in developing and emerging countries. The GBEP Indicators are used to analyse the sustainability of using bioenergy based on environmental, economic, and social aspects.

3.6.2.2. Climate protection programme for developing countries

This project is carried out for by the Gesellschaft für Internationale Zusammenarbeit (GIZ) for the federal government (Federal Ministry for Economic Cooperation and Development – BMZ). It supports active participation by developing countries in shaping the international climate system after 2012 and in developing strategies, action plans and monitoring systems for adapting to climate change and for climate protection.

The climate protection programme supports the international dialogue on climate with developing countries to strengthen their role in and responsibility for the climate policy process. The programme supports trials of new approaches to the issues. Current areas of emphasis include the following:

- Development of approaches to planning and measuring the success of activities to adapt to climate change in developing countries, including support for the process of national adaptation planning (NAP), in close cooperation with the Least Developed Countries Expert Group (LEG) of the UNFCCC

- Support for the use of established and new mechanisms in the carbon market, including the CDM, for the efforts of developing countries to make their own reductions
- Supporting international processes for mainstreaming climate change into development planning
- Communication of new developments and trends for adaptation and reduction at events and in publications and newsletters
- Supporting the Federal Ministry for Economic Cooperation and Development in its tasks related to national and international climate policies. One cross-cutting task of the climate protection programme is to contribute to developing and expanding institutional and human resources capacities in German development cooperation’s partner countries.

3.6.2.3. Political and other measures that expired or were cancelled during the reporting period

During the reporting period, no major political or other climate protection measures expired or, if they did expire, they were transferred to other statutory provisions. For example, the Electricity Feed-in Act (Stromeinspeisungsgesetz) that was adopted in 1991 was replaced by the Renewable Energies Act (Erneuerbare-Energien-Gesetz) of 2000.

4. Emissions scenarios and projections of the total effect of measures

4.1. How informative are scenarios and projections?

Projections and scenarios are indispensable tools for gaining a picture of what might be possible in the future and assessing the impact of possible measures. However, the climate policy debate often loses sight of the fact that there are no certainties about the future and that scenarios are very clearly "if-then propositions". All projections are closely linked to future developments that are considered to be likely. Thus, the outcome predicted by a given scenario depends on the underlying premises. That means that – depending on the assumptions about how economic, demographic and policy environment might develop and on the assessment of the complex interplay of factors affecting energy consumption – a number of descriptions of the future can coexist simultaneously, each of them inherently coherent and consistent. The main features of the methodology for calculating emissions projections are impact analyses and an integrated view of the combined effect of different measures and policies. The longer the projection time scales, the more numerical models have to be relied upon, which by their very nature can paint only a limited picture of reality. The fact that variables become increasingly fuzzy as they proceed along the time axis means that analyses of the impact of individual measures no longer produce reliable predictions.

The projections in this report are based on Germany's 2013 Projection Report, which was produced by a research consortium for the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The framework was set in spring 2012 following consultation with other government departments. Two different scenarios are explored in the Projection Report: a "with measures" scenario and a "with additional measures" scenario. The "with measures" scenario (WMS) and its policies and measures are described below.

4.2. Methodological approach

The "with measures" scenario (WMS) takes into account the current legal situation and all measures in place by October 2012. They are also described in Chapter 3. The situation is compared against a (hypothetical) situation that would have occurred had these measures not been put in place or had existing policies and measures not been amended. The measures taken into consideration are those that were in force before the start date of the measures covered by the WMS.[77]

The process of analysing and evaluating the different measures, calculating the greenhouse gas emissions by source category and ascertaining the background information and indicators needed for the Projection Report is based on different meth-

[77] Exactly how the different measures are classified differs from sector to sector. The start date of the measures covered by the WMS is explicitly recorded in the overview tables. All the policies and measures in place before the start date named are thus classified as part of the "without measures" scenario (WOM). Although the WOM situation was ascertained on a sector-specific basis, the individual sector analyses were not combined to produce an overall scenario.

odological approaches and sets of models for the different sectors which permit an adequate analysis based on the data and information available for those sectors.

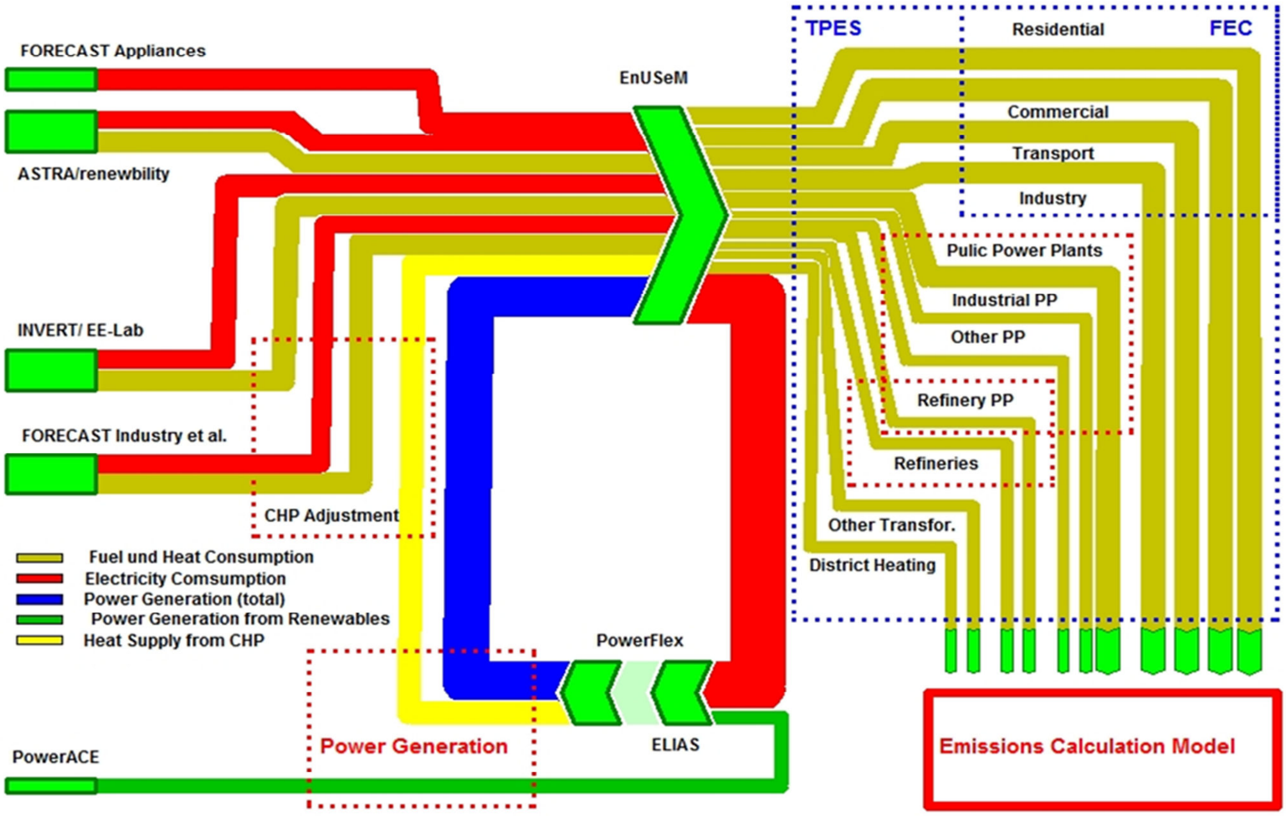
For energy-related greenhouse gas emissions from combustion processes, the analyses are based on a complex system of different models (Figure 16). The analyses for the electricity and fuel requirement of industry, commerce, trade and services were carried out by the FORECAST model at the Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI), which is based on individual sector models.

- For the transport sector, transport demand was ascertained using the ASTRA-D model at Fraunhofer ISI. Other input data are based on TREMOD 5.2 and the Öko-Institut's technology database.
- For the building sector (residential and non-residential buildings), Fraunhofer ISI's INVERT/EE-Lab model was used.
- Analyses for the remaining fuel and electricity demand in the private household sector were carried out using the FORECAST model at Fraunhofer ISI.
- Electricity generation from fossil fuels and from renewable energy sources is analysed using models at the Öko-Institut (ELIAS/PowerFlex) and Fraunhofer ISI's PowerACE model.
- Integration of the energy consumption figures and ascertaining primary energy consumption and energy used in other energy conversion sectors is carried out using the Öko-Institut's integration model

A series of iteration runs is needed to model the energy sector:

- To ascertain electricity consumption by end-users and the energy conversion sectors as an input variable to model the electricity market
- To compare heat generated in CHP plants for supply to public, industrial and commercial property and heat demand in industry, trade, commerce and services and private households

Figure 16: Overview of models used to analyse energy-related greenhouse gas emissions



Greenhouse gas emissions from combustion processes were ascertained using the Öko-Institut's emissions model, which evaluates emissions aspects of energy demand projections for the various end-use and conversion sectors within the national greenhouse gas emissions system.

For fugitive emissions in the energy sector, the Öko-Institut's emissions model carries out source group-specific modelling based on the energy demand and supply volumes and the methods used in the national greenhouse gas inventory.

Three different approaches are used for emissions from industrial processes:

- For process-related emissions connected with the energy sector, emissions are ascertained on the basis of the energy demand and supply volumes in the Öko-Institut's emissions model, using the methods employed in the national greenhouse gas inventory.
- For process-related emissions that are not connected with the energy sector, emissions are ascertained on the basis of production estimates in the Öko-Institut's emissions model, using the methods employed in the national greenhouse gas inventory. A separate model estimate was used for N_2O emissions from adipic and nitric acid production plants.

- For HFCs, PFCs and SF_6 emissions, existing projections were updated and adjusted.

For greenhouse gas emissions from agriculture, a projection developed by the Thünen Institute was used. The Öko-Institut's model used to prepare the national greenhouse gas inventories was expanded to create the projection for greenhouse gas emissions from the waste management sector. To analyse energy-related greenhouse gas emissions, a principal component analysis was also used, with which a singular value decomposition analysis can then be performed to describe emissions trends on the basis of trends in population growth, economic growth, the energy productivity of the economy as a whole, the share of fossil fuels in the total primary energy supply and the greenhouse gas intensity of the fossil energy sources used.

Using this set of models, the WMS and corresponding background and indicator data were developed and a sensitivity analysis was done for a number of decisive assumptions (population trends, economic development, energy prices etc.).

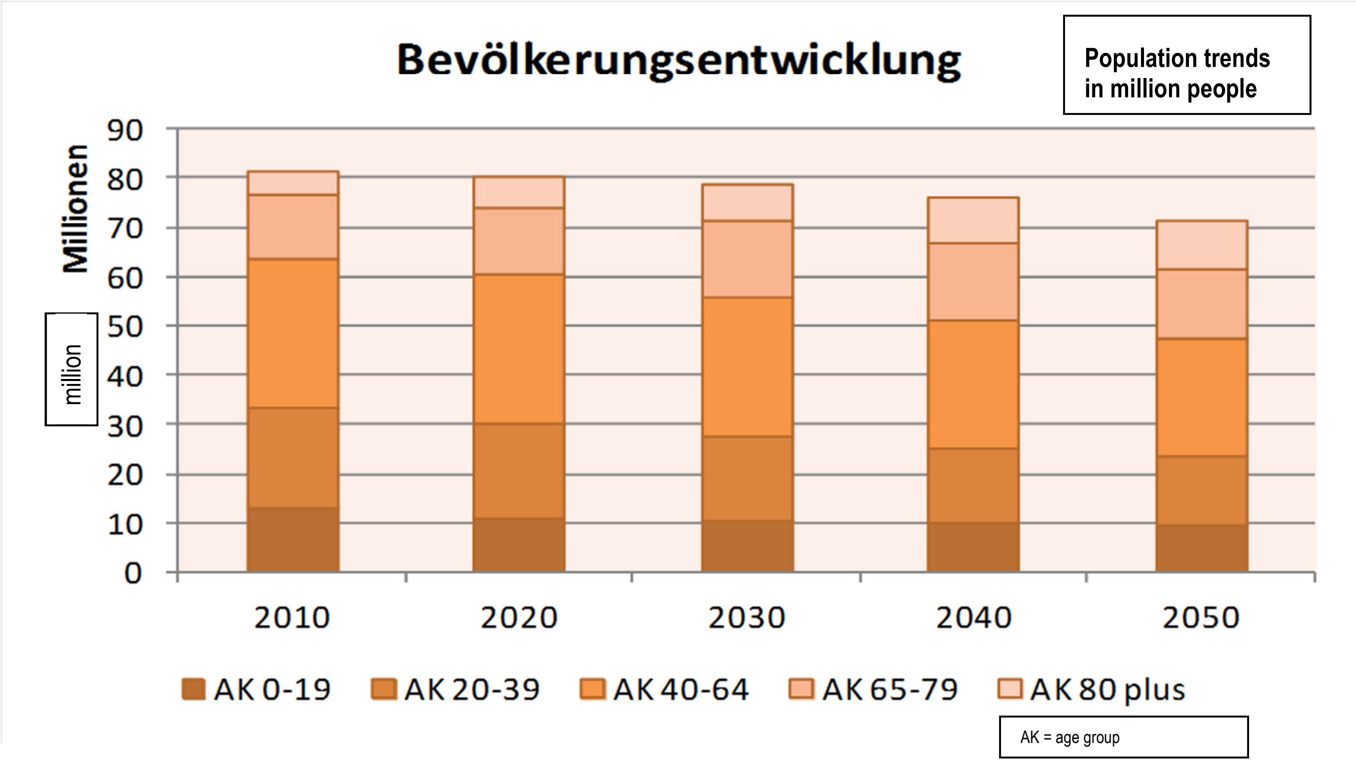
4.3. Description of key data

4.3.1. Population and households

Population trends, including current population statistics, are modelled endogenously in ASTRA-D. The primary data inputs used were the assumptions of the 12th coordinated update of the population statistics carried out by the Federal Statistical Office, supplemented by Eurostat data. The assumptions made in the Renewbility II project were used and updated beyond 2030. NUTS 2 level units were used (Nomenclature of Territorial Units for Statistics). The following basic assumptions were made:

- Proportion of women in the overall population from 2005 onwards: 0.5121 (distributed across the total number of inhabitants per NUTS area in the 15-39 age group)
- Migration based on energy scenarios (2020: 365,161, 2030: 314,205, 2040: 301,467, 2050: 288,728)
- Fertility rate (average across all NUTS 2 areas): 2020: 1.385, 2030: 1.445, 2040: 1.481, 2050: 1.505
- Improvements in child mortality and life expectancy rising gradually to 8% in 2050 (compared with 2005)

Figure 17: Population projection from ASTRA-D up to 2050



Source: ASTRA-D

Figure 17 shows the results of ASTRA's endogenous population calculation. The figure for 2050 is close to that in Option 3 – W1 in the 12th coordinated update of the population statistics (destatis, 2012). It assumes a slightly lower birth rate but net migration is higher, i.e. more positive for trends in the demographic structure.

Based on the selected parameters, the updated population figures fall within the group of variants described by the Federal Statistical Office as "medium population" and thus do not represent an extreme variant. This has the positive effect of making the results more robust when sensitivity analyses are performed on demographic trends.

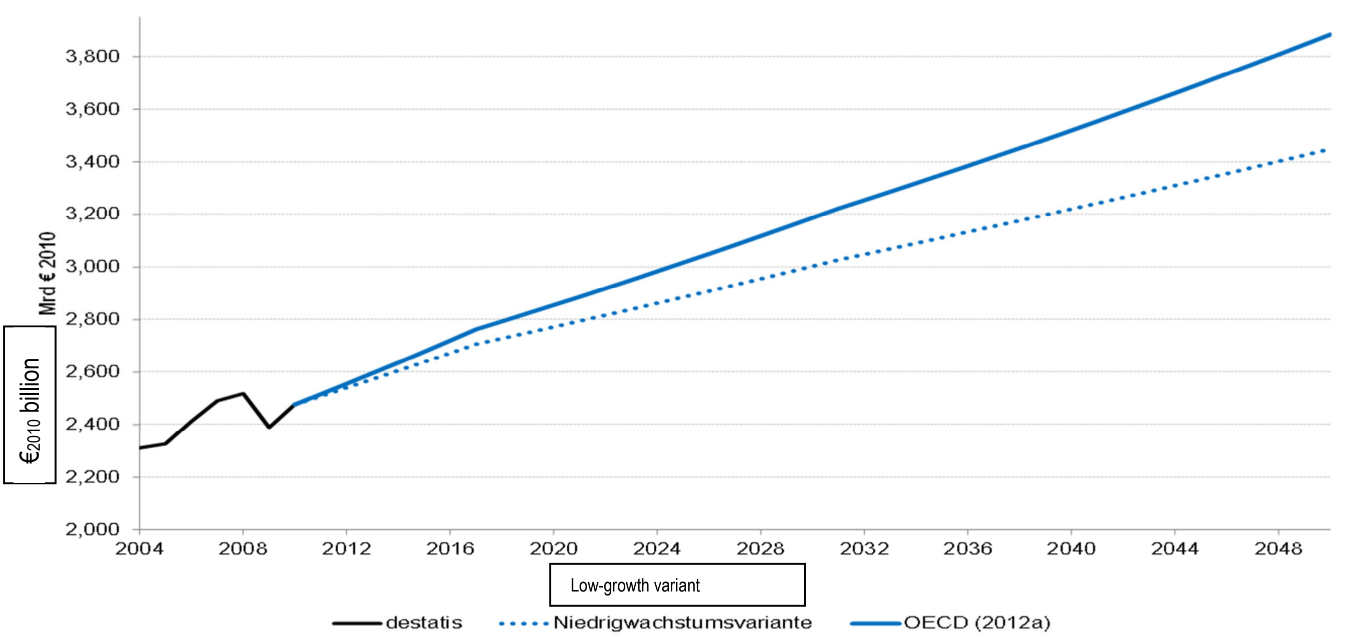
Migration was not modelled in NUTS 2 areas, and instead was distributed across the NUTS 2 areas based on current economic attractiveness. The fact that population movements within Germany were not modelled could well have an impact on things such as mobility behaviour or the employment structure of each region. There are plans to review during the course of the project whether this causes significant inaccuracies that would warrant refining the model. However, evidence indicates that regional mobility in Germany is relatively low (disregarding the effects of German unification in 1990; see Sachverständigenrat, 2011).

The fact that population movements are not modelled does not mean that demographic developments will be the same in each region. The internal migration that occurred following German reunification has already impacted on the regional population structure; the individual NUTS 1 to NUTS 3 areas are developing differently.

4.3.2. Economic growth and structure

Projections of macroeconomic trends are based on the growth rates projected in the OECD Economic Outlook 2012/1 preliminary version (OECD 2012a). Since they are somewhat optimistic, a low-growth variant of -0.3 percentage points has also been used. The gross domestic product (GDP) in real terms for Germany is depicted in Figure 18 as a solid blue line.

Figure 18: Projection of GDP in real terms in EUR2010 billions, including a low-growth variant (-0.3 percentage points)



Source: Destatis (2012c), OECD (2012a), Öko-Institut calculations

As a result of the global recession that began in mid-2008, gross domestic product in Germany in 2009 shrank by 5% compared to the previous year. Germany began an unexpectedly robust recovery in 2010 starting from the greatly reduced level of economic activity in 2009.

Future developments remain uncertain. However, the OECD (2012b) assumes that Germany's economic activity will continue to expand robustly after a dynamic start to 2012, as a result of renewed confidence and a revival of domestic demand. The anticipated recovery in world trade will help to ensure that the weakness in the remaining euro zone is not likely to weaken Germany's economic development (OECD, 2012b).

The projection of gross domestic product in real terms shows an average growth of 1.6% per annum from 2012 to 2017. From 2018 to 2030, an average growth rate of just under 1.1% per annum is assumed. For the period from 2031 to 2050, slightly lower growth of about 1.0% per annum is assumed, since the effect of the population decline will begin to be felt from 2030 onwards. At the same time, the economic restructuring will continue.

The following variation on the aforementioned growth data, which is based on the approach taken in the "Klimaschutzszenarien 2050" project, was used for the sensitivity analyses performed at aggregate GDP level: for the time horizon up to 2050, average growth rates for GDP in real terms for the low-growth variant are 0.3 percentage points below the reference case (dotted curve in Figure 18).

The sectoral breakdown of value added comprises the following sectors:

- Agriculture
- Industry
- Services

To make predictions about economic growth by sector, the FARM EU model was calibrated to the economic development shown in OECD (2012a), in order to derive value creation figures for individual sectors from the model results. Table 32 provides a summary of gross value added by sector up to 2050.

Table 32: Gross value added in real terms by sector and gross domestic product (based on 2000 prices), 2008–2030.

	2008	**2020**	**2030**
	€ billion		
Gross value added (GVA)			
Manufacturing industry	644	649	677
Services	1,404	1,557	1,717
Agriculture	23	23	23
Total GVA	2,072	2,229	2,418
Gross domestic product (GDP)	2,270	2,437	2,632

Source: Destatis (2012c) , OECD (2012a), calculations by the Öko-Institut

The aggregated data on economic development is broken down in greater detail for individual industrial sectors in FARM EU and summarised in Table 33 following the classification used in the Federal Statistical Office's National Accounts (Destatis 2012c).

Table 33: Breakdown of gross value added by industry (EUR2000 billion), 2008–2030

Sector	**2003 categorisation of sectors**	**2008**	**2015**	**2020**	**2025**	**2030**
		€ billion				
Stone and earth quarrying, miscellaneous mining	13, 14 (or 10.30, 12)	2.56	1.98	1.81	1.60	1,49
Food and tobacco	15, 16	29.14	27.06	26.93	27.15	27,27
Paper	21	10.42	10.75	10.49	10.28	10,31
Basic chemicals	24.1	25.90	25.64	25.14	25.13	25,05

Sector	2003 catego-risation of sectors	2008	2015	2020	2025	2030
		€ billion				
Other chemicals	24 or 24.1	27.47	26.86	27.72	29.09	29,76
Rubber and plastic goods	25	25.71	25.27	25.75	27.06	27,52
Glass and ceramics	26.1 to 26.3	5.89	6.26	6.27	6.32	6.19
Processing stone and earth	26 or 26.1 to 26.3	9.95	8.41	8.42	8.76	8.76
Manufacture of metal prod-ucts	27.1	5.65	5.64	5.55	5.06	4.65
Non-ferrous metals, found-ries	27.4, 27.5	7.17	7.49	7.50	7.47	7.48
Metalworking	DJ or 27.1, 27.4, 27.5	46.29	44.92	46.34	47.03	48.26
Engineering	29	72.37	78.11	82.37	85.14	88.29
Automotive engineering	34, 35	75.51	73.50	76.11	80.39	82.53
Other manufacturing industry	17, 18, 19, 20, 30, 31, 32, 33, 36, 37	152.42	153.17	159.86	162.84	169.07
Total manufacturing industry and stone and earth quarrying, miscellaneous mining		496.45	495.33	510.70	523.68	536.98

Source: Federal Statistical Office, 2012c

4.3.3. Employment trends

Employment in ASTRA-D results from the interaction between productivity, the potential labour force and trends in gross value added for the 57 sectors defined in the Federal Statistical Office's 2003 classification. Demographic trends are also a key factor, of course, as illustrated above. A shift in the age structure of the population produces an inevitable rise in the average age of the workforce. This is not expected to be a crucial factor influencing labour productivity (Sachverständigenrat, 2011).

The potential labour force results from the participation rate of the working population; this includes everyone between the ages of 15 and 65. That figure is multiplied by the economic activity rate, which produces the total number of people who are either working or seeking work. The reserve labour force is not explicitly reported.

The total number of hours worked is part of the Cobb-Douglas production function used to calculate potential output. Hours worked depend on the average annual working time. However, feedback effects occur here whenever final demand is very close to or greater than potential output.[78] Overtime balances this out.

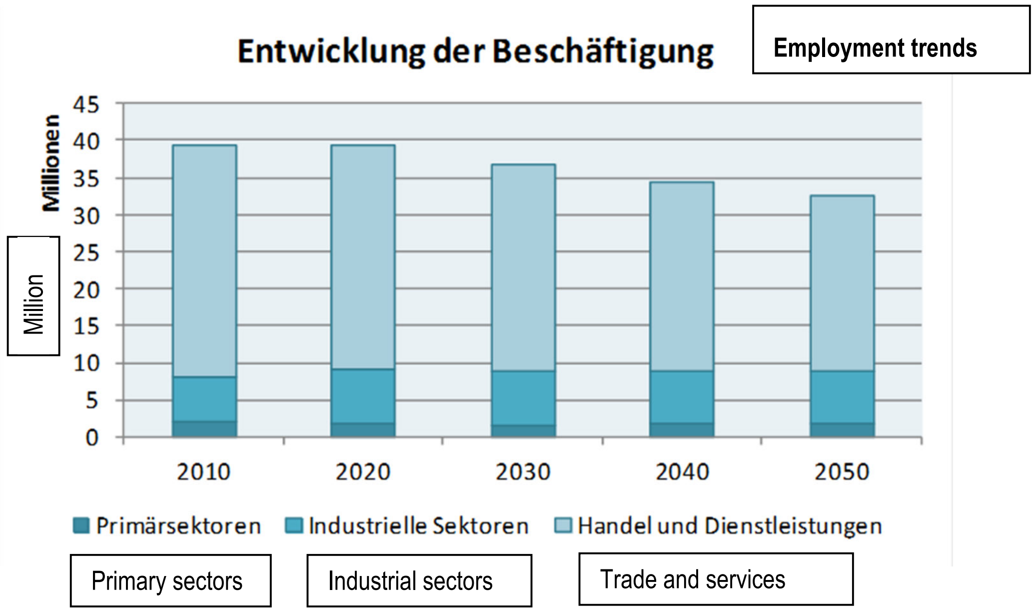
The employment levels depicted in

Figure 19 are based on full-time equivalent jobs; self-employed people are included in these figures. Labour productivity is external and based on the Federal Statistical Office's 1995 input-output tables; it is also influenced by whether the economy is close to full employment (when the unemployment rate falls below 5%).The break-down in

Figure 19 does not go into detail at the level of the individual sectors, but gives only a rough breakdown into three sectors (primary sector, industrial production sector, trade and services). This is also due to the fact that predicting future trends in labour productivity is highly speculative. Labour productivity trends are based on the fore-cast of the OECD's 2012 Economic Outlook; the total factor productivity reciprocals are used to calculate value added per employee. The percentage of part-time em-ployees per sector is kept constant from 2015. The OECD projection in Table 32 was also used as a baseline value for trends in the economy as a whole.

Trends in the economic activity rate are positive throughout the entire forecasting period as labour productivity matches the OECD Outlook: 78.5% is assumed for 2020, 79.9% for 2030, 81.4% for 2040 and 82.8% for 2050 – measured on the eco-nomically active population between the ages of 15 and 65. The average working hours per annum decrease from 1,711 in 2030 to 1,585 in 2050.

Figure 19: Overall employment trends up to 2050



Source ASTRA-D

Employment per sector is calculated first. The total number of people employed in a given sector is then multiplied by the average number of hours worked per annum. This creates the basis for the production function used to calculate annual growth in

[78] Here, ASTRA-D, which is a system dynamics model, differs from neo-Classical assumptions, which as a rule assume that the output gap will be closed in the short to medium term.

a given sector. It must be noted that ASTRA-D does not make distinctions between different levels of qualification. The level of detail given about employment in the transport sectors is higher.

4.3.4. Projection of the development of primary energy prices and exchange rates

4.3.4.1. Preliminary remarks

The future development of fuel prices is a decisive determinant for formulating projections of future energy and emissions developments. Assumptions about future prices of energy sources have a major influence on the configuration of the energy system and its total system costs, as well as energy prices for the various consumer groups. Two main questions result for the preparation of fuel price projections:

- What are the key variables for energy price development and the parameters for determining them?
- What influence do those key variables have on the development of energy prices for the different areas of application?

This analysis explores these questions for those fuel prices that are highly dependent on developments in the international fuel markets for oil, natural gas and coal and are also relevant for the electricity generation sector.

The investigation follows a three-step analytical approach for the various aspects:

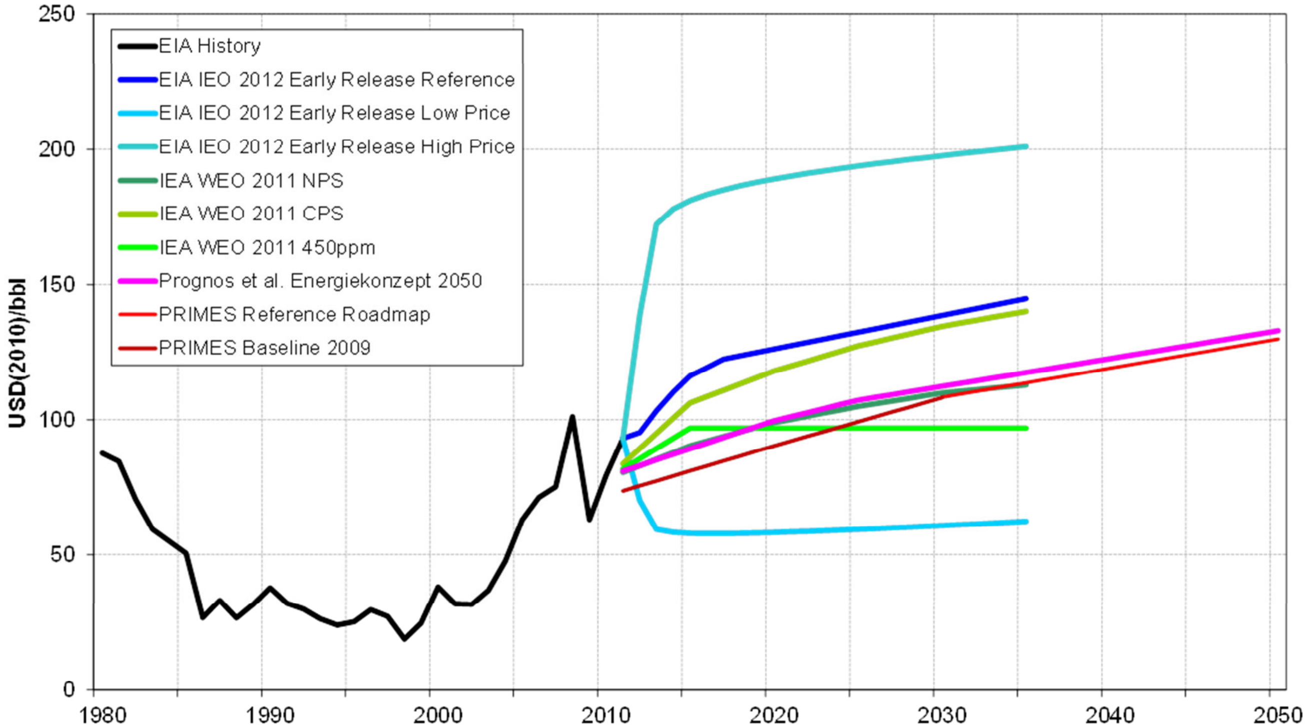
- During a first step, the historical development of the border prices for crude oil, natural gas and coal and the influence of exchange rates and price adjustments are documented.
- During a second step, several current mainstream projections for global crude oil prices are presented and a recommendation is made for the projection on which the projections will be based and for the corresponding exchange rate variables.
- During a third step, the developments of the border prices for crude oil, natural gas and coal are extrapolated based on the development of the price of crude oil.

4.3.4.2. Price projection for crude oil on the world market

The trend on the crude oil markets is an important anchor for the development of primary energy sources that are traded internationally or on the world market.

The long-term development of oil prices depends on many factors: in addition to the market power of OPEC, it depends in particular on future growth of the world economy and on energy and environmental strategies followed all over the world. The future development of those factors is fraught with uncertainty. Uncertainty about the development of oil prices is amplified by the fact that crude oil prices are increasingly also determined by financial markets. The volatility of prices has increased considerably in recent years under the influence of uncertain expectations about future developments.

Figure 20: History and current projections for the development of the price of crude oil on the world market, 1980-2050



Source: EIA (2012), IEA (2011), Prognos, et al. (2010), EC (2010), EC (2011), calculations by Öko-Institut

The compilation of selected price projections in Figure 20 shows the broad range of the oil price projections assumed in current analyses. All price information not given in constant 2010 prices was converted to a 2010 price basis. The GDP deflators published by the Federal Statistical Office (Destatis) for the euro and by the U.S. Bureau of Economic Analysis (BEA) for the U.S. dollar were used for the price adjustments.

Several interesting aspects become apparent when comparing the various projections:

- The rather prognostically oriented projections in the reference variant of the Annual Energy Outlook (AEO) of the Energy Information Administration (EIA 2012) and in the Current Policy Scenario (CPS) of the World Energy Outlook 2011 of the International Energy Agency (IEA 2011) expect price levels to be almost $126 or $118 per barrel of oil ($/bbl) in 2020 (in constant 2010 prices). According to these projections, the price rise will continue until 2030, reaching the level of $145 or $140/bbl around 2035.
- In contrast, the PRIMES baseline scenario 2009, which is also prognostic, and the PRIMES reference price pathway for the analyses of the European Commission

generated in the context of the Energy Roadmap 2050 (EC 2010, EC 2011) assume that oil prices will be $90/bbl by 2020, rising to $108/bbl by 2030. The expert report for the federal government's Energy Concept (Prognos, et al. 2010) used an increase in oil prices to almost $100/bbl in 2020, with price levels of $112/bbl in 2030, $123/bbl in 2040 and $133/bbl in 2050 as growth rates trended downward.

- The EIA projection (2012) examines scenarios for high and low crude oil prices in addition to reference variants. The upper margin of the price spectrum (approximately $189/bbl in 2020 and almost $200/bbl after 2030) is based on increasing the market power for OPEC that would result if non-conventional oil extraction outside of OPEC is not increased fast enough to compensate for falling conventional oil extraction in the event of a sharp increase in demand. However, measures such as improved yields of conventional resources, increased use of alternative fuels and additional climate protection measures could also put considerable downward pressure on a rise in the price of crude oil. If (very) low economic growth is accompanied by (very) high investments in the petroleum sector, very low price levels (about $60/bbl for 2020/2030 time horizon) are estimated at the lower margin.
- An interesting sensitivity analysis is repeatedly presented in the World Energy Outlook (IEA 2011). It takes into account the influence of climate protection policies and the concomitant effects on demand. The oil price used in the New Policy Scenario (NPS), which reflects implementation of the reduction commitments initiated at the 15th Conference of the Parties to the UN Framework Convention on Climate Change (Copenhagen Accord), is almost $100/bbl in 2020. This is almost $20/bbl lower than the CPS Reference Scenario (see above). Under that scenario, a value of just over $113/bbl is reached in 2035, about $27/bbl less than in the reference scenario. In a scenario that is oriented to compliance with what is known as the 2 degrees C target and to limiting CO_2 concentrations in the atmosphere to 450 ppm (450 scenario), crude oil prices also remain at a level of $97/bbl over the longer term.

Against the background of the analyses from the international sphere, the price pathway from the Reference Scenario in the Early Release of the Annual Energy Outlook (EIA 2012), which is up to $10 higher than the reference variant of the World Energy Outlook (IEA 2011), is used as a basis for the scenario discussed here. The growth dynamic from previous years is also used for the period after 2035, resulting in the following price assumptions for the basket of crude oil varieties that are relevant for Germany (as a comparison, the price level was about $100/bbl in 2008):

- $117/bbl for 2015
- $127/bbl for 2020
- $138/bbl for 2030
- $151/bbl for 2040
- $163/bbl for 2050.

This price pathway is used to derive the primary energy prices for natural gas and coal or the respective secondary energy sources.

4.3.4.3. Projection for the development of exchange rates

In addition to the development of the crude oil price on a dollar basis, the future development of the exchange rate is decisive for development of the price signals from the energy markets which influence Germany. Two recent prognostic works can be used as a reference for development of the exchange rates between the euro and the U.S. dollar:

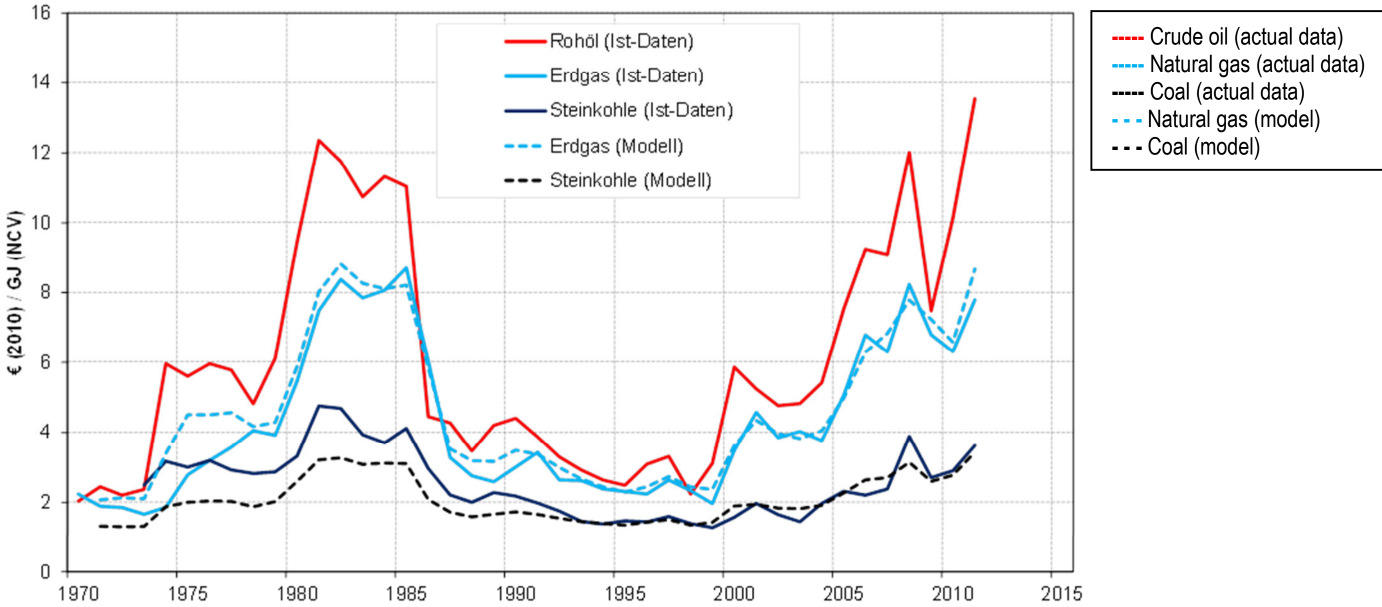
- An exchange rate of $1.25/euro in 2020 can be calculated back from the expert report for the Energy Concept (Prognos, et al. 2010). That exchange rate assumption is based on a continuing downward trend: the exchange rate is still $1.16 in 2030 and $1.07 in 2040. A value of only $0.87 is assumed for 2050.
- The exchange rate development is very similar in the PRIMES baseline projection of the European Commission (EC 2010). Values of about $1.22/€ in and $1.16/€ in 2030 are assumed.

In light of current developments and with a view toward the development of purchasing power parities between the U.S. dollar and the euro, an exchange rate of $1.22/€ is used for the modelling and $1.16/€ is assumed for 2030. The exchange rate remains constant at $1.16/€ during the period after 2030.

4.3.4.4. Price projection for natural gas and coal

The world market prices of coal and prices of natural gas on the continental European natural gas market have historically tracked the price of crude oil very closely, although with different dynamics. Figure 21 clearly shows this connection for a clarification model that is used to model border prices for natural gas and coal based on crude oil prices (Öko-Institut 2010). With very few exceptions, a robust explanation of the prices of natural gas and coal based on the price of crude oil price has been possible since the mid-1990s.

Figure 21: History and modelling of crude oil, natural gas and coal prices, 1970-2010

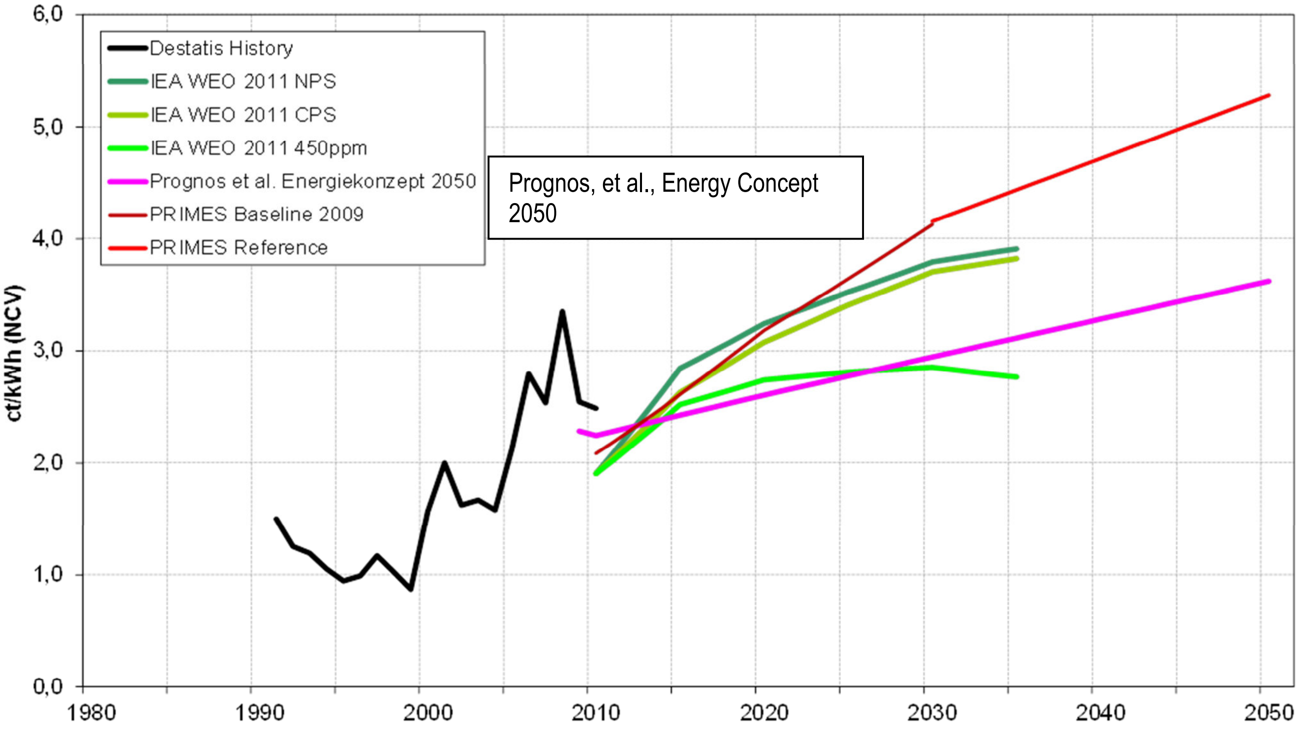


Source: Federal Statistical Office (Destatis), calculations by Öko-Institut

The question of whether these pricing mechanisms can be extrapolated (to Europe) has recently been the subject of vigorous debate. One line of reasoning relates to the massive increase in the extraction of unconventional natural gas, primarily in the United States, and the resulting reduced need for imports of liquefied natural gas (LNG). Given the enormous expansion of the extraction and transport infrastructures for LNG in recent years, this could cause considerable quantities of LNG to be diverted from the originally intended target market in the U.S. to markets in European and Asia, leading to excess supplies there (gas glut) and putting downward pressure on prices. At the same time, Japan is absorbing a portion of the LNG quantities after most of its installed nuclear power plant capacities were shut down. Although it is certainly very likely that large quantities of natural gas will be available for the European market in the medium term, the question remains of the extent to which changed pricing mechanisms will gain acceptance or be enforced.

The range of current projections of natural gas border prices for Europe is shown in Figure 22.

Figure 22: History and current projections for the development of the price of natural gas on the continental European market, 1980-2050

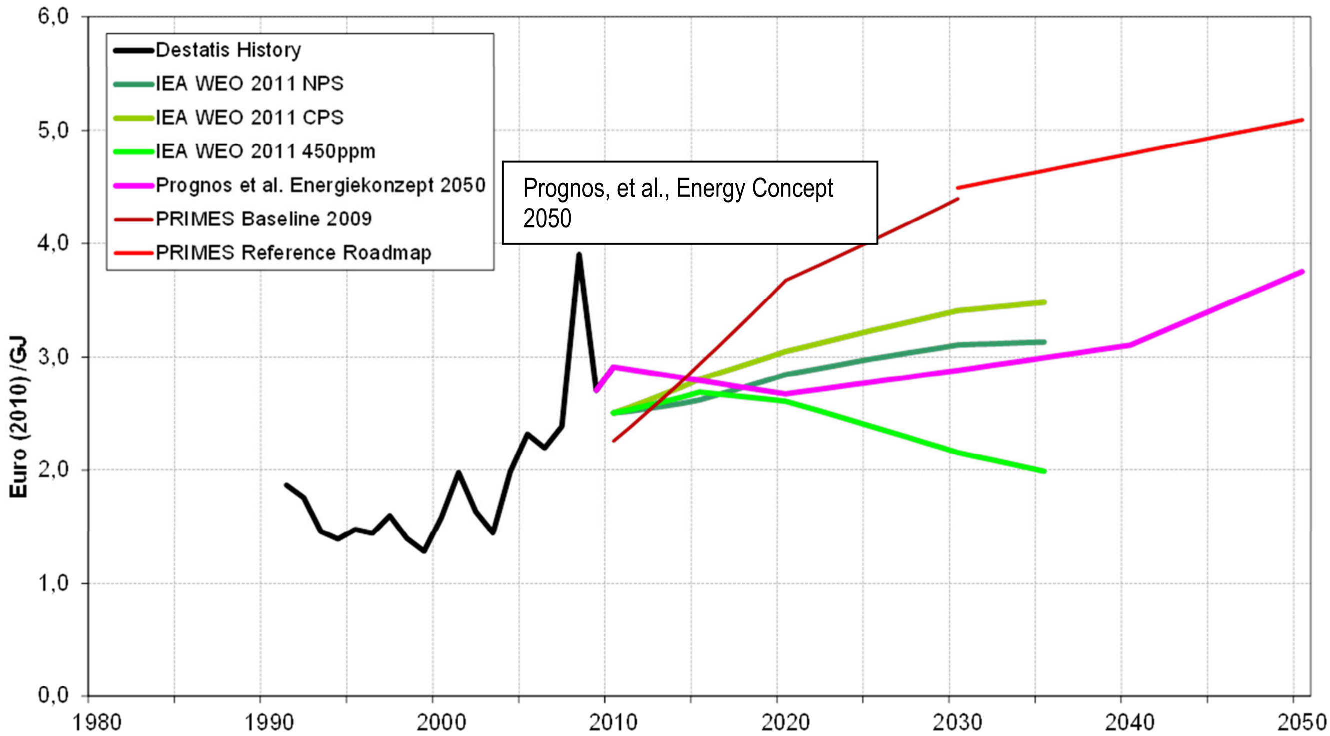


Source: Federal Statistical Office (Destatis), IEA (2011), Prognos et al. (2010), EC (2010), EC(2011), calculations by Öko-Institut

The projections of the IEA (2011) and the analyses done for the European Commission (EC 2010, EC 2011) differ markedly from the expert opinion for the Energy Concept (Prognos et al. 2010). Although the IEA highlights the gas glut issue for Europe, the assumptions for the 2035 time horizon in the current policy scenario are almost 1 euro cent per kilowatt hour (ct/kWh) – at 2010 prices and based on net calorific value (Hu/NCV) – above the assumptions by Prognos, et al. (2010).[79] Natural gas prices are a bit lower only in the scenarios with ambitious climate scenarios, primarily as a result of the lower oil price level calculated there. The values according to Prognos, et al. (2010) for the development of world market or import prices of coal for north-western Europe are also lower than the assumptions in the scenario variants of the IEA in the current World Energy Outlook (IEA 2011) which are relevant for development of a reference under the current framework conditions (Current Policies Scenario – CPS). The price projections for coal in the PRIMES baseline 2009 and the reference pathway in the Energy Roadmap 2050 (EC 2011) are both very steep compared with all other projections.

[79] The natural gas prices reported by IEA (2011) in U.S. cents were converted into euro cents using the above assumptions for exchange rates between the U.S. dollar and the euro. If the exchange rates that, according to Prognos et al. (2010), continue to fall after 2030 were used, the differences between the natural gas prices of the World Energy Outlook (IEA 2010) and Prognos, et al. (2010) would be much greater between 2030 and 2035.

Figure 23: History and current projections for the development of the world market coal price for deliveries to north-western Europe, 1980-2050

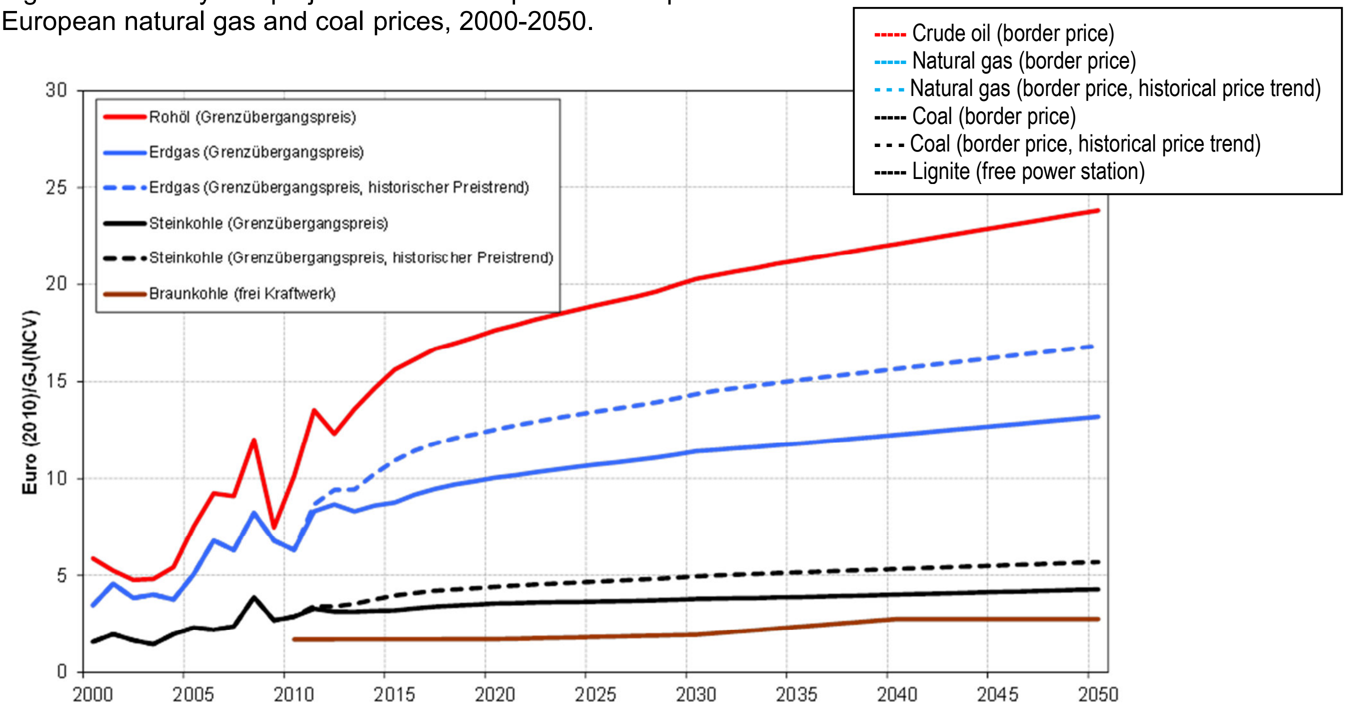


Source: Federal Statistical Office (Destatis), IEA (2011), Prognos, et al. (2010), EC (2010), EC(2011), calculations by Öko-Institut

In light of the above, the scenario being discussed applies an adjustment coefficient based on IEA projections to the statistical relationships that were determined in the past between the development of the price of crude oil on the one hand and the price of natural gas and coal (for both continental or north-western Europe) on the other hand (Öko-Institut 2010).

Figure 24 shows the effects of introducing this adjustment factor, as well as the enormous price-driving effect of the (moderate) exchange rate assumption. The sensitivity of natural gas and coal prices to development of the price of crude oil is thus somewhat moderated but remains clearly recognizable.

Figure 24: History and projection for development of the price of crude oil on the world market and European natural gas and coal prices, 2000-2050.



Source: Federal Statistical Office (Destatis), IEA (2011), Prognos et al. (2010), EC (2010), EC(2011), calculations by Öko-Institut Source: Federal Statistical Office (Destatis), IEA (2011), Prognos et al. (2010), EC (2010), EC(2011), calculations by Öko-Institut

4.3.4.5. Price projection for lignite

According to Prognos (2011), fuel costs will remain constant at €4.6$_{2009}$/MWh$_{th}$ for lignite during the period until 2050. This was reviewed using current annual reports of Vattenfall Europe Mining and Mibrag. Simply splitting the revenues and sales of crude lignite between the Lippendorf and Schkopau power plants shows costs of €7.6/MWh$_{th}$ in 2010 (Mibrag 2011). Crude lignite costs of €6.1/MWh$_{th}$ were determined for Vattenfall Europe Mining in 2010.[80] Unfortunately, no lignite costs could be determined for RWE Power because the corresponding indicators are not published.

It is obvious that the lignite prices used by Prognos (2011) were too low, at least in the sense of full costs. The lignite price of Vattenfall Europe Mining in the amount of €6.1/MWh$_{th}$ is used as the basis for the energy price projection in the scenario being discussed here.

Declining capacity utilization of lignite power plants and therefore also of the open-pit lignite mines supplying the power plants directly and without interim storage must also be anticipated. Because about half of the costs of lignite production are fixed costs, lower capacity utilization will mean higher full production costs. According to Prognos/EWI/GWS (2011), the number of hours during which lignite power plants operate at full load will fall to slightly more than 5,000 by 2030. For 2020

[80] Sales of processed products (briquettes, dust and lignite used for fluidized beds) were valued at €15/MWh$_{th}$.

Prognos/EWI/GWS (2010) estimates only about 3,000 hours at full load in Scenario A. That value is kept constant until 2050.[81]

Table 34: Development of fuel costs for lignite in Germany, 2008-2050

		2010	2020	2030	2040	2050
Hours at full load	**h**	**6,814**	**6,692**	**5,265**	**3,000**	**3,000**
Fixed costs	€ /kW	20,783	20,783	20,783	20,783	20,783
Fixed costs	€/ MWh	3.1	3.1	3.9	6.9	6.9
Variable costs	€ /MWh	3.1	3.1	3.1	3.1	3.1
Total costs	€ /MWh	6.1	6.2	7.0	10.0	10.0
Total costs	€ /GJ	1.7	1.7	1.9	2.8	2.8
Note: The hours at full load in 2008 (Prognos/EWI/GWS 2011) were used for 2010.						

Sources: VEWM (2011), Prognos/EWI/GWS (2010), Prognos/EWI/GWS (2011), calculations by Öko-Institute

The supporting calculations in Table 34 show that, in view of declining capacity utilization, the full costs of supplying lignite will rise from the current level of €6.1$_{2010}$/MWh$_{th}$ to about €10$_{2010}$/MWh$_{th}$ for the 2040 to 2050 time horizon.

4.3.4.6. Summary for the projection of primary energy prices

The results of the data analyses and calculations on the development of the prices of primary energy sources (border prices for crude oil, natural gas and coal or the production costs of lignite) for the reference case are summarized in Table 35.

By 2020 the prices of the fossil fuels crude oil and natural gas will be well above the high price level for 2008. However, the price of coal rises more slowly and does not exceed the 2008 level until the decade between 2030 and 2040.

Table 35: Results of the reference price projections for crude oil, natural gas, coal and lignite, 2008-2050

		Historical values		Projection				
		2005	2008	2015	2020	2030	2040	2050
Crude oil	US-$/bbl	58	104	117	127	138	151	163
Crude oil	€/t	329	493	641	724	832	907	978
Natural gas	€/MWh (Ho)	16.5	26.7	28.5	32.7	37.1	39.9	42.9
Coal	€/t SKE	68	114	94	105	111	118	126
Crude oil	€/GJ	7.5	12.0	15.6	17.6	20.3	22.1	23.8
Natural gas	€/GJ	5.1	8.2	8.8	10.1	11.4	12.3	13.2
Coal	€/GJ	2.3	3.9	3.2	3.6	3.8	4.0	4.3
Lignite	€/GJ		1.7	1.7	1.7	1.9	2.8	2.8

[81] According to Prognos/EWI/GWS (2010), the installed capacity of lignite-fired power plants in 2050 will be less than 1 GW. At the same time, the number of hours at full load will again be more than 5,000 hours in 2050. The rising number of hours at full load is obviously attributable to a special effect in the calculation. The number of hours at full load was corrected to 3,000 in 2050 to calculate the cost structure.

Note: All prices as real prices (basis 2010) unless referenced otherwise.

Sources: Calculations by Öko-Institut

4.3.4.7. Prices of greenhouse gas allowances

The forecasts of future prices for emissions trading allowances also involve great uncertainty. The current price, about €7 per EU Allowance Unit (EUA), is lower than expected, primarily due to the surplus of allowances in the wake of the economic crisis (and the massive influx of emission reduction credits from the flexible mechanisms of the Kyoto Protocol) (Öko-Institut 2012). It is likely that that the CO_2 allowance prices will improve again once the economic crisis has been overcome and the excess quantities have been reduced. The future development of CO_2 prices also depends (aside from energy prices) on targets for reductions of CO_2 emissions, the inclusion of additional emission reduction credits from the flexible mechanisms, and the impact of complementary policies (renewable energies and energy efficiency). Considerable uncertainty remains for all of these aspects at present.

However, a distinction must be made between two different price pathways for the development of CO_2 prices: one pathway that covers the current political framework and another that covers a price development that reflects the European Union embarking on an ambitious climate protection pathway.

The situation described below results for the reference development. In the analyses of the expert report for the Energy Concept (Prognos, et al. 2010), the CO_2 price in the 2020 reference development was set at €20/EUA in 2020 and €30/EUA in 2030 and then adjusted to €40 or €50/EUA until 2040/2050 (price basis 2008 in each case). The analyses of the European Commission in the Energy Roadmap 2050 for the reference development used CO_2 prices of €18/EUA for 2020 and €40/EUA for 2030, with prices of around €50/EUA resulting for 2040/2050 (price basis 2008 in each case).

Table 36: Projection in EU Energy Roadmap 2050 for the prices of greenhouse gas allowances, 2020-2050.

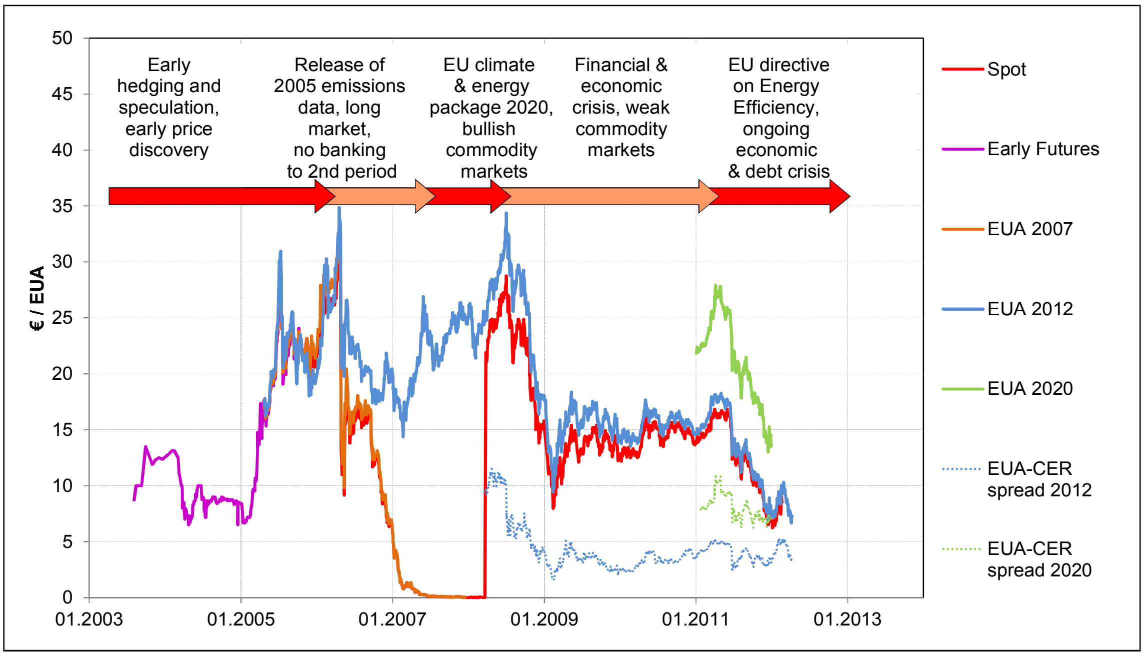
	EUA price				Reduction pathway			
	2020	2030	2040	2050	2020	2030	2040	2050
	€ (2008) / EUA				Compared with 2005			
Reference Scenario	18	40	52	50	-23%	-37%	-55%	-62%
Current Policy Initiative Scenario	15	32	49	51	-28%	-38%	-52%	-57%
High Efficiency Scenario	15	25	87	234	-32%	-51%	-74%	-93%
High Renewables Scenario	25	35	92	285	-32%	-56%	-76%	-92%
High Nuclear / Delayed CCS Scenario	25	55	190	270	-32%	-54%	-76%	-92%
High CCS / Low Nuclear Scenario	20	63	100	310	-30%	-51%	-74%	-94%
Diversivied Supply Options Scenario	25	52	95	265	-32%	-53%	-74%	-93%
Note: The emission reduction rates are for stationary plants covered by the EU ETS.								

Source: EU (2011), calculation by Öko-Institut

This reference development is confirmed in view of current market developments (futures for deliveries in 2020 are already being traded on the ICE ECX).

Figure 25 shows the development of prices for EU emission allowances for delivery in December 2020, i.e., in fulfilment of compliance requirements for 2020. The summary shows that prices of €15/EUA (nominal) are currently being obtained. Other model analyses arrive at somewhat higher results for 2020 with respect to the question of the 20% vs. 30% target for the European Union in 2020. PIK, et al. (2011) calculate a price of almost €20/EUA for 2020, also based on the PRIMES model.

Figure 25: Settlement prices for the EUA spot market and EUA futures with delivery in December 2012 and December 2020, 2010 to 2011



Source: EEX, ICE EEX

However, lower CO_2 prices must be anticipated for 2020, because the above model analyses do not (cannot) reflect the current surplus situation in the EU ETS and that surplus situation will last far into the decade between 2010 and 2020 unless further measures are taken. Therefore, values that were estimated in a study that focused specifically on the supply and demand situation of the EU ETS (Öko-Institut 2012) are used as a basis for 2020. The following price trajectories for EU emission allowances are thus used for the reference scenario (in 2010 prices):

- €14/EUA for 2020
- €30/EUA for 2030
- €40/EUA for 2040
- €50/EUA for 2050

The CO_2 price developments that are expected under an ambitious climate protection pathway of the EU are based on the following considerations:

A price of €20/EUA for 2020, €38/EUA for 2030, €57/EUA for 2040 and €75/EUA for 2050 was determined for the corresponding variants in the initial assumptions by Prognos, et al. (2010). The following ranges (all information in 2008 prices) result in the analyses for the EU Energy Roadmap 2050 (EU 2011), primarily as a function of the profile of the technology mix and the extent of complementary policies:

- Between €15 and €25/EUA for 2020

- Between €25 and €63/EUA for 2030
- Between €87 and €190/EUA for 2040
- Between €234 and €310/EUA for 2050

The assumptions for the CO_2 prices here are based on the following considerations:

- The assumption for 2020 is derived from the Öko-Institut analyses of the supply and demand situation (Öko-Institut 2012), resulting in a price level of about €30/EUA (this is consistent with an EU reduction target of 25% compared to 1990 in the area of the domestic contribution)
- The values for 2030 and 2040 are derived from the modelling work for the EU Energy Roadmap 2050 and are estimated at €50/EUA (2030) and €90/EUA (2040) (this corresponds to a development in which complementary policies play a major role in the area of renewable energy sources and increased energy efficiency)
- The approach used in the analyses for the EU Energy Roadmap 2050 is not followed for the outlook for 2050 (i.e., the year during which extensive decarbonisation is planned), and instead implementation of the final emission reduction level as a result of measures with much less pronounced distribution effects is assumed, which would lead to CO_2 prices of about €130/EUA.

4.3.5. Framework data in individual sectors

4.3.5.1. Transport

Demand for transport, broken down by passenger and goods transport, is shown as framework data in Table 37 The basis for the "with measures" scenario is the modelling of demand for transport done for the deficit scenario in the Climate Protection Scenario 2050 (Klimaschutzszenario 2050) study (Öko-Institut et al., in press), which was confirmed as the basis for environmental scenarios during the interministerial consultation in autumn 2012. With the exception of air transport, the modelling was done by Fraunhofer ISI using the ASTRA-D model. Öko-Institut used an extrapolation from the historical development based on data from TREMOD 5.2 (ifeu 2011) to determine air transport, which contains the measures listed in the "with measures" scenario.

Table 37: Demand for passenger and goods transport, 2010-2030

	2,010	2,020	2,030	2,010	2,020	2,030
	Passenger transport [billion passenger-kilometres]			Goods transport [billion tonne-kilometres]		

	2,010	2,020	2,030	2,010	2,020	2,030
	Passenger transport [billion passenger-kilometres]			Goods transport [billion tonne-kilometres]		
Road – not including public transport	965	1180	1170	443	561	709
Road-based – public transport	42	37	29	0	0	2
Rail - including (tram, underground and suburban rail)	69	51	34	104	143	183
Inland waterways	0	0	0	62	66	71
Air transport	194	249	304	11	13	18
Total	1,270	1,517	1,537	620	784	984

Source: Öko-Institut et al.

A more detailed forecast of demand for passenger and goods transport up to 2030 which covers various regions is currently being done for the Federal Ministry of Transport, Building and Urban Development (BMVBS). Its conclusions, which are not yet available, will be used for federal road planning.

4.3.5.2. Private households

Number of private households

The number of private households has grown continuously in recent years. This trend is primarily due to the increase in single and two-person households, which will continue in the future. This is also confirmed by a study by Prognos/Öko-Institut.[82] The slight downward trend for the population since 2002 will merely slow this development. The projection of the number of private households is based on the development of the population and the number of persons in each household. The indicators from selected studies are shown in Table 38.

Table 38: Development of the number of persons per private household 2008-2050 from selected studies

Study	Unit	2008	2020	2030	2040	2050
Model Germany – Climate Protection to 2050	Pers./hh	2.09	1.99	1.94	1.88	1.86
Development of Energy Markets to 2030	Pers./hh	2.06	1.96	1.9	-	-
Energy scenarios for the federal government's Energy Concept	Pers./hh	2.07	1.98	1.93	1.87	1.86

Source: Prognos; Öko-Institut (2009); IER; RWI; ZEW (2010); Prognos; EWI; GWS (2010)

As shown in Table 39, each study assumes a decrease in the number of persons per private household up to the end of the projection horizon, with approximately 1.86 people per household in 2050. Based on the empirical development and the summary of studies (Table 39), the development in Table 40 is assumed in this

82 Prognos / Öko-Institut 2009, IER / RWI / ZEW 2010; Prognos; EWI; GWS 2010.

study. A population decrease of around 8 million was calculated, particularly between 2030 and 2050, so the number of private households will fall during the same period from 40.97 million to 38.81 million. There is thus a downward trend for the number of private households over the long term. The population decrease will have a tremendous effect starting in 2040, with a decline of around 2 million households between 2040 and 2050. The population will also decrease by some 4 million during that period, while the trend toward smaller household sizes will reach saturation point.

Table 39: Development of the number of persons per private household and the number of private households 2008-2050

	Unit	2008	2015	2020	2025	2030	2035	2040	2045	2050
Persons per private household	Pers./hh	2.07	2.02	1.98	1.95	1.93	1.9	1.87	1.87	1.86
Private households	million	39.48	40.12	40.76	40.96	40.97	40.9	40.62	39.67	38.61

Source: Projection Report 2013

Space heating and hot water

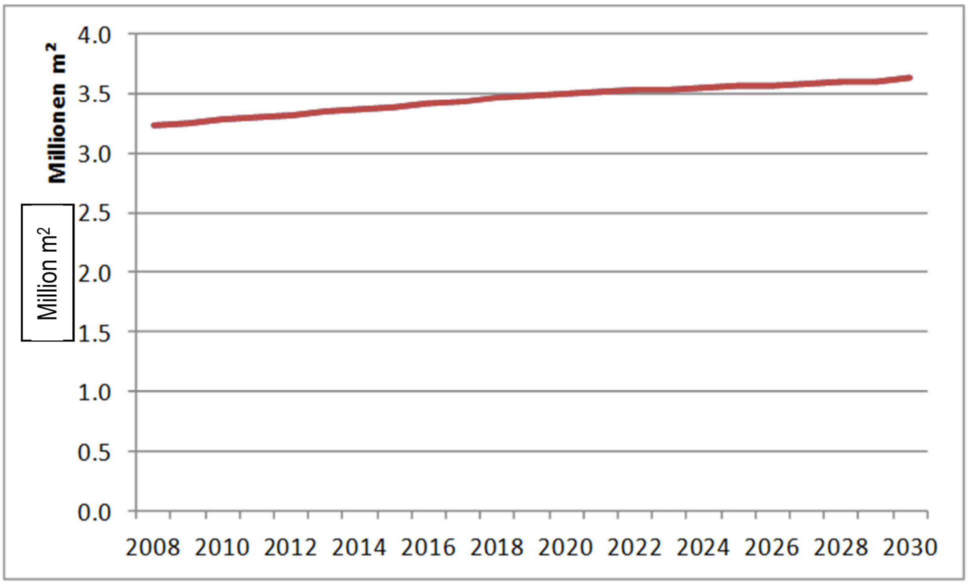
Demand for residential floor space will increase by a factor of 1.3 by 2030. The growth rate will be about 0.5% up to 2020, then flatten out to around 0.33% by 2030. Table 40 and Figure 26 show the overall development of residential floor space up to 2030.

Table 40: Residential floor space in 2010, 2015, 2020, 2025 and 2030

	2010	2015	2020	2025	2030
Residential floor space in thousand m²	3,275,541	3,387,865	3,501,196	3,558,613	3,636,581
Average annual growth rate	0.69%	0.67%	0.41%	0.33%	0.43%

Source: Projection Report 2013

Figure 26: Development of residential floor space 2008-2030



Source: Projection Report 2013

4.3.5.3. Industry and the trade, commerce and services sector – electricity and process heat/steam

The most important macroeconomic framework data for the industry sector and the trade, commerce and services sector are the development of real gross value added by economic sector and the development of the number of gainfully employed people. The assumptions for this are described in detail in section 4.3.2.

In the energy-intensive industrial sectors, physical production quantities are the relevant factors determining energy consumption. The assumptions for the development of production in those sectors are presented in Table 41 and Table 42. The production quantities for 2008 come from various statistics of the trade associations and the Federal Statistical Office, while the update reflects an assumption that was validated in discussions with sector representatives. The development of value creation in the higher-ranking statistical unit, the NACE two-digit classification (according to the European activity classification) does not necessarily run parallel to physical production, because most value creation is oriented more to the production of higher-value, less energy-intensive intermediate products than to the production of energy-intensive basic materials.

For the trade, commerce and services sector, the second most important determining factor (see Table 43) after the number of gainfully employed people is heated or cooled floor space. Energy services such as room lighting or ventilation systems are oriented more to floor space than to the number of employees. This was determined using specific characteristic values based on the assumptions for development of the number of gainfully employed people, which is presented in section 4.3.3.

Table 41: Manufacturing data for selected energy-intensive products/processes

Process/Product		**Unit**	**2000**	**2010**	**2020**	**2030**
Iron and Steel						
	Sintering	kt	30845	28560	27726	25715
	Basic oxygen steel – blast furnace	kt	33052	30615	29721	27565
	Electrosteel – EAF	kt	13324	13215	17018	17797
	Rolled steel	kt	38974	36827	40432	39241
	Coke oven	kt	9115	8171	7932	7357
	Smelting reduction	kt	-	-	-	-
	Direct reduction	kt	455	487	593	593
Non-ferrous metals						
	Aluminium, primary	kt	644	403	550	485
	Aluminium, secondary	kt	572	611	824	899
	Aluminium, extruded	kt		559	617	680
	Aluminium, foundries	kt	646	810	869	959
	Aluminium, rolling	kt		1877	2069	2281
	Copper, primary	kt	310	402	350	350
	Copper, secondary	kt	399	302	301	301
	Copper processing	kt	1999	1732	1858	1858
	Primary zinc	kt	261	238	238	238
	Secondary zinc	kt	67	89	89	89
Paper industry						
	Paper	kt	18182	22509	25040	25567

Process/Product		Unit	2000	2010	2020	2030
	Cellulose – processing	kt	873	1383	1355	1107
	Wood fibres – processing	kt	1342	1520	1490	1217
	Used paper material	kt	13677	15378	17242	17929
Glass						
	Container glass	kt		4379	4601	4818
	Flat glass	kt		1814	1906	1996
	Glass fibres	kt		1013	1064	1114
	Other glass	kt		479	504	527
Ceramics						
	Household and plumbing ceramics	kt		120	122	123
	Technical ceramics	kt		239	242	242
	Tiles, slabs, fireproof ceramics	kt		2192	2298	2378
Non-metallic minerals						
	Clinker burning (dry)	kt	24303	22823	23790	22122
	Clinker burning (semi-dry)	kt	1978	1718	-	-
	Clinker burning (wet)	kt	-	-	-	-
	Processing limestone	kt		24311	23567	21915
	Gypsum	kt		953	953	953
	Cement grinding	kt	35414	32721	32589	32061
	Lime milling	kt		5250	5250	5250
	Bricks	kt	18307	10642	12956	12746
	Lime burning	kt	7382	6339	7000	7000

Source: Fraunhofer-ISI

Table 42: Manufacturing data for selected energy-intensive products/processes, 2000–2030, continued

Process/Product		Unit	2000	2010	2020	2030
Chemistry						
	Adipic acid	kt		358	456	552
	Ammonia	kt	3221	3128	3450	3450
	Calcium carbide	kt		180	190	190
	Carbon black	kt	346	684	684	684
	Chlorine, diaphragm method	kt	860	1104	1162	-
	Chlorine, membrane method	kt	2035	2611	3615	4777
	Chlorine, amalgam method	kt	642	824	-	-
	Ethylene	kt		4794	5299	5842
	Methanol	kt	1922	1924	2025	2025
	Nitric acid	kt	1828	2513	3086	3581
	Oxygen	kt		7312	8082	8910
	Polycarbonate	kt		432	601	727
	Polyethylene	kt		2704	3287	3624
	Polypropylene	kt	1337	1832	2227	2455
	Polysulfone	kt		323	449	594
	Soda	kt	1422	1454	1454	1454
	TDI	kt		380	528	639
	Titanium dioxide	1000m3		437	483	533
Food						
	Sugar	kt		3846	3963	3884
	Dairy	kt		13877	14298	14015
	Beer brewing	kt		9853	9951	9560
	Meat processing	kt	3116	4631	4880	4929
	Baked goods	kt		4328	4504	4459
	Starch	kt		1811	1885	1866
Plastics processing						

Process/Product		Unit	2000	2010	2020	2030
	Extrusion	kt		4325	5006	5438
	Injection moulding	kt		2178	2521	2738
	Blow moulding	kt		950	1099	1194

Source: Fraunhofer-ISI

Table 43: Total heated and cooled floor space by segment in the trade, commerce and services sector

Segment	WZ 2008	2008	2010	2015	2020	2025	2030
		million m2					
Education	P	144	142	136	130	124	117
Financial and insurance activities	K	38	38	38	38	37	36
Human health and social work activities	Q	116	114	113	112	109	106
Accommodation and food service activities	I	85	85	83	82	77	72
Wholesale and retail trade; repair of motor vehicles	G	385	391	397	405	405	405
Public administration and defence	O	160	156	147	139	129	119
Transport, information and communication	H+J	119	123	127	132	139	146
Other sectors	L+M+N+R+S	361	369	364	362	350	338
All economic activities		1410	1418	1406	1400	1371	1340

Source: Fraunhofer-ISI

4.4. Results of the forecasts by sector and scenario

4.4.1. Electricity generation

The results of projections for the “with measures” scenario (WMS) for electricity generation are described below.

The evaluation of measures in the WMS deals exclusively with *direct* effects, i.e. CO_2 reductions that have a direct impact in the electricity sector. They include CO_2 reductions resulting from changes to the power station portfolio (efficiency improvements, switch to a different fuel) and effects caused by a fall in demand for fossil electricity generation (as a result of both renewable electricity generation and lower demand). Indirect effects, especially as a result of switching from separate heat generation to combined heat and power generation (CHP), and changes in electricity prices are considered in the final-energy sectors. The fact that conventional power stations may be forced to choose a less efficient mode of operation in response to electricity feed-in from renewable energy sources has not been taken into account.

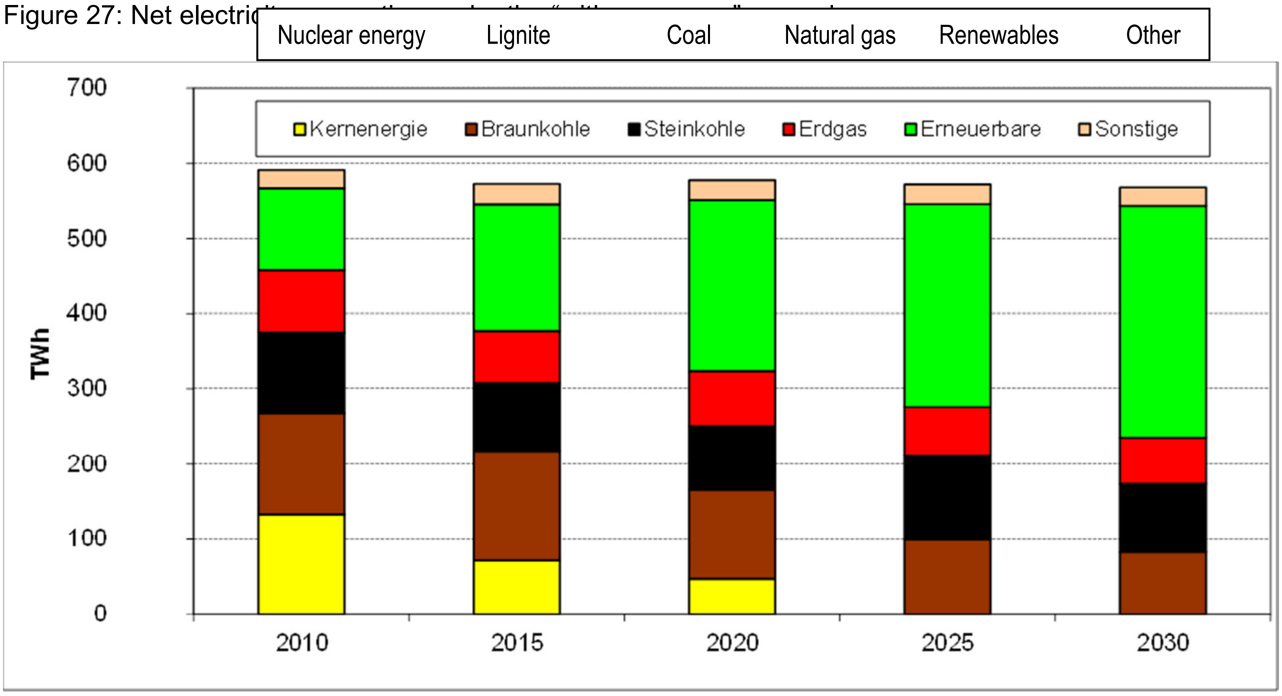
Figure 27 and Table 44 depict electricity generation for the WMS up to 2030.[83] Based on the assumed installed renewable capacity and use of the available supply, electricity generation from renewable energy sources increases from 109 TWh in 2010 to 309 TWh in 2030. As prescribed under the Atomic Energy Act (AtG), electricity generation in nuclear power plants falls from 133 TWh in 2010 to 0 TWh in 2025.[84] Lignite-fired electricity generation falls by over 50 TWh from its 2010 level of 134 TWh to

[83] The word “old” is used here to refer to power stations that were already in operation in 2010. “New” refers to a power station that came on stream during the scenario horizon.
[84] The last nuclear power station is decommissioned in 2022.

83 TWh in 2030. Due to the closure of old lignite-fired power stations, this means that 16 TWh of electricity will be generated in new lignite-fired power stations. Electricity generation in coal-fired power stations falls from 107 TWh (2010) to 91 TWh (2030), with 48 TWh being generated in new condensing power stations. Natural gas-fired electricity generation decreases from 84 TWh to 61 TWh, with just less than a third of that (18 TWh) being generated by new CHP plants in 2030. Electricity generated in fossil fuel-fired CHP plants decreases from 77 TWh (2010) to 63 TWh (2030). Electricity generated from renewable CHP increases from 10 TWh (2010) to 28 TWh (2030). The CHP target (25% share in total electricity generation in 2020) will not be achieved.

The increase in large-scale power station capacity in the scenario horizon is basically met by the power stations currently under construction. Correspondingly, the adopted policy measures impact mainly on power station use and on the expansion of renewable and small-scale CHP plants.

Figure 27: Net electric



Source: Projection Report 2013

Table 44: Net electricity generation under the “with measures” scenario

			2,010	2,015	2,020	2,025	2,030
			TWh				
Nuclear energy			133	71	47	0	0
Lignite			134	146	119	100	83
	of which new condensing power stations		0	22	20	18	16
	of which old condensing power stations		69	55	35	29	24
	of which old CHP		65	70	63	52	43
Coal			107	90	84	112	91

			2,010	2,015	2,020	2,025	2,030
			TWh				
	of which new condensing power stations		0	45	41	56	48
	of which old condensing power stations		61	7	7	15	6
	of which old CHP		46	38	36	40	38
Natural gas			84	70	74	64	61
	of which new condensing power stations		0	0	0	1	1
	of which new		0	8	17	17	18
	of which old condensing power stations		8	0	0	1	3
	of which old CHP		76	62	57	45	39
Renewables			109	169	228	271	309
Other			24	27	26	26	24
Total			**592**	**573**	**578**	**573**	**569**
memo item: CHP electricity generation according to FW 308			87	86	94	93	90
	of which fossil CHP		77	73	77	69	63
	of which biogenic CHP		10	14	17	24	28

Source: Projection Report 2013

In the “with measures” scenario, CO_2 emissions from electricity generation fall from around 373 million tonnes in 2010 to 297 million tonnes in 2030. On the emissions side, electricity generation from renewable energy sources (309 TWh in 2030) more than compensates for the phase-out of nuclear power (electricity production in 2010: 133 TWh).

Table 45 presents a summary of the impact of measures in place to date. The data refers exclusively to direct CO_2 effects, i.e. measures that have a direct effect in the power plant sector. Indirect effects arising from the use of district heating instead of separately generated heat are taken into account in the sectors that use CHP heat.

Table 45: Summary of the impact of measures to date in the “with measures” scenario

Measure/ Implementation/ Institution	Type	Description/objectives (area of impact)	Implementation status (start date)	Direct impact on emission reduction			
				2015	2020	2025	2030
				Million tonnes of CO2 equivalents			
Introduction of emissions trading scheme	E	Cost-effective CO2 reduction	2005	5	3	1	2

Measure/ Implementation/ Institution	Type	Description/objectives (area of impact)	Implementation status (start date)	Direct impact on emission reduction			
				2015	2020	2025	2030
				Million tonnes of CO2 equivalents			
Abolition of tax on natural gas	F	Make the option of generating electricity from natural gas more attractive	2006	0	0	0	0
Payment for not using the grid	O	Economic incentive for distributed generators feeding into the grid (especially CHP)	2001	0	0	0	0
Combined Heat and Power Act	E	Payments for electricity generated in CHP plants () large-scale plants)	2002, amendments in 2008, 2011 und 2012	0	0	0	0
	E	Payments for electricity generated in CHP plants (micro systems)	2002, amendments in 2008, 2011 und 2012	1	3	4	4
Stimulus programme for micro CHP systems	E	Investment grants to install micro CHP systems	2012	0	1	1	1
Renewable Energy Act	R,E	Minimum payment for renewable electricity	2000, several amendments, most recently in 2012	7	14	14	11
Electricity savings	O	Reduce electricity consumption compared with the WOM	2010	16	28	33	33
Total impact of the individual measures				30	49	54	50
Total impact of the individual measures (excluding overlap)				32	49	48	44

Source: Calculations by Öko-Institut

The overview shows that, for the most part, CO_2 reductions in 2030 are due to the decrease in fossil electricity generation under the WMS by comparison with the WOM, with 11 million tonnes of CO_2 savings being accounted for by renewable energy and 33 million tonnes by electricity savings. The effect of the introduction of emissions trading is seen in 2030 in the reduction of 2 million tonnes of CO_2 compared with the WOM. Over time, the CO_2 reduction decreases (from 5 million tonnes in 2015) as the CO_2 intensity of the power station portfolio declines and with it the achievable reductions. Under the WMS, the Combined Heat and Power Act has no impact on large-scale CHP plants, since the increase in capacity in large-scale power stations is essentially covered by the power stations and renewable energy facilities already under construction (see above). The increase in small-scale CHP units as a result of the Combined Heat and Power Act produces a CO_2 reduction of 4 million tonnes CO_2 in 2030 compared with the WOM. Furthermore, the funding available for micro-CHP units leads to a CO_2 reduction of 1 million tonnes in 2030. However, the total effect of CHP units on CO_2 reduction is greater than shown here. The effects resulting from the substitution of plants for generating heat separately (heat from boilers) are quantified in the final consumption sectors (households, TCS and industry). The introduction of payments for not using the grid and abolition of tax on natural gas have only a minor – or even negligible – effect by comparison with other measures. The effects of the other individual measures add up to a total of 50 million tonnes of CO_2 in 2030.

When the scenario results are adjusted to take account of the fact that some of the effects of individual measures overlap, the final outcome is that the package of measures under the WMS achieve an overall reduction 44 million tonnes of CO_2 in 2030.

4.4.2. Other energy conversion sectors

Within the other energy conversion sectors, the following are of primary importance:

- Heating plants
- Refineries
- Coking plants

All refineries and coking plants, and some heating plants (< 30 MW rated thermal input), fall under the EU Emissions Trading Scheme. This means that the price of EU emissions allowances and any relevant allocation regulations have to be taken into account.

Table 46 gives an overview of the trends for CO_2, CH_4 and N_2O emissions from heat generation plants in the remaining energy conversion sectors. The list clearly illustrates that CO_2 is the main greenhouse gas in the overall emissions in this sector. As was the case for the trend from 1990 to 2005, greenhouse gas emissions in the other energy conversion sectors are to some extent dependent on the level of energy demand and the structure of the energy supply. The dwindling role played by coal and coal-based products continues in the period up to 2030. In that same time frame the contribution of oil products to the energy supply also decreases as they are partially replaced by natural gas and partially by renewables. Whereas the provision of natural gas in the energy conversion sector does not entail additional energy consumption and therefore does not produce additional emissions,[85] the increasing role of biofuels does trigger additional energy demand in the bio-refineries. However, since they use biomass for their own energy requirements, no additional CO_2 emissions are caused and the extent of the additional CH_4 and N_2O emissions from these conversion plants is minor.

Table 46: CO_2, CH_4 and N_2O emissions in the remaining energy conversion sectors under the "with-measures" and "with additional measures" scenarios, 1990-2030

	1990	1995	2000	2005	2010	2015	2020	2025	2030
	kt of CO2 equivalents								
CO2 emissions									
Trend 1990 – 2010	36,117	33,653	24,901	32,286	33,535				

85 In line with the conventions of greenhouse gas inventories, the consumption and emissions from natural gas compression stations are allocated to the transport sector and form part of the balance drawn up for that sector.

		1990	1995	2000	2005	2010	2015	2020	2025	2030
		kt of CO2 equivalents								
	With measures scenario						29,308	29,244	28,575	25,412
CH4 emissions										
	Trend 1990 – 2010	86	74	70	31	24				
	With measures scenario						41	48	45	43
N2O emissions										
	Trend 1990 – 2010	229	165	101	146	190				
	With measures scenario						354	402	390	361
Total CO2+CH4+N2O										
	Trend 1990 – 2010	36,432	33,892	25,072	32,464	33,749				
	With measures scenario						29,703	29,695	29,010	25,816
Total CO2+CH4+N2O							Change from 1990 onwards in %			
	With measures scenario						-18.5	-18.5	-20.4	-29.1
Total CO2+CH4+N2O							Change from 2005 onwards in %			
	With measures scenario						-8.5	-8.5	-10.6	-20.5
Note: only energy-related emissions as defined in the NIR, without power plants in refineries and the remaining conversion sector										

Source: Öko-Institut

As a result of changes in the energy source mix, greenhouse gas emissions in the remaining energy conversion sectors decrease by about 6.6 million tonnes of CO_2 equivalents by 2030 compared with 2005 in the “with measures” scenario (WMS).

4.4.3. Fugitive emissions in the energy sectors

Table 47 shows the trend in fugitive emissions in the energy sector under the “with measures” scenario (WMS). The total decline in emissions from 8 million tonnes of CO_2 equivalents in the 2005 to 2030 period is largely due to the decline of German coal mining, the net effect of which (decreasing emissions from active mining operations and constant emissions from decommissioned coal mines) is a reduction of roughly 5 million tonnes of CO_2 equivalents. There are also minor changes in emissions from natural gas distribution systems, resulting from a decline in the use of natural gas in private households and the trade, commerce and services sector. Overall, fugitive emissions in the energy sector decline by 56% in the period from 2005 to 2030.

Table 47: Trends in fugitive emissions in the energy sector in the “with measures” scenario, 2000-2030

	2000	2005	2010	2015	2020	2025	2030
	kt						
CH4 emissions							
Active coal mining							
Underground coal mining	*439.8*	*254.5*	*122.6*	*78.2*	*0.0*	*0.0*	*0.0*
Coal processing	*19.3*	*14.3*	*7.4*	*4.7*	*0.0*	*0.0*	*0.0*
Open-cast lignite mining	*1.8*	*2.0*	*1.9*	*1.9*	*1.5*	*1.2*	*1.0*
Coal conversion	0.4	0.4	0.4	0.4	0.4	0.3	0.3
Decommissioned mines	129.1	2.9	0.7	0.7	0.7	0.7	0.7
Oil production and supply							
Exploration	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Production	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Transport	*0.3*	*0.4*	*0.3*	*0.3*	*0.3*	*0.2*	*0.2*
Storage	*11.7*	*11.0*	*10.5*	*10.7*	*9.8*	*9.1*	*8.1*
Distribution of oil products	*4.8*	*2.8*	*2.2*	*2.3*	*2.2*	*1.9*	*1.8*
Natural gas							
Production	*7.2*	*5.0*	*2.2*	*2.3*	*2.0*	*1.7*	*1.2*
Transport	*37.7*	*41.3*	*40.4*	*37.5*	*37.6*	*35.0*	*34.2*
Distribution	*192.3*	*190.9*	*192.4*	*183.5*	*176.9*	*169.7*	*160.6*
Other leaks	*70.0*	*64.0*	*59.0*	*56.3*	*54.2*	*52.0*	*49.3*
Flares	19.5	10.2	6.6	7.4	7.4	7.4	7.4
Oil	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*	*0.1*
Gas	*19.4*	*10.1*	*6.5*	*7.3*	*7.3*	*7.3*	*7.3*
Sub-total CH4	934	600	447	386	293	279	265
CO2 emissions							
Decommissioned mines	0	0	0	0	0	0	0
Oil production and supply	1	1	1	1	1	1	0
Exploration	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Production	*1.2*	*1.4*	*1.3*	*1.2*	*0.9*	*0.6*	*0.3*
Transport	*NA*	*NA*	*NA*				
Natural gas							
Production	*1,853*	*1,735*	*1,166*	*1,191*	*1,045*	*900*	*610*
Flares	305	327	284	318	319	319	319
Oil	*300.4*	*321.3*	*272.8*	*305.5*	*306.9*	*306.9*	*306.9*
Gas	*4.6*	*5.6*	*10.7*	*12.0*	*11.8*	*11.8*	*11.8*
Sub-total CO2	2,159	2,063	1,451	1,510	1,365	1,220	929
N2O emissions							
Flares	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Oil	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Gas	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
Sub-total N2O	0	0	0	0	0	0	0
Total (kt of CO2 equivalents)	21,775	14,657	10,830	9,617	7,516	7,086	6,488
Change since 2005	*48.6%*	-	*-26.1%*	*-34.4%*	*-48.7%*	*-51.7%*	*-55.7%*

Source: UBA (2010a+b), calculations by Öko-Institut

4.4.4. Transport

Table 48 shows the final energy demand for the entire transport sector under the WMS. It can be seen that a 9% increase in the transport sector’s final energy demand by 2020 compared with 2010 was ascertained; however, by 2030 final energy consumption declines by 2% compared with 2010. Furthermore, the increase in biofuel blending in the period up to 2020 is noticeable.

Table 48: Final energy demand in the transport sector under the WMS, in PJ

	2005	2010	2015	2020	2025	2030
Petrol	998	823	780	697	624	569
Diesel	1,109	1,191	1,360	1,314	1,275	1,233
LPG	0	0	0	0	0	0
Natural gas	0	0	0	0	0	0
(Bio-)ethanol	7	32	73	114	102	93
Biodiesel/FAME	72	91	128	214	208	201
Vegetable oil	0	0	0	0	0	0
Hydrogen	0	0	0	0	0	0
Electricity	58	45	41	37	35	35
Kerosene	29	27	26	27	26	25
Total (national)	2,273	2,207	2,408	2,402	2,270	2,155
Internat. Aviation	315	335	342	350	359	362
Deep-sea shipping	103	115	130	139	147	154

Source: Federal Environment Agency, calculations by Öko-Institut

Table 49: Emissions reduction in the transport sector under WMS, a review of individual measures

Measure	**Type**	**Description/objectives**	**Implementation status/start date**	**Emission reduction Million tonnes of CO2 equivalents**				
				2010	2015	2020	2025	2030
CO_2 emissions standard for cars	R	EU emissions standards for new car registrations, 2012 - 2019: 130 g CO_2/km, from 2020: 95 g CO_2/km	Affects new registrations from 2007	0.1	1.1	2.5	6.2	8.9
CO_2 emissions standard for light commercial vehicles	R	EU emissions standards for new light commercial vehicle registrations, 2014 - 2019: 175 g CO_2/km, from 2020: 147 g CO_2/km	Affects new registrations from 2010	0.0	0.0	0.1	0.3	0.5
Biofuel blending	R	Reducing the greenhouse effect resulting from biofuels in line with Biofuel Sustainability Ordinance and blending in compliance with biofuel and greenhouse gas reduction quotas (Federal Pollution Control Act - BImschG): 12 % biofuel in blend from 2020	Starts to impact from 2006, increasing up to 2020	1.9	2.8	5.1	6.8	7.6
Increasing the efficiency of maritime transport	V	Obligation adopted by IMO's MEPC to introduce an Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP)	Impact from 2011	0.3	0.9	1.6	2.3	3.2
HGV toll	E	Increase the toll to between € 0.141-0.274/km and extend it to apply to federal highways	Impact from HGV toll from 2005	1.4	1.3	1.2	1.9	2.3

Measure	Type	Description/objectives	Implementation status/start date	Emission reduction Million tonnes of CO2 equivalents				
				2010	2015	2020	2025	2030
Changes to motor vehicle tax	F	Motor vehicle tax based on CO2 and other pollutant emissions from 01.07.2009	Impact from 2009	0.6	0.8	0.8	1.1	1.3
Aviation tax	F	Introduction of taxation for flights out of Germany. 2012: €7.50 - 42.18 per ticket; €1000 million cap on the financial burden from aviation tax and emissions trading	Impact from 2010	0.0	0.6	0.5	0.4	0.4
Emissions trading for aviation	E	Introduction of an emissions trading scheme for flights departing from and arriving in the EU	Impact from 2012					
Promote electromobility	D	Prepare and implement initial measures towards achieving the target of 1 million electric vehicles by 2020 and 6 million by 2030	Impact from 2010	0.0	0.0	0.0	0.1	0.5
Increase aviation efficiency	V	Voluntary commitment by ICAO to increase efficiency by 2 % per annum	Impact from 2010	0.0	1.6	3.3	5.0	6.7
Total emissions reduction				4.3	9.0	15.2	24.1	31.3

Source: Calculations by Öko-Institut

It is important to note that the suspension of the emissions trading scheme for international flights for 2010 to 2012 has not been taken into account in the table above because of the cut-off date for defining measures.

Table 49 shows the changes in greenhouse gas emissions resulting from the individual measures under the WMS. With regard to greenhouse gas emissions, it can be seen that the introduction of emissions regulations for cars and biofuel blending had the greatest effect on emission reductions. At least in the case of biofuel blending, it should be noted that emissions from manufacturing and distributing biofuels were shifted to other energy-demanding sectors and that no CO_2 emissions were allocated to biofuels in the transport sector.[86] The toll for heavy goods vehicles also produces a significant reduction in greenhouse gases compared with a scenario without a toll.

If the voluntary commitment by the International Civil Aviation Organisation (ICAO) to achieve a specific increase in energy efficiency of 2% per annum is adhered to, this measure in the aviation industry will produce a significant emission reduction compared to a scenario without the voluntary agreement. However, absolute emissions from aviation continue to rise until 2030.

An emissions reduction of 8% a year compared with the 2005 level is achieved under the WMS. The most effective measures are CO_2 emissions standards and biofuel blending. To curb the rise in emissions in the aviation sector and maritime shipping, compliance with the ICAO's voluntary agreement and the introduction and enforce-

[86] The same effect must be taken into account for electricity as a source of energy. Measures to promote electromobility shift emissions into the electricity generation sector. If the average emission factor for electricity generation is used to produce a final balance, it will be seen that electromobility causes additional emissions in the electricity sector (WMS: 2020: 0.1 million tonnes of CO_2 equivalents, 2030: 0.9 million tonnes of CO_2 equivalents.

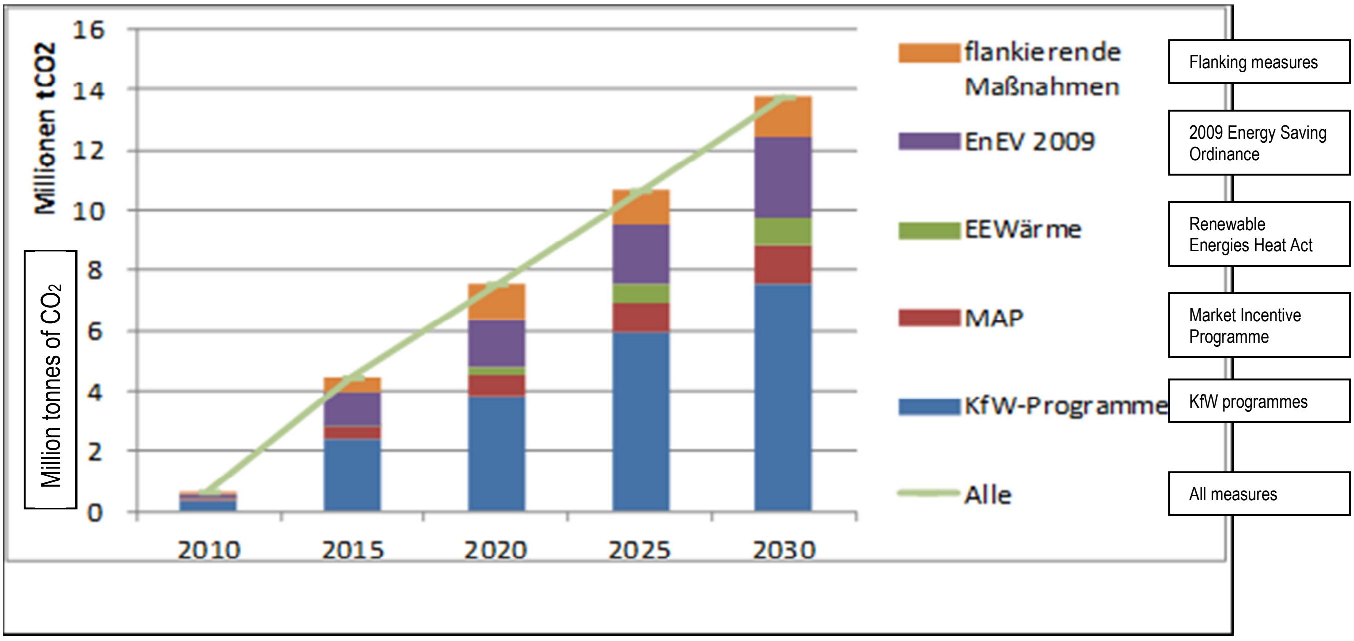
ment of the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP) in shipping are crucial.

4.4.5. Buildings sector – heat and cooling supply

The description of building stock follows the German building typology developed by IWU (Diefenbach 2007), distinguishing different building categories (such as detached houses, apartment buildings of varying sizes, hotels, public buildings etc.). Each of these building categories is subdivided by construction period and thermal standard. Refurbishment measures carried out in the past, on which IWU collected data, are also taken into account (Difenbach 2010). Each of the resulting building types is then linked to a set of heating and hot water supply systems and air conditioning technologies, which in turn are associated with a particular source of energy.

Figure 28 depicts the contributions of the individual policy instruments and the total savings. It is not possible to unequivocally ascribe the CO_2 savings to specific measures. The methodology for this can be found in the descriptions of the individual methods.

Figure 28: Overview of the cumulative contribution of the measures to reduce CO2 emissions directly caused by fuels under the “with measures” scenario



Source: Projection Report 2013

Table 50: Resulting effect per measure for buildings in the household sector under the WMS

Measure/ implementation/ institution	Type	Implementation status (Start date)	2015	2020	2025	2030	2015	2020	2025	2030
			Direct emission reduction effects				Fuel savings			
			Million tonnes of CO2 equivalents				PJ			
KfW programmes	F	2014	2.39	3.84	5.94	7.58	6.81	12.21	17.16	21.19
Market Incentive Programme	F	2014	0.42	0.70	1.00	1.23	0.87	1.59	2.37	3.19
2009 Energy Saving Ordinance	F	2014	1.07	1.55	1.95	2.70	6.29	11.14	15.60	19.43

Renewable Energies Heat Act	F	2014	0.05	0.28	0.64	0.94	-2.69	-5.70	-7.84	-9.21
Flanking measures	R	2016	0.53	1.17	1.13	1.31	5.85	10.50	14.87	18.07
Weighted total effect of individual measures			4.46	7.55	10.65	13.76	17.13	29.75	42.15	52.67
			Effect on electricity supply							
			TWh							
KfW programmes	F	2014	0.18	-0.07	-0.07	-0.03				
Market Incentive Programme	F	2014	-0.01	-0.06	0.07	0.07				
2009 Energy Saving Ordinance	F	2014	0.22	0.21	0.15	0.50				
Renewable Energies Heat Act	F	2014	1.16	2.94	4.34	5.86				
Flanking measures	R	2016	0.34	0.28	0.34	0.53				
Weighted total effect of individual measures			1.90	3.31	4.84	6.93				

Source: Projection Report 2013

The negative fuel savings as a result of the Renewable Energies Heat Act indicate that the Act has caused a rise in final energy demand, which includes both fossil and renewable energy sources. The reason for this is that renewable technologies have a lower efficiency than conventional technologies. It is evident that solar thermal and ambient heat account for the majority of the renewables share.

<u>KfW programmes to promote energy-efficient refurbishment and new builds</u>

Table 51: CO_2 savings resulting from KfW programmes in 2015, 2020, 2025 and 2030

KfW programmes		**2015**	**2020**	**2025**	**2030**
Average CO2 reduction/p.a.	Million t	0.41	0.29	0.42	0.33
comprising: - KfW-Programm O18 - Energetische Stadtsanierung Energieeffizient Sanieren“ für Kommunen	Million t	0.13	0.12	0.19	0.18
- KfW-Programm „IKU - Energetische Stadtsanierung – Energieeffizient Sanieren“ für gemeinnützige Organisationen und kommunale Unternehmen	Million t	0.04	0.03	0.05	0.05
Cumulative CO2 savings	Million t	2.39	3.84	5.94	7.58
Cumulative electricity savings	TWh	0.18	-0.07	-0.07	-0.03

Source: Calculations by Fraunhofer-ISI

In the scenario, KfW's energy-efficient construction and energy-efficient refurbishment programmes were considered. All the efficiency classes (KfW 55 to KfW 115) and individual measures were included. CO_2 reductions resulting from refurbishment schemes funded by KfW were therefore ascribed in full to the KfW programme in question.

The CO_2 savings were allocated to the KfW programmes based on the assumption that there is a proportional relationship between the number of cases funded and the specific CO_2 reduction achieved and that the funding budget under the WMS remained constant. Table 51 shows the CO_2 reductions from 2015.

Market Incentive Programme (MAP)

Table 52: CO2 savings resulting from the Market Incentive Programme in 2015, 2020, 2025 and 2030

Market Incentive Programme		2015	2020	2025	2030
Average CO2 reduction/p.a.	Million t	0.07	0.06	0.06	0.05
Cumulative CO2 savings	Million t	0.42	0.70	1.00	44,927
Cumulative electricity savings	TWh	-0.01	-0.06	0.07	0.07

Source: Calculations by Fraunhofer-ISI

The Market Incentive Programme provides grants and thus ensures that more heating systems using renewable energy are installed. A grant towards a renewable system tips the balance in its favour, making it a more attractive financial option than purchasing a conventional system without an MAP grant. The use of renewable energy increases as a result. However, it is possible that a new fossil-fuel system is more efficient and that the installation of the renewable alternative increases final energy demand, although at the same time CO_2 emissions decrease.

In the evaluation approach chosen, the CO_2 reduction is calculated by comparing the investment options; in other words, the potential CO_2 reduction is compared with the most economically efficient new system without an MAP grant. The baseline is not CO_2 saved by comparison to the existing system. Hence, CO_2 reductions resulting from the replacement of old systems by new ones (which would have been carried out anyway) have not been taken into account. These reductions are ascribed to autonomous progress. The CO_2 reductions calculated on the basis of this approach are shown in Table 52.

The Energy Saving Act (EnEG) and Energy Saving Ordinance (EnEV)

Table 53: CO_2 savings resulting from the Energy Saving Ordinance of 2009 in 2015, 2020, 2025 and 2030

2009 Energy Saving Ordinance		2015	2020	2025	2030
Average CO2 reduction/p.a.	Million t	0.18	0.10	0.08	0.15
Cumulative CO2 savings	Million t	41,456	20,090	34,700	25,600
Cumulative electricity savings	TWh	0.22	0.21	0.15	0.50

Source: Calculations by Fraunhofer-ISI, IEF-STE

The Energy Saving Ordinance requires that new build and refurbishment schemes comply with limit and reference values for energy demand and energy-efficient insulation. The CO_2 reductions thus result from a decrease in energy demand and not from replacing fossil fuels with renewables.

Table 53: shows the saving resulting from the 2009 Energy Saving Ordinance. It includes the total CO_2 savings achieved by carrying out refurbishment work as prescribed under the Energy Saving Ordinance Standard. All savings generated as part of refurbishment work receiving funding from KfW are excluded. Some buildings and parts of buildings do not undergo energy-efficient refurbishment in line with the Energy Saving Ordinance, although they actually need it, but are simply repaired instead. An average energy-efficient refurbishment rate of 0.75% produces the CO_2 reductions listed in Table 53.

The Renewable Energies Heat Act (EEWärmeG)

Table 54: CO_2 savings in 2015, 2020, 2025 and 2030 resulting from the obligation specified in the Renewable Energies Heat Act to use renewables to meet part of the heat demand in buildings

Renewable Energies Heat Act		**2015**	**2020**	**2025**	**2030**
Average CO2 reduction/p.a.	Million t	0.01	0.05	0.07	0.06
Cumulative CO2 savings	Million t	0.05	0.28	0.64	0.94
Cumulative electricity savings	TWh	1.16	2.94	4.34	5.86

Source: Calculations by Fraunhofer-ISI

The CO_2 savings resulting from the Renewable Energies Heat Act are largely due to changes in the energy mix used to supply heat for buildings. The energy source mix is influenced primarily by the statutory obligation to use heating systems based at least partially on renewables, which is laid down in the Renewable Energies Heat Act. The exact details of this obligation vary depending on the energy source. The Act also includes an option to choose specified alternative measures that save energy instead of replacing conventional energy sources by renewables. They include, for example, using waste heat or heating networks or improving the building's energy efficiency. The CO_2 reductions achieved as a result of the Renewable Energies Heat Act are listed in Table 54.

Flanking instruments

A number of flanking instruments – energy performance certificate, information services offered by the **German** Energy Agency (DENA), on-site energy advice and energy advice for private households – help to inform stakeholders. Owners, investors and contractors carrying out the work are given information about the technical options and legal requirements and about the consequences of their decisions. Any CO_2 savings not explained by the quantified measures must therefore be ascribed to these information activities. They are aimed at helping people to take the initiative and make responsible and considered decisions about energy investments and the use of energy in the buildings sector.

4.4.6. Private households – electricity

Table 55 provides an overview of the trends in electricity consumption of private households under the WMS, broken down by use sector. It can be seen that the electricity consumption of private households decreases steadily up to 2030.

Table 55: Trends in electricity consumption in private households 2010–2030 under the WMS

Electricity consumption under WMS	2010	2015	2020	2025	2030
	GWh				
White goods	33367	32028	29356	27198	25897
Electric cooker	11846	11890	11818	11873	11741
ICT equipment	26113	26466	26837	27341	27204
Lighting	10920	8540	7776	8056	7710
Air handling units	824	1863	3337	4759	5617
Other elec. (incl. small electrical appliances)	24245	23107	23471	22291	21998
Total	107315	103894	102596	101519	100167

Source: Estimates by Fraunhofer-ISI

The relevant measures assessed under the WMS include the Energy Labelling Directive Energy Consumption Labelling Ordinance (EnVKV), minimum standards based on the EU Ecodesign Directive, and the introduction of smart meters for household electricity consumption in new buildings. Based on the assumptions described above, this produces annual savings of 25.9 TWh in 2020 under the WMS. These savings increase to 33.1 TWh in 2030 (see

Table 56). The greatest savings are a result of the Ecodesign Directive. The reason for this is that in this sector the WMS assumes an ambitious implementation of the Ecodesign Directive for all products based on the implementation measure provided for under the Directive or, if no such measure is yet in place, based on the lowest life cycle costs. Since only the impact of smart meters in new buildings was quantified under the WMS, this measure produces only a 0.2 TWh decrease in electricity consumption up to 2030.

Table 56: Effect of electricity-related measures in the private household sector – WMS

Measure	Description/objectives (area of impact)	Implementation status (start date)	Effect on electricity supply			
			2015	2020	2025	2030
			TWh			
Energy Consumption Labelling Ordinance (EnVKV)	Statutory labelling for household electrical appliances and some household light bulbs giving information on consumption of energy and other resources (product groups included: refrigeration and freezing equipment, washing machines and dishwashers, dryers, electric ovens, lighting, air conditioning units)	Running since 1.1.1998	1.7	3.9	4.6	5.5
Minimum standards I (EU Ecodesign Directive)	Minimum standards for energy-using products based on “implementing measures” or lowest life-cycle costs	Phased implementation starting in 2010	10.3	14.9	17.1	19.4
Smart metering	Introduction of smart meters to measure electricity consumption in new buildings	Implementation from 2010	0.0	0.1	0.2	0.2
Flanking			3.9	7.0	7.0	7.9

Measure	Description/objectives (area of impact)	Implementation status (start date)	Effect on electricity supply			
			2015	2020	2025	2030
			TWh			
instruments						
Unweighted total impact of the individual measures			15.9	25.9	28.9	33.1
Weighted total impact of the individual measures (excluding overlap)			15.9	25.9	28.9	33.1

Source: Estimates by Fraunhofer-ISI

Table 57 gives a different breakdown of the effect of electricity-related measures – this time by category of appliance. It indicates that the greatest impact of the Ecodesign Directive, given the assumptions made under the WMS, was achieved by ICT appliances and lighting. Further savings from ICT appliances can be achieved through flanking measures. In the case of the Energy Consumption Labelling Ordinance, large household appliances have the greatest savings potential (Table 57).

Table 57: Effect of electricity-related measures in the private household sector by appliance category – WMS

Measure	**Appliance category**	**Effect on electricity supply**				
		2010	**2015**	**2020**	**2025**	**2030**
		TWh				
Energy Consumption Labelling Ordinance (EnVKV)	White goods	0.0	1.3	2.5	2.9	3.3
	Electric cookers	0.0	0.3	0.5	0.6	0.7
	ICT equipment	0.0	0.2	0.8	1.0	1.5
	Lighting	0.0	0.0	0.0	0.0	0.0
	Air conditioning	0.0	0.0	0.1	0.1	0.1
	Total	0.0	1.7	3.9	4.6	5.5
Minimum standards I (EU Ecodesign Directive)	White goods	0.0	1.4	1.9	1.3	1.7
	Electric cookers	0.0	0.3	0.4	0.3	0.3
	ICT equipment	0.0	5.6	8.3	11.1	12.7
	Lighting	0.0	2.9	4.2	4.4	4.6
	Air conditioning	0.0	0.0	0.0	0.0	0.0
	Total	0.0	10.3	14.9	17.1	19.4
Smart metering	White goods	0.0	0.0	0.1	0.2	0.2
	Total	0.0	0.0	0.1	0.2	0.2
Flanking instruments	White goods	0.0	0.1	0.3	0.3	0.3
	Electric cookers	0.0	0.0	0.1	0.1	0.1
	ICT equipment	0.0	3.5	5.6	5.7	6.9
	Lighting	0.0	0.2	1.1	0.9	0.5
	Air conditioning	0.0	0.0	0.0	0.1	0.1
	Total	0.0	3.9	7.0	7.0	7.9
Unweighted total impact of the individual measures		0.0	15.9	25.9	28.9	33.1
Weighted total impact of the individual measures (excluding overlap)		0.0	15.9	25.9	28.9	33.1

Source: Estimates by Fraunhofer-ISI

4.4.7. Industry and trade, commerce and services (TCS) - electricity and process heat/steam

A description of the effect of the individual measures by sector and scenario is provided below. This is followed by a comparison of their effects and of the resulting energy demand.

Table 58: Resulting effect per measure under WMS in the industrial sector

Measure/ implementation/ institution	**Type**	**Description/objectives (area of impact)**	**Implementation status stand (start date))**	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
				Direct emissions reduction effect				**Fuel savings**			
				Million tonnes of CO2 equivalents p.a.				**PJ/a**			
Emissions trading	E	Trading emissions allowances (cap and trade). Affects primarily energy-intensive industries.	In force since 2007	0.76	1.52	2.45	3.41	1.04	1.49	2.17	2.81
Special Fund - Energy Efficiency in SMEs	F	Linking subsidised energy advice and low-interest loans to implement measures. Target group: SMEs	In force since 2008	0.58	0.93	1.26	1.59	7.68	12.21	16.34	20.60
Minimum standards (EU Ecodesign Directive)	R	Minimum standards for energy-using products based on the implementation measure or lowest life-cycle costs	Phased implementation from 2010-2014	0.19	0.61	0.94	1.25	2.98	9.58	15.24	20.82
Changes to energy taxation	V	Energy tax relief for industry is linked to energy management and voluntary commitments to improving efficiency.	In force since 2013	0.01	0.01	0.02	0.02	0.10	0.22	0.31	0.37
Funding programme for cross-cutting technologies in SMEs	F	Financial support for investment in cross-cutting technology (pumps, motors, waste heat etc.)	Implementation early 2013	0.01	0.02	0.04	0.05	0.14	0.39	0.60	0.81
Unweighted total impact of the individual measures											
Weighted total impact of the individual measures (excluding overlap)				1.55	3.09	4.71	6.32	11.94	23.89	34.65	45.41
				Effect on the electricity supply							
				TWh/a							
Emissions trading	E	Trading emissions allowances (cap and trade). Affects primarily energy-intensive industries.	In force since 2007	0.0	0.0	0.1	0.1				

Measure/ implementation/ institution	Type	Description/objectives (area of impact)	Implementation status stand (start date))	2015	2020	2025	2030	2015	2020	2025	2030
				Direct emissions reduction effect				Fuel savings			
				Million tonnes of CO2 equivalents p.a.				PJ/a			
Special Fund - Energy Efficiency in SMEs	F	Linking subsidised energy advice and low-interest loans to implement measures. Target group: SMEs	In force since 2008	2.4	3.8	5.2	7.7				
Minimum standards (EU Ecodesign Directive)	R	Minimum standards for energy-using products based on the implementation measure or lowest life-cycle costs	Phased implementation from 2010-2014	13.9	27.7	37.8	44.9				
Changes to energy taxation	V	Energy tax relief for industry is linked to energy management and voluntary commitments to improving efficiency.	In force since 2013	1.6	3.9	6.0	9.4				
Funding programme for cross-cutting technologies in SMEs	F	Financial support for investment in cross-cutting technology (pumps, motors, waste heat etc.)	Implementation early 2013	0.5	1.5	2.4	3.9				
Unweighted total impact of the individual measures											
Weighted total impact of the individual measures (excluding overlap)				18.46	36.93	51.49	66.05				

Source: Fraunhofer ISI

Table 59: Resulting effect per measure under WMS in the TCS sector

Measure/ implementation/ institution	Type	Description/ objectives (area of impact)	Implementation status stand (start date)	2015	2020	2025	2030	2015	2020	2025	2030
				Direct emissions reduction effect				Fuel savings			
				Million tonnes of CO2 equivalents p.a.				PJ/a			
Special Fund - Energy Efficiency in SMEs	F	Linking subsidised energy advice and low-interest loans to implement measures. Target group: SMEs	In force since 2008	0.10	0.19	0.30	0.41	0.75	1.52	2.32	2.93
Procurement of energy-efficient products (federal agencies)	V	Procurement by federal agencies of energy-efficient products and services	In force since 2008	0.58	-	-	-	-	-	-	-
Minimum standards (EU Ecodesign Directive)	R	Minimum standards for energy-using products based on the implementation measure or lowest life-cycle costs	Phased implementation from 2010 to 2012	-	-	-	-	-	-	-	-

Measure/ implementation/ institution	Type	Description/ objectives (area of impact)	Implementation status stand (start date)	2015	2020	2025	2030	2015	2020	2025	2030
				Direct emissions reduction effect				**Fuel savings**			
				Million tonnes of CO2 equivalents p.a.				**PJ/a**			
Changes to energy taxation	V	Energy tax relief for industry is linked to energy management and voluntary commitments to improving efficiency.	In force from 2013	0.00	0.01	0.03	0.04	0.03	0.12	0.21	0.28
Unweighted total impact of the individual measures											
Weighted total impact of the individual measures (excluding overlap)				0.11	0.20	0.32	0.45	0.78	1.63	2.53	3.21
				Effect on the electricity supply							
				TWh/a							
Special Fund - Energy Efficiency in SMEs	F	Linking subsidised energy advice and low-interest loans to implement measures. Target group: SMEs	In force since 2008	0.20	0.43	0.81	1.39				
Procurement of energy-efficient products (federal agencies)	V	Procurement by federal agencies of energy-efficient products and services	In force since 2008	0.06	0.13	0.23	0.37				
Minimum standards (EU Ecodesign Directive)	R	Minimum standards for energy-using products based on the implementation measure or lowest life-cycle costs	Phased implementation from 2010 to 2012	14.63	29.22	47.06	64.63				
Changes to energy taxation	V	Energy tax relief for industry is linked to energy management and voluntary commitments to improving efficiency.	In force from 2013	0.11	0.42	0.92	1.73				
Unweighted total impact of the individual measures											
Weighted total impact of the individual measures (excluding overlap) ( )				15.00	30.21	49.01	68.12				

Source: Fraunhofer ISI

4.4.8. Industrial processes (CO_2, CH_4 and N_2O emissions)

With regard to the particularly relevant process-related CO_2 emissions, it is possible to lower emissions by 7% by 2030 compared with 2010 under the WMS as a result of slight production changes using less emissions-intensive secondary processes (such as electric arc furnace) (Table 60).

Table 60: Trends in process-related CO_2 emissions for selected production processes under the “with measures” scenario, 2000-2030

	2000	2005	2010	2015	2020	2025	2030
	kt t CO2						
Cement clinker production (2A)	15,102	12,921	12,188	12,668	12,609	12,178	11,725
Limestone production (2A)	5,862	5,454	5,019	5,542	5,542	5,542	5,542
Glass production (2A)	731	706	762	820	839	858	879

	2000	2005	2010	2015	2020	2025	2030
	kt t CO2						
Ceramics production (2A)	531	359	309	309	309	309	309
Soda ash (2A)	301	313	323	323	323	323	323
Ammonia production (2B)	7,539	7,805	7,437	7,437	7,437	7,437	7,437
Carbide production (2B)	18	16	17	17	17	17	17
Catalytic converters (2B)	2,894	2,883	2,992	2,878	2,632	2,415	2,100
Conversion losses (2B)	3,760	3,776	3,776	3,632	3,321	3,047	2,650
Methanol production (2B)	1,264	1,314	718	718	718	718	718
Carbon black production (2B)	678	652	1,341	1,341	1,341	1,341	1,341
Iron and steel production (2C)	20,263	20,929	18,208	18,262	18,300	17,258	16,162
Manufacture of ferrous alloys (2C)	9	8	6	6	6	6	6
(Primary) aluminium production (2C)	880	883	551	752	752	708	664
Total	59,832	58,018	53,645	54,705	54,146	52,157	49,871
Compared with 2010	*11.5%*	*8.2%*	-	*2.0%*	*0.9%*	*-2.8%*	*-7.0%*

Source: UBA (2012a+b),FhG-ISI, calculations by Öko-Institut

It has been possible to carry out Joint Implementation Projects in Germany since 2008. As a result of current experience acquired through these projects, a 50% emissions reduction compared with 2009 for nitric acid production and a 90% reduction for adipic acid production have been taken into account (Table 61).

Table 61: Trends in CH_4 and N_2O emissions from industrial processes and use of products under the WMS, 2000-2030

	2000	2005	2010	2015	2020	2025	2030
	kt						
CH_4 emissions							
Carbon black production	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Iron and steel production	0.26	0.22	0.21	0.23	0.23	0.23	0.23
Sub-total CH4	0.27	0.23	0.23	0.25	0.25	0.25	0.25
N2O emissions							
Raw steel production	0.06	0.06	0.06	0.06	0.06	0.06	0.05
Nitric acid production	12.30	15.87	9.78	5.62	5.62	5.62	5.62
Adipic acid production	4.48	10.57	2.31	2.22	2.44	2.69	2.96
Caprolactam production	NO	NO	NO	NO	NO	NO	NO
Production of n-dodecanoic acid	C	C	C	C	C	C	C
Use of N_2O as an anaesthetic	3.52	1.30	0.92	0.92	0.92	0.92	0.92
Other (technical) uses of N_2O	0.23	0.25	0.24	0.24	0.24	0.24	0.24
N_2O used in explosives	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sub-total N2O	20.60	28.05	13.31	9.06	9.28	9.53	9.79
Total (kt of CO2 equivalents)	6,391.51	8,699.23	4,130.04	2,814.30	2,883.19	2,959.07	3,041.36
Compared with 2005	*-26.5%*	-	*-52.5%*	*-67.7%*	*-66.9%*	*-66.0%*	*-65.1%*

Source: UBA (2012a+b),FhG-ISI, calculations by Öko-Institut

4.4.9. Industrial processes – use of products (fluorinated greenhouse gases)

Under the “with measures” scenario (WMS), the methodological approach described produces the emissions trend shown in Table 62.

HFCs will continue to make the greatest contribution to emissions in the future. Based on the measures taken into account, an absolute decline in emissions from cooling and air-conditioning systems can be expected in this source group, which saw strong growth up to 2009. SF_6 emissions resulting from disposal of noise-reduction windows continue to rise until 2020 and then decline sharply as a result of a ban on their usage dating back to 2007. Overall under the WMS, the emissions levels for HFCs, PFCs and SF_6 for the 2020 time horizon are almost back to what they were in 2000. By 2030, an emissions reduction of 30% compared with 2000 is expected under the WMS, which equates to a decline of 45% over 1995 (baseline year for F-gases).

Table 62: Trends in emissions of fluorinated greenhouse gases from industrial processes and use of products under the WMS 2000-2030

	2000	**2005**	**2010**	**2015**	**2020**	**2025**	**2030**
	kt of CO2 equivalents						
HFC emissions							
Production of halogenated hydrocarbons and SF6	1,207	516	166	200	200	200	200
Cooling and air conditioning units	3,564	7,679	10,086	6,550	5,447	5,064	4,680
Foam manufacture	1,206	1,163	670	884	910	936	962
Fire extinguishers	2	7	24	12	15	12	9
Aerosols and medicinal sprays	486	616	457	515	525	528	530
Semiconductor production	17	16	9	12	12	12	12
Not specified/confidential	559	255	186	21	22	23	25
Sub-total HFCs	*7,040*	*10,252*	*11,597*	*8,193*	*7,131*	*6,774*	*6,418*
PFC emissions							
Aluminium production	356	338	135	184	184	173	162
Cooling and air conditioning units	80	120	53	NO	NO	NO	NO
Production of halogenated hydrocarbons and SF6	NA,NO	NA,NO	NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO
Semiconductor production	346	249	121	189	189	189	189
Photovoltaics	NO	2	0	IE	IE	IE	IE
Not specified/confidential	IE,NO	IE,NA,NO	IE,NA,NO	NO	NO	NO	NO
Sub-total PFCs	*781*	*709*	*309*	*373*	*373*	*362*	*351*
SF6 emissions							
Magnesium foundries	330	728	107	106	111	117	123
Production of halogenated hydrocarbons and SF6	215	239	90	100	100	100	100
Semiconductor production	56	75	18	17	17	17	17
Electrical plant and equipment	1,158	762	543	614	614	614	614
Tyre inflation	1,195	65	14	NO	NO	NO	NO
Tracer gas	12	12	4	4	4	4	4
Noise reduction windows	1,303	1,502	2,223	2,758	3,521	1,868	214
Glass fibre optics	NO	72	197	123	123	123	123
Photovoltaics	NO	20	55	55	55	55	55
Not specified/confidential	IE	IE	IE	373	377	381	385
Sub-total SF6	4,269	3,475	3,250	4,150	4,923	3,279	1,636

	2000	2005	2010	2015	2020	2025	2030
	kt of CO2 equivalents						
Total	12,091	14,436	15,155	12,717	12,426	10,416	8,405
Compared with 2000	-	*19.4%*	*25.3%*	*5.2%*	*2.8%*	*-13.9%*	*-30.5%*
Compared with 1995 (15.349 kt of CO2 equivalentsb)	*-21.7%*	*-6.5%*	*-1.8%*	*-17.6%*	*-19.5%*	*-32.5%*	*-45.6%*
Notes: a Emission values from various applications such as aluminium casting, particle accelerators, radar equipment, welding, sports shoes, solvents, which are reported as being confidential. b Calculated using the GWP values defined in the 2nd IPCC Assessment Report, which are significant for Kyoto reporting							

Source: UBA 2011b, Öko-Recherche 2011, calculations by Öko-Institut

4.4.10. Agriculture

The results presented are based on the National Inventory Report on the German Greenhouse Gas Inventory (NIR) 1990-2010 (UBA, 2012a). They were expanded to include future trends in the baseline projection for 2021 carried out by the Johann Heinrich von Thünen Institute's Agricultural Economics Division. These projections have been defined as a "with measures" scenario (WMS).

Projections for 2015, 2020, 2025 and 2030 are developed based on the assumptions mentioned above. Table 63 shows the historical and projected trends in activity data for livestock population for 1990-2030. Here the number of cattle declined sharply and in 2030 was 14.4% lower than in 2005 and 42.7% lower than in 1990. A 13.8% decrease in pig production was witnessed between 1990 and 2030.

Table 63: Trends in agricultural activity data, 1990-2030

Categories of greenhouse gas sources and sinks	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
	Activity data (population) in thousands									
1. Cattle	19,488	15,890	14,538	13,036	12,945	*12,809*	*11,985*	*11,160*	*11,160*	*11,160*
Dairy cattle	6,355	5,229	4,570	4,236	4,205	*4,183*	*3,998*	*3,813*	*3,813*	*3,813*
Non-dairy cattle	13,133	10,661	9,968	8,799	8,739	*8,626*	*7,986*	*7,346*	*7,346*	*7,346*
2. Buffalos	0	0	1	1	2	*2*	*2*	*2*	*2*	*2*
3. Sheep	3,266	2,991	2,743	2,643	2,350	*2,089*	*2,044*	*2,000*	*2,000*	*2,000*
4. Goats	90	100	140	170	220	*150*	*150*	*150*	*150*	*150*
5. Camels and lamas	NO	NO	NO	NO	NO	*NO*	*NO*	*NO*	*NO*	*NO*
6. Horses	491	626	491	500	489	*462*	*462*	*462*	*462*	*462*
7. Mules and donkeys	9	9	9	9	9	*9*	*9*	*9*	*9*	*9*
8. Pigs	26,502	20,387	21,768	22,743	23,021	*22,244*	*22,550*	*22,856*	*22,856*	*22,856*
9. Poultry	113,879	111,228	120,180	120,561	128,221	*128,900*	*129,833*	*130,766*	*130,766*	*130,766*
10. Other (to be specified)	NE	NE	NE	NE	NE	*NE*	*NE*	*NE*	*NE*	*NE*
1990- 2009, 2010 Greenhouse Gas Inventory *From 2010 from APS* NE = not estimated NO = not occurring										

Source: UBA (2012a), Offermann et al. (2012), calculations by Öko-Institut

Table 64 and Table 65 illustrate the impact of changes in the livestock population and the associated land use on trends in methane and nitrous oxide emissions. In the comparison between 2030/2005 (and 2030/1990), overall methane emissions in the relevant areas of fermentation and manure management decrease by 8.9% (28%). The reduction is primarily due to the decrease in the numbers of dairy and non-dairy cattle.

Table 64: Trends in methane emissions in agriculture, 1990-2030

Agriculture (CRF 4)	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
	2010 Greenhouse Gas Inventory					WMS				
	kt CH4									
A. Enteric fermentation	1,270.1	1,112.7	1,046.1	975.2	975.4	965.6	924.3	883.0	883.0	883.0
B. Manure management	301.2	277.5	272.9	267.8	270.4	265.4	257.2	249.0	249.0	249.0
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total	1,571.3	1,390.1	1,319.1	1,243.0	1,245.8	1,231.0	1,181.5	1,132.0	1,132.0	1,132.0
Total in kt of CO2 equivalents	32,996	29,193	27,700	26,102	26,161	25,851	24,811	23,772	23,772	23,772
Change compared with 1990		-11.5%	-16.1%	-20.9%	-20.7%	-21.7%	-24.8%	-28.0%	-28.0%	-28.0%
Change compared with 2005					0.23%	-1.0%	-4.9%	-8.9%	-8.9%	-8.9%
NO = not occurring										
NA = not applicable										

Source: UBA (2012a), Offermann et al. (2012), calculations by Öko-Institut

Table 65: Trends in nitrous oxide emissions in agriculture, 1990-2030

Agriculture (CRF 4) N2O emissions	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
	2010 Greenhouse Gas Inventory					WMS				
	kt N2O									
A. Enteric fermentation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Manure management	8.3	7.6	7.3	7.2	7.4	7.3	7.1	6.9	6.9	6.9
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	153.7	134.2	141.6	133.9	129.7	127.0	131.0	135.0	131.8	128.6
E. Prescribed burning of savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field burning of agricultural residues	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
G. Other	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total	162.0	141.8	148.9	141.1	137.1	134.3	138.1	141.9	138.7	135.5
Total in kt CO2 equivalents	50,215	43,951	46,161	43,751	42,497	41,628	42,808	43,989	43,000	42,011

Agriculture (CRF 4) N2O emissions	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
	2010 Greenhouse Gas Inventory					WMS				
	kt N2O									
Change compared with 1990		-12.5%	-8.1%	-12.9%	-15.37%	-17.1%	-14.7%	-12.4%	-14.4%	-16.3%
Change compared with 2005					-2.9%	-4.9%	-2.2%	0.5%	-1.7%	-4.0%
NO = not occurring										
NA = not applicable										

Source: UBA (2012a), Offermann et al. (2012), calculations by Öko-Institut

Total nitrous oxide emissions in the relevant areas of manure management and agricultural soils decrease by 4% between 2005 and 2030, and nitrous oxide emissions decrease by 16.3% between 1990 and 2030. Agricultural methane and nitrous oxide emissions decrease by 5.8% between 2005 and 2030 and by 20.9% between 1990 and 2030 to 65,784 kt of CO_2 equivalents in 2030.

Table 66: Trends in methane and nitrous oxide emissions in agriculture in kt of CO_2 equivalents, 1990-2030

Total emissions in kt of CO2 equivalents	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
N2O, from 2010 under WMS	50,215	43,951	46,161	43,751	42,497	41,628	42,808	43,989	43,000	42,011
CH4, from 2010 under WMS	32,996	29,193	27,700	26,102	26,161	25,851	24,811	23,772	23,772	23,772
Total	83,211	73,143	73,861	69,853	68,659	67,479	67,620	67,761	66,772	65,784
Change compared with 1990		-12.1%	-11.2%	-16.1%	-17.5%	-18.9%	-18.7%	-18.6%	-19.8%	-20.9%
Change compared with 2005					-1.7%	-3.4%	-3.2%	-3.0%	-4.4%	-5.8%

Source: UBA (2012a), Offermann et al. (2012), calculations by Öko-Institut

Uncertainties

Due to uncertainties about how agricultural policy will develop in the future, about consumer behaviour and with regard to different price assumptions, it is difficult to estimate the cumulative effects on emissions from agriculture.

4.4.11. Waste management

The results of the projection calculations under the WMS show that the huge reduction in methane emissions from landfills is the main factor in trends in greenhouse gas emissions in the waste sector (see). Neither scenario addresses reduction measures in the biomechanical waste treatment sector.

The significant decline in waste input to landfills (65% between 2005 and 2030) as a result of the regulatory framework for the waste sector is of decisive importance in this scenario. Total greenhouse gas emissions in the waste sector decrease by 11 million tonnes of CO_2 equivalents in the 2005-2030 period.

The dramatic decline in waste input in the 2005 to 2030 period causes methane emissions from landfills to decrease by 75%. As a result of the declining population, the percentage of textiles, nappies and organic waste decreases (see Table 67), which in turn leads to a further decrease in emissions.

Under this scenario, there is a 43% reduction in methane emissions from municipal wastewater treatment and a 4% reduction in nitrous oxide emissions. Seen in relation to the overall greenhouse gas inventory, this is not a major source. There are no changes from the baseline year in the composting and biomechanical waste treatment sector under the WMS (see Table 67).

Table 67: Trends in methane and nitrous oxide emissions in the waste management sector under the "with measures" scenario, 2000-2030.

	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
	kt									
Waste input										
Landfills	40,249	19,525	8,506	4,079	1,440	1,439	1,439	1,433	1,426	1,419
Biological waste treatment plants	724	5,168	9,030	9,207	8,860	8,860	8,860	8,860	8,860	8,860
Municipal wastewater treatment	4,847	4,629	4,714	4784	4747	4744	4697	4679	4644	4587
Biomechanical waste treatment	n.a	n.a	1,246	9,207	4,900	5,000	5,000	5,000	5,000	5,000
CH4 emissions										
Landfills	1,838.40	1,727.00	1,132.62	679.40	464.05	427.35	308.55	243.99	199.12	166.71
Municipal wastewater treatment	106.0	42.3	8.32	5.75	3.85	3.38	3.36	3.34	3.32	3.28
Composting	2.4	15.9	26.03	26.18	25.66	25.66	25.66	25.66	25.66	25.66
Biomechanical waste treatment	n.a	n.a	0.19	0.25	0.27	0.28	0.28	0.28	0.28	0.28
Sub-total CH4 (kt)	1,946.74	1,785.15	1,167.16	711.59	493.84	456.66	337.85	273.27	228.37	195.92
Compared with 1990	-	-8.3%	-40.0%	-63.4%	-74.6%	-76.5%	-82.6%	-86.0%	-88.3%	-89.9%
Compared with 2005			64.0%	-	-30.6%	-35.8%	-52.5%	-61.6%	-67.9%	-72.5%
N2O emissions										
Municipal wastewater treatment	7.17	7.13	7.32	7.49	7.43	7.43	7.35	7.33	7.27	7.18
Composting	0.05	0.35	0.66	0.68	0.64	0.64	0.64	0.64	0.64	0.64
Biomechanical waste treatment	n.a	n.a	0.29	0.44	0.49	0.50	0.50	0.50	0.50	0.50
Sub-total N2O	7.22	7.48	8.27	8.60	8.56	8.57	8.49	8.47	8.41	8.32
Compared with 1990	-	3.7%	14.5%	19.2%	18.6%	18.7%	17.7%	17.3%	16.5%	15.3%
Compared with 2005	-		-3.9%	-	-0.5%	-0.4%	-1.3%	-1.6%	-2.2%	-3.3%
Total (kt of CO2 equivalents)	43,119	39,808	27,073	17,611	13,025	12,246	9,728	8,363	7,403	6,694
Compared with 1990	-	-7.7%	-37.2%	-59.2%	-69.8%	-71.6%	-77.4%	-80.6%	-82.8%	-84.5%
Compared with 2005	-		53.7%	-	-26.0%	-30.5%	-44.8%	-52.5%	-58.0%	-62.0%

Note: Only the share in the total amount treated in mechanical systems with a biological phase is relevant for greenhouse

	1990	1995	2000	2005	2009	2010	2015	2020	2025	2030
	kt									
gas emissions										

Source: Projection Report 2013

4.4.12. Forestry

Measures in this sector were not taken into consideration in the 2013 Projection Report, which means it is not possible to make a robust assessment of their impact on climate change. The German government is reviewing whether the 2017 Projection Report might include this sector and, if so, in what form.

5. Vulnerability, impact of climate change and adaptation measures

5.1. Future climate change in Germany

The horizontal grid spacing of global climate models currently ranges from 120 to over 200 km, which means that the spatial resolution is not fine enough to be able to make any predictions about specific regions in Germany. For that reason, methods are used to obtain a regional breakdown which include regional climate models combined with information from the calculations of the global models. These models use physical numerical methods to transfer global climate projections to Central Europe and to a finer horizontal resolution, currently about 10 kilometres.

The simulation runs of the EU FP6 project ENSEMBLES can be used to project Germany's future climate on a regional scale. This increases the number of deterministic regional climate projections available for Germany to over 30 simulation runs. To create the ensemble, DWD – as part of KLIWAS BMVBS's departmental research programme (see section 5.2) – used those climate projections that have been calculated both on the basis of emission scenario A1B and up to the end of the 21st century. Thus, an ensemble of 19 regional climate projections has been created. Due to the relatively high number, a statistical analysis of quantiles[87] of the overall ensemble was carried out in order to depict a particular range. Figure 29 lists the combinations of global and exclusively dynamic regional climate models.

[87] To achieve ranges that can be interpreted, the 15% and 85% quantiles of the climate projection ensemble were determined each grid point throughout Germany. They can basically be interpreted as follows: 15% quantile: there is an 85% probability that the signals of change described in the ensemble will be exceeded; in other words, 85% of the projections predict higher rates of change and 15% predict the rates of change described or lower. 85% quantile: there is an 85% probability that the signals of change described in the ensemble will not be exceeded or, in other words, 85% of the ensemble predict the rates of change described or lower and 15% predict higher rates of change. Thus, the range between the upper and lower limit represents a 70% probability of occurrence with regard to the ensemble under consideration. Note: the terms probability and quantile used here are based solely on the climate prediction ensemble used. This ensemble represents only a fraction of possible future climate trends, so that the results presented here cannot be regarded as statistical probabilities of occurrence in the strictest sense of the word.

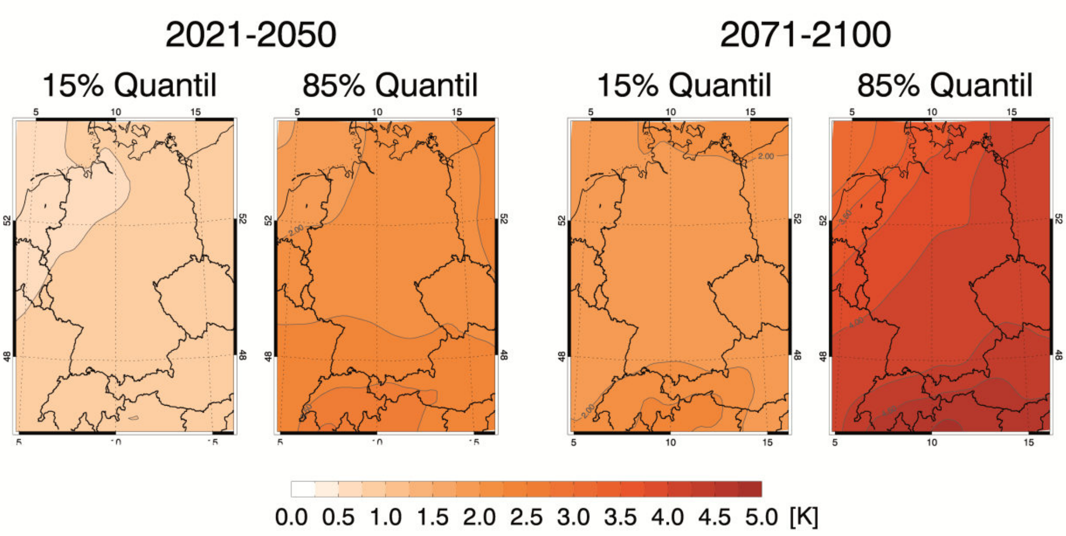
Figure 29: Climate projections used for the ensemble analysis. Listed are the combinations of global and regional climate models based on the A1B emissions scenario.

SRES-Scenario

SRES-Szenario	GCM	RCM	
A1B	HadCM3Q0	CLM	EU-ENSEMBLES
		HadRM3Q0	EU-ENSEMBLES
	HadCM3Q16	HadRM3Q16	EU-ENSEMBLES
		C4IRCA3	EU-ENSEMBLES
	HadCM3Q3	HadRM3Q3	EU-ENSEMBLES
		SMHIRCA	EU-ENSEMBLES
	BCM	SMHIRCA	EU-ENSEMBLES
		HIRHAM5	EU-ENSEMBLES
	ECHAM5-r3	SMHIRCA	EU-ENSEMBLES
		REGCM3	EU-ENSEMBLES
		HIRHAM5	EU-ENSEMBLES
		RACMO2	EU-ENSEMBLES
		REMO	EU-ENSEMBLES
	ECHAM5-r2	REMO	BfG
		CLM	UBA
	ECHAM5-r1	CLM	UBA
		REMO	UBA
	ARPEGE	HIRHAM5	EU-ENSEMBLES
		RM5.1	EU-ENSEMBLES

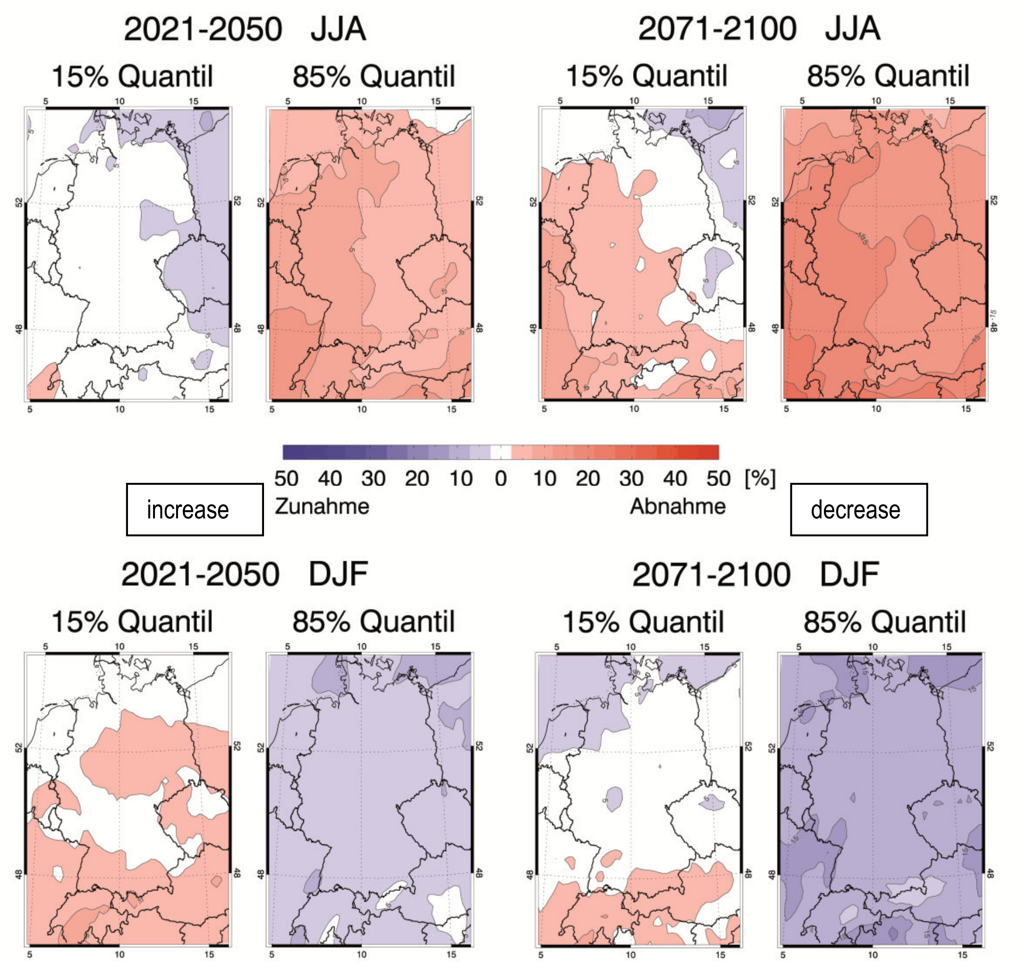
Source: German federal government 2011

Figure 30: Projected change in the average annual air temperature, average over the projection periods 2021-2050 (left) and 2071-2100 (right); for climate projections used see above.



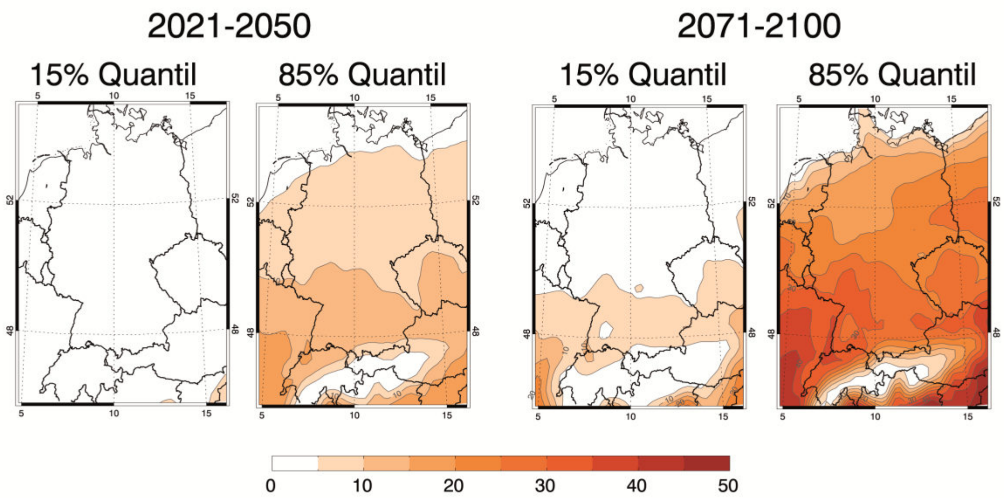
Source: German federal government 2011

Figure 31: Projected relative change in average summer precipitation (JJA, top) and winter precipitation (DJF, bottom) in %. Average over the projection periods 2021-2050 (left) and 2071-2100 (right); see above for climate projections used.



Source: German Fedaral Government 2011

Figure 32: Projected change in the number of hot days (Tmax≥30°C), average over the projection periods 2021-2050 (left) and 2071-2100 (right), see above for climate projections used.



Source: German federal government 2011

To evaluate the climate projection ensemble defined in this way, the signals of change for the "near" (2021-2050) and "distant" (2071-2100) future were analysed relative to the reference period 1961-1990. To specify a range, Figures 28 to 30 show the isosurfaces of the change in average annual air temperature, average total precipitation in summer and winter and the hot day index, which were ascertained using statistical analysis methods. The figures showing the quantiles should be interpreted as follows:

- With regard to the change in average annual air temperature for the period 2021 to 2050, an increase of at least 0.5°C is likely in Germany. A temperature increase of more than 2°C (northern Germany) or 2.5°C (southern Germany) is unlikely.
- For the period 2071-2100, an increase in average air temperature of at least 1.5°C and at most 3.5°C in northern Germany and 4°C in southern Germany can be considered likely.

The seasonal difference in trends in precipitation calls for a more differentiated view. Generally speaking, there is a trend towards decreasing precipitation in the summer months, whereas an increase is likely in the winter months. The projected relative changes in average summer precipitation range from a very slight decrease to a 15% decrease for the period 2021-2050. A decrease in precipitation of up to 25% has been shown for 2071-2100. Some climate models also show a slight increase in summer precipitation in some regions.

The model calculations indicate that a small increase in winter precipitation is to be anticipated for the period 2021-2050, with values not likely to exceed 10%. An increase of more than 15% is unlikely for the period 2071-2100.

The hot days index – i.e. the number of days on which the maximum temperature is at least 30°C – is a measure of extreme weather. It is likely that the number of hot days will increase for both the 2021-2050 and the 2071-2100 periods. By the middle of the century, the number of hot days in northern Germany could increase by between 5 and 10, and southern Germany could see 10-15 more hot days. A maximum increase of 10-15 days (northern Germany) and 30-35 days (south-west Germany) by the end of the century is assumed. However, according to the projections made by individual climate models, there is also a slight probability that the number of hot days in Germany will remain essentially unchanged for the entire time horizon under consideration.

5.2. Methods and approaches to analysing the consequences of and vulnerability to climate change

Very different methodological approaches to analysing the impact of and vulnerability to climate change are used in Germany. A review of the literature in 2012 analysed 157 studies that were concerned in the broadest sense with assessing the consequences of climate change that can be expected in Germany. About 80% of the studies assessed were conducted between 2009 and 2012. The majority of the studies – around 60% – make statements about several sectors, but only a few studies aggregate the results of the analysis across sectors to create an overall index, for example.

Both statistical and dynamic regional climate models are used. Only studies that were developed after 2009 take ENSEMBLES into account when determining a climate signal. Most of them look at time frames up to 2100. A number of different IPCC scenarios are used, although A1B is most frequently selected as the reference scenario (followed by A2 and B1). Both statistical and model-based approaches are used to determine the consequences of climate change, depending on the sector under consideration. Most calculations of the potential future consequences of climate change use only climate projections, and socioeconomic background conditions such as demographics or land use are seen as constants. Most of the studies are quantitative in nature with qualitative elements; climate signals and consequences of climate change are usually calculated quantitatively using models or indicators. Adaptation capacity plays only a minor role in most of the studies and is included, if at all, in a qualitative way, for example in the form of expert surveys, so that they could be regarded as vulnerability studies.

In conclusion, it can be noted that there is a broad spectrum of conceptual approaches. A number of different basic approaches (IPCC 2007 vulnerability approach or risk approach), time frames (e.g., 2050, 2085, 2100), climate models, climate scenarios and regionalisation approaches etc. are used. Some of the studies use integrated models to estimate future impacts, while in others plausible assumptions are made based on analyses of recent data. Often the impacts were normalised for the individual geographic units, so that a comparison of the findings of the different studies is precluded, as is a transfer to other geographic levels. In considering the individual findings of the vulnerability studies, it becomes apparent that the results are highly dependent on the background conditions, primarily the sectors selected, as well as the study’s methodology and design (choice of evaluation criteria, formulation of the conclusions and stipulation of definitive conclusions or not).

Consequently, it is currently not really possible on the basis of existing studies to make comparative statements about the impacts of and adaptation to climate change in Germany beyond the boundaries of particular sectors or regions, which underlines the necessity of a standard methodology with comprehensive statements that cut across all sectors within Germany's adaptation strategy.

A nationwide, cross-sectoral and consistent method for analysing the impacts of climate change and vulnerability, which builds on these experiences, is currently being carried out. The concept therefore includes:

- A cross-sectoral approach that takes into account the interaction between sectors and includes all sectors within the German Strategy for Adaptation to Climate Change (2008)
- A geographic breakdown of the results (by county)
- A clear specification of the time frames under consideration and connections between the climate projections and socioeconomic scenarios for three time slices: present (1961-1990), near future (2016-45), distant future (2071-2100)
- The use of worst-, medium- and best-case climate projection data and socioeconomic scenarios to cover the entire spectrum of possible future scenarios
- A complete depiction of all the consequences and impact chains in all sectors, with no pre-selection of sectors or consequences of climate change as a result of data bottlenecks or for practical reasons connected with the amount of work involved
- The use – wherever possible – of quantitative, indicator-based data with qualitative predictions being used (a) to fill in gaps in quantitative data for the near future (2030) and (b) to include narrative qualitative knowledge for the distant future (2085)
- Consideration of adaptation capacity in quantitative terms wherever possible, otherwise qualitatively
- A discussion and transparent development of normative decisions by representatives of various higher federal authorities

As part of the German Strategy for Adaptation to Climate Change, the KLIWAS research programme (Impacts of climate change on waterways and navigation - Searching for options of adaptation), which was commissioned by BMVBS, is developing the essential data sets needed to put operationally feasible adaptation measures in place for transport infrastructure and is also developing and evaluating possible adaptation options. The ensemble approach, which KLIWAS has broadened to include hydrology issues, is of key importance for the implementation of the above-mentioned concept.

The purpose of the KLIWAS research programme is the assessment of climate-induced changes of flows and water levels in navigable inland waterways. In coastal waters, the question is how climate influences currents and tidal water levels and what consequences such variations may have for navigation. Other fields of interest are the span of such variations, their effects on the physico-chemical status (temperature, salinity, behaviour of contaminants) and ecology of waters, the economic consequences – especially for navigation – and ultimately the identification of options for the adaptation to changes.

The first step will build on ensemble findings based on several regional climate models and will estimate the regional effects of climate change. The second step will be to bias correct these results and then feed them into hydrological models; for inland waterways changes in flow are modelled and for coastal waters changes in tides, wave heights and lengths, and wind directions. In the third step, changes in sediment transport and the morphology of water bodies are modelled using hydrodynamic/morphodynamic models. At the same time, possible changes in water quality (such as temperature, oxygen content, algae formation) are identified. Changes in the morphology of water bodies and flow are in turn incorporated into models of safety and ease of navigation for inland shipping. At the same time, adaptation options are identified which could be used to adapt the waterways to the changes in conditions and thus keep them navigable even with reduced low flows. At the same time, an estimate is made of what the ideal number of cargo vessels on the Rhine would have to be to keep freight costs as low as possible under changed flow conditions. For coastal waters, coastal protection measures are analysed in terms of their effectiveness and possible external effects. At the end of what is known as the KLIWAS model chain are studies of climate-induced changes in the water chemistry, levels of contaminants in the sediments, pathogenic microorganisms in the water and sediments, shore vegetation and alluvial vegetation. An estimate is also made for inland waterways of the extent to which a change in “ice days” is likely as a result of climate change. As part of the research by KLIWAS, BMU is also funding a project on changes in contaminant patterns in inland waterways. The KLIWAS research programme looks at the periods 2021 to 2050 and 2071 to 2100 and compares them with the reference period 1961 to 1990. For each stage in the modelling process, as many models as possible are used to make it possible to assess the range of changes and thus the uncertainties with regard to the impact of climate change.

KLIWAS’s results, including the data acquired, will be extensively publicized to make them available for further research work.

There are plans to use the KLIWAS approach for all modes of transport in Germany, making it possible to estimate, for example, the vulnerability of the entire transport infrastructure. This is essential if adaptation measures are to be put in place to minimise the economic consequences of large-scale events (such as flooding of the Elbe, Danube, and Weser in 2013, for example).

5.3. Approach to developing the German Strategy for Adaptation to Climate Change

The German government sees adaptation to the effects of climate change as something that needs to be tackled in the future by the whole of society and as something that requires individuals, businesses and the government to take action. In 2008, the German Strategy for Adaptation to Climate Change (DAS) set the framework for a medium-term national process to:

- Identify the risks associated with climate change
- Specify the need for action
- Define goals
- Develop and implement possible adaptation measures

DAS’s overarching aim is to reduce the country’s vulnerability to the effects of climate change and maintain or increase its adaptation capacity. The Adaptation Action Plan

(APA), adopted by the federal cabinet on 31 August 2011, fleshes out the German Strategy for Adaptation to Climate Change with specific activities to be undertaken by the federal government over the next years (see 5.5). To draw up and develop the strategy, two formal bodies were created in 2007, each headed by the Federal Environment Ministry as chair or co-chair: the Interministerial Working Group on Adaptation to Climate Change (IMA), made up of representatives from all the federal ministries, and a joint federal government/Länder working group (AFK), which assists the Conference of German Federal and Länder Environment Ministers and meets twice a year (see also 3.4.6). Both bodies ensure horizontal (IMA) and vertical (AFK) policy integration of the resolutions relating to the German Strategy for Adaptation to Climate Change. The different responsibilities in Germany's federal system should be pointed out here: in recent years, it has become obvious that powers and responsibilities in the field of adaptation to climate change lie only partially with the federal government. The implementation and execution of climate change adaptation measures are often the responsibility of the Länder and/or local authorities. The number of climate change adaptation activities undertaken by the Länder, and increasingly by local authorities, has risen considerably. They range from policy strategies through to the implementation of extensive research projects (see also section 3.5).

DAS sometimes describes the effects of climate change and options for action from a sector-specific and sometimes from a cross-sectoral angle. It includes 15 fields of action such as water management/flood protection/coastal protection, soil, land and forest management, energy, finance, transport, tourism, civil defence and disaster management, regional planning and Germany's international responsibility for worldwide climate change adaptation activities.

DAS takes an integrated approach that identifies the need for action on a step-by-step basis and develops adaptation measures in conjunction with the responsible stakeholders. The measures are based on principles of subsidiarity and proportionality, openness and cooperation. The strategy is knowledge-based, yet at the same time focused on the precautionary princible. The intention is to take it forward in such a way that is flexible enough for adjustments to be made whenever new insights emerge. It is envisaged that the Adaption Strategy and Action Plan will be updated.

5.4. Evaluating the effects of climate change and vulnerability

Knowledge of the possible scope of the effects of climate change and awareness of possible areas of vulnerability in Germany has grown enormously since the 5th National Communication. Key projects within the work on the Adaptation Action Plan (see section 5.5) are seeking to develop a methodology for vulnerability appraisals and preparation of a vulnerability analysis for Germany (see also section 5.2). They are currently still ongoing.

5.5. Adaptation measures

In August 2011 the federal cabinet passed the Adaptation Action Plan, which was a key milestone for the German Strategy for Adaptation to Climate Change of December 2008. The Action Plan supports the goals and options for action set out in the German Strategy for Adaptation to Climate Change with specific activities to be carried out by the federal government in the future. The idea is that that the Strategy and the Action Plan be continually updated on the basis of these activities. Key elements of this include work on the indicators report, which is intended to describe the status of the effects of climatic changes in the various fields of action, analysis and evaluation of Germany's vulnerability and, based on that, identification of the action that needs to be taken at federal level. The Adaptation Action Plan contains activities in four areas:

Making knowledge available, providing information, playing an enabling role

This area comprises initiatives by the federal government to expand knowledge bases, provide and communicate information, expand the research and information infrastructure and support stakeholder dialogue, participation and networking.

The federal government sets the framework

This area specifies projects with which the federal government provides or reviews incentives for adaptation and lays the necessary foundations, which include legal and technical enabling environments, standardisation and funding policy. In this way it supports stakeholders.

Activities for which the federal government has direct responsibility

This area illustrates how the federal government intends to take climate change into consideration in its role as the owner of land, property and infrastructure or as property developer. The Action Plan contains, for example, proposals for incorporating adaptation aspects into the evaluation system used to ensure that sustainable construction methods are used for federal buildings and for planning, management and maintenance of transport infrastructure.

International responsibility

This field describes Germany's contributions to designing and implementing the Adaptation Framework adopted in Cancun in the context of the United Nations Framework Convention on Climate Change, in its development cooperation activities, through the International Climate Initiative, in its research cooperation and through other international activities carried out by government departments in the field of adaptation to climate change. References to activities at EU level are also made.

One of the Adaptation Action Plan's main goals is to strengthen stakeholders' ability to take action at all relevant levels and increase their capacity to take preventive action themselves. This means that federal government activities need to be complemented by measures by the Länder and local authorities. These are listed in table form in Annex 1 of the Adaptation Action Plan.[88]

[88] German federal government 2011.

6. Financial support and technology cooperation

The German government has further increased its funding to support developing countries in reducing greenhouse gases (GHG), adapting to the effects of climate change, and forest and biodiversity conservation (including REDD+) up to 2012. Technology transfer and capacity building are components of virtually all the government's bilateral cooperation projects. In this way, the government is meeting its commitments under the United Nations Framework Convention on Climate Change to provide new and additional funds. At the Conference of the Parties in Copenhagen at the end of 2009, the industrialised countries pledged to provide additional public funds amounting to USD 30 billion for 2010 to 2012 in what is known as fast-start finance for developing countries. The German government's contribution to this totals €1.289 billion. Since there is no universally accepted definition of "new and additional", Germany has defined additionality with regard to its fast-start pledge as follows: the funds represent an increase over climate-related funds in 2009 and come from an innovative source of finance such as revenue from emissions trading.

The aim was for Germany's fast-start funds to be allocated in a balanced way to projects on emissions reduction, adaptation to climate change and forest and biodiversity conservation (including REDD+). The fast-start finance was made available through the Federal Environment Ministry's International Climate Initiative (IKI) and through the Federal Ministry for Economic Cooperation and Development's (BMZ) international development activities.

The federal government uses a broad range of instruments and institutions for its international cooperation activities in the field of climate and development:

- Bilateral financial and technical cooperation
- Multilateral cooperation such as the Climate Investment Funds, the Kyoto Protocol's Adaptation Fund, the Global Environment Facility, the Forest Carbon Partnership Facility, and various multilateral development banks and UN organisations

Support for mitigation, adaptation and forest and biodiversity conservation (including REDD+) in developing countries is integrated into Germany's cross-cutting development cooperation strategies and programmes. The International Climate Initiative (IKI) has complemented the federal government's existing cooperation activities since 2008. In implementing it, the government takes guidance both from the resolutions of the Parties to the United Nations Framework Convention on Climate Change and from the principles of the Paris/Accra/Busan Agenda to increase aid effectiveness (which include ownership by the partner countries, using the institutions and procedures in the partner countries, coordination among donors, results orientation and mutual accountability on the part of partners and donors).

6.1. Bilateral cooperation

Within its bilateral cooperation activities the German government supports its partner countries in their efforts to reduce their greenhouse gas output and carry out measures to adapt to the effects of climate change. Forest and biodiversity conservation also play an important role. The main approaches include:

- Investment measures that support the transition to a climate-friendly economy and adaptation to the effects of climate change
- Cooperation on building and strengthening institutional and human resource capacities (capacity building)
- Technology cooperation with a focus on transfer of know-how

The International Climate Initiative (IKI) has funded projects with a total funding volume of €860 million (as at March 2013) since 2008. The main focus is on strengthening capacities in partner countries and promoting dialogue on climate policy.

Since 2009, the Federal Ministry for Economic Cooperation and Development's (BMZ) has significantly increased its bilateral climate-relevant commitments in development cooperation with partner countries from €845 million to €1.3 billion (2011) per year. The direct objective of many development cooperation projects is to promote reduction of greenhouse gas emissions and adaptation to climate change. Furthermore, climate considerations are included as a matter of course in development cooperation activities as cross-cutting issues. The activities are devised as part of a dialogue between partners and in compliance with the Paris/Accra/Busan Agenda.

6.1.1. Cross-sectoral initiatives

A number of cross-sectoral initiatives support international climate protection. BMZ and BMU consult closely on their implementation. They prioritise different areas and are described in more detail below.

6.1.1.1. International Climate Initiative - IKI

The German government (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety- BMU) launched its International Climate Initiative (IKI) in 2008. It is active in four areas: mitigating greenhouse gases, adaptation to the effects of climate change, conserving natural carbon sinks with a special focus on reducing emissions from deforestation and forest degradation (REDD+) and conserving biodiversity. BMU uses this instrument to strengthen the federal government's cooperation on climate issues with developing countries, emerging economies and transition countries.

In line with a Bundestag resolution, the International Climate Initiative receives €120 million in funding from the federal budget. BMU also receives funding for cooperation on climate issues from the federal government's Special Energy and Climate Fund (EKF), which is financed from revenue from the auction of emissions allowances.

Between IKI's launch and March 2013, BMU supported 336 projects with total funds of €860 million. Additional funds provided by the institutions carrying out the projects, along with further private and public-sector finance (such as co-financing from the European Union for certain projects), bring the total volume of funding for IKI projects to over €2.4 billion.

6.1.1.2. Initiative for Climate and Environmental Protection - IKLU

The Initiative for Climate and Environmental Protection (IKLU) was launched in 2008 by BMZ and the Kreditanstalt für Wiederaufbau (KfW). It continues the work of the Special Facility for Renewable Energies and Energy Efficiency, which was created in 2005. Between 2008 and 2012, €6.7 billion was committed for climate and environment-related investment in developing countries in the form of concessional loans through the IKLU Facility. Areas funded by IKLU are:

- Renewable energy: investment in the expansion of renewable energy, such as wind power, biomass, solar energy, geothermal and hydropower
- Energy efficiency: investment in improving energy efficiency, for example, in generation, in transmission and distribution of energy, or in the rational use of energy in trade and industry and private households
- Industrial environmental protection: investment in environmental protection in small and medium-sized enterprises and in industrial parks
- Low-energy transport: investment in energy-efficient transport systems, such as rail and bus transport

6.1.1.3. Special Energy and Climate Fund (EKF) – international climate and environmental protection

Additional funding for international climate and environmental protection measures has been available to the federal government since 2011 through the Special Energy and Climate Fund (EKF) (see section 3.2.2), which is jointly managed by BMZ (55%) and BMU (45%). In 2011 and 2012, €53 million in cash funds was made available and new commitments of €1.8 billion (including market finance) were authorised. The funds are used in the following areas:

- The German Climate Technology Initiative
- Climate change adaptation activities, including the involvement of German civil-society organisations in partner countries - see chapter 6.1.3
- Biodiversity/forests; see section 6.1.2

<u>German Climate Technology Initiative</u>

The German Climate Technology Initiative was set up in 2011. Within the federal government, BMZ and BMU have joint responsibility for policy and implementation. The Initiative aims to accelerate the spread of technologies to reduce greenhouse gases in emerging economies, developing countries and transition countries. The fields of technology it focuses on are renewable energy, energy efficiency in industry and buildings, smart grids, waste management and climate-friendly transport.

The German Climate Technology Initiative integrates the various instruments of technical and financial cooperation. It uses low interest loans to create special leverage for climate protection. Ten projects with a volume of €1.16 billion were approved in 2011 and 2012.

6.1.2. Financing and technology transfer for mitigation activities

6.1.2.1. Energy

Cooperation in the field of energy aims to achieve an energy transition in emerging economies and developing countries with a shift towards a sustainable, low-emission and climate-resilient energy supply structure.

To reduce dependence on fossil fuels and lower the output of greenhouse gases, the German government supports the use of renewable energy, endeavours to increase energy efficiency and the dissemination of sustainable, decentralised energy production technologies. It does this through investment and by providing know-how transfer and policy advice in partner countries.

The German government has launched numerous new initiatives in the field of energy and made extensive funding available in recent years: As at December 2012, 182 projects in the field of greenhouse gas mitigation are being funded under the International Climate Initiative (IKI). Energy is one of the five priority areas of BMZ's development policy. In this reporting period, BMZ has supported bilateral energy projects in over 60 partner countries. Most of BMZ's funding is allocated to energy projects. Energy partnerships and energy forums, during which intensive discussions of policy environments and efficient funding mechanisms are held, are important bilateral instruments for advising developing countries and emerging economies on energy policy. They also provide platforms for involving the private sector and civil society. Cooperation in technical working groups can lead to cooperation projects being instigated (for example, as part of the International Climate Initiative or development cooperation). In this way, a link between the project level and policy dialogue is established.

The German government has energy partnerships with Morocco and Tunisia and an institutionally well-established energy forum in India, which, in addition to technical sub-working groups, also has a permanent liaison office in Delhi.

6.1.2.2. The transport sector

Transport is becoming an increasingly high priority in climate protection. Sustainable development is virtually impossible without a well-functioning traffic and transport system. However, the high volume of road traffic in the transport system is causing a sharp rise in greenhouse gas emissions in many developing countries. One of German development cooperation policy's aims is therefore to increase energy efficiency in the transport sector and promote modes of transport that are less harmful to the environment. The German government is supporting the establishment and expansion of public transport systems in developing countries and emerging economies, along with the introduction of regulations and measures for environmentally friendly transport, making vehicle fleets more energy efficient and environmentally sound and improving transport planning in towns and cities.

Through the International Climate Initiative, the federal government funds, for example, the development of strategies for low-carbon transport in India, emissions reduction strategies in the transport sector as a Nationally Appropriate Mitigation Action (NAMA) in a number of countries, including Colombia, Indonesia, Mexico and South Africa, and efforts to link climate protection and electromobility in China. A total of eight projects on this subject have been funded since 2008.

BMZ's funding in the transport sector focuses on investment in environmentally sound public transport.

6.1.2.3. Forest conservation

Forests are of great importance in the global carbon cycle, both as a sink and a source. Deforestation and degradation is responsible for about 17% of global anthropogenic greenhouse gas emissions. Without efficient conservation of tropical forests, it will not be possible to keep global warming below 2°C. With this in mind, the federal government's international forest policy aims to contribute to halting deforestation and further forest degradation and to preserving forests as greenhouse gas sinks. The German government greatly increased its support for forest conservation programmes from 2008 to 2012. The funds came from headings in the budgets of BMZ, BMU and BMELV and from the Special Energy and Climate Fund (EKF).

Since the International Climate Initiative began, 93 projects dealing with the conservation and sustainable use of natural carbon sinks have been funded. Projects on reducing emissions from deforestation and degradation (REDD+) have featured strongly in IKI's funding portfolio since 2010, i.e. since the beginning of fast-start finance.

The German government is providing funding in several partner countries to implement the international REDD+ mechanism. One of the aims is to gain insights from demonstration projects that can be used in the future to refine the REDD+ mechanism to be agreed under the United Nations Framework Convention on Climate Change (UNFCCC).

The German government also supports the World Bank's Forest Carbon Partnership Facility (FCPF). The government's REDD Early Mover Programme (REM) targets pioneers who have already driven forward forest and climate protection on their own initiative and have received results-based payments at national or individual state level. The programme is being implemented by the KfW development bank and the technical advisory organisation GIZ.

6.1.3. Adaptation to climate change

Developing countries are the ones most severely affected by rising temperatures, changing precipitation patterns, rising sea levels, accelerated glacier melt and an increase in extreme weather events such as droughts, flooding and storms. Depending on the individual case, the geographical location, the pre-existence of an extreme climate, high economic dependence on agriculture, poverty, and weak government and institutions can make a state and its society highly vulnerable to climate change. Climate change affects natural resources such as water, forests and soil first and foremost. It impacts on agricultural and industrial production, income and food security. It can be responsible for higher prices for water and other resources, damage to infrastructure, economic losses and the loss of biodiversity and new threats to human health and can aggravate the imbalance that already exists. It can hamper development and progress or even destroy progress that has already been made.

For this reason, Germany sees supporting developing countries to adapt to climate change as an important task. This international responsibility is one of the four pillars of the German Strategy for Adaptation to Climate Change (2008) and of the Adaptation Action Plan designed to implement it (2011). The federal government also regards adaptation to climate change as a cross-cutting issue for German development cooperation.

In the field of adaptation to the effects of climate change, the federal government – through the International Climate Initiative – supports countries and regions that are particularly vulnerable to climate change in increasing their capacity to adapt to its effects. Funding prioritises the ecosystem-based adaptation approach. IKI projects also help to design and implement national adaptation strategies. They also develop strategies and instruments for managing risks connected with the effects of climate change.

BMZ and BMU finance their activities in this field from their own budgets and also from the Special Energy and Climate Fund (EKF).

6.1.3.1. Integrating adaptation into national development planning and building adaptation capacities

Adapting to the effects of climate change means reviewing decisions and priorities in many areas on the basis of what is often limited knowledge about vulnerabilities, the risks associated with climate impacts and adaptation options. Preparing adaptation measures requires good planning. The following areas are important in this:

- Advice on drafting national and sectoral adaptation strategies and integrating them into development strategies (such as designing participation processes and using particular procedures for prioritising adaptation needs) and subnational adaptation strategies (such as incorporating climate change factors into local authority planning processes) and on designing regional programmes
- Support for national and sectoral investment and funding planning for short-, medium- and long-term infrastructure investment and development planning
- Generating climate and vulnerability information and training planners and experts from the public sector and civic society
- Advice on risk identification and management
- Building capacity and strengthening institutions to enable them to implement adaptation strategies (such as strengthening intersectoral coordination mechanisms)
- Strengthening the private sector to enable them to take into account the business risks and opportunities brought about by climate change (such as development of appropriate financial products)
- Promoting and establishing cooperative activities with the private sector and academia in partner countries in order to mobilise expertise and resources for adaptation to climate change

6.1.3.2. Agriculture/food security, land degradation

Agriculture is particularly affected by the effects of climate change. Climate change can increase land degradation and have a negative effect on agricultural productivity. The main problems are unavailability of water, temperatures exceeding the upper limits that crops can tolerate, droughts, changing precipitation patterns and soil erosion. These problems are made worse by the overuse of forests and soil, cultivation systems that have little diversity and are thus more susceptible, improper use of fertilisers and pesticides, changes in people's eating habits and rising population pressure. The most important target group consists of small farmers, who produce the vast majority of food in developing countries.

The following areas are important in Germany's international cooperation activities:

- Research on climate change and its effects on agriculture
- Policy advice on increasing productivity and resource efficiency in agricultural production and processing; adapting policies in the agricultural sector to the challenges of climate change
- Technical advice to small farmers on adaptation to climate change and reducing environmental degradation, by using sustainable cultivation methods, for example, which conserve resources and do not damage the climate, changing the varieties cultivated, terracing and use of micro-catchment systems or switching from annual crops to plantation farming and from arable to livestock farming (or vice-versa, using locally tried and tested agricultural adaptation strategies
- Promoting access to financial and technical services for small farmers (such as drought early warning systems, building climate expertise in agricultural advisory services, access to loans and weather and crop failure insurance)
- Water and agriculture: tackling water scarcity by using water more efficiently and by integrated water resource management (see below), improving the soil water balance and creating economic incentives to save water. More efficient irrigation systems will be a key factor in food security. Climate protection aspects must be taken into account.

6.1.3.3. Water

Precipitation and evaporation are changing as a result of climate change. The declining availability and quality of water is impacting negatively on food security, health and energy production. Poor people are particularly hard hit and conflicts may result. The measures described below can be taken to assure sustainable development, effective poverty reduction, preservation of ecosystems and biodiversity.

Integrated water resource management (IWRM) is designed to facilitate sustainable management of surface waters, groundwater and in some cases coastal waters. Monitoring programmes, modelling and analysis must be used to improve collection of data on hydrology and climate and the ability to make forecasts, and cross-sectoral plans must be developed. Practical measures include surface and groundwater resources protection, source and erosion protection, infiltration and reafforestation. This is flanked by advice on water sector reforms, legislation, cross-sectoral planning and possibly cross-border water management.

Improving municipal water management: access to water – especially for poor people in slums – can be made possible and safeguarded by improving water distribution, reducing water losses and promoting a sustainable water supply and provision of sanitation. Regulation, charging systems, and participatory management structures improve supply management. Efficient use of water in industry, treating wastewater for use in agricultural use or as drinking water and waste management protect water resources. This helps to overcome periodic and climate-induced bottlenecks and reduce supply risks.

Flood management: acceleration of the hydrological cycle caused by global warming can be slowed down again by expanding water storage facilities. Construction schemes such as dams, dykes, reservoirs, flood plains, efficient discharge of excess water, groundwater replenishment and rainwater collection should be flanked by disaster preparedness measures (see below). The aim is to avoid flood damage, use water's energy and build up reserves for use during periods of drought.

6.1.3.4. Ecosystem-based adaptation (EbA)

Ecosystems perform important services for people. For example, they preserve soil fertility, provide clean water and protect against flooding and erosion. These ecosystem services can also help to mitigate the impact of climate change on people. The concept of ecosystem-based adaptation (EbA) is therefore concerned with using biodiversity, natural resources and their ecosystem services to increase people's capacity to adapt to the negative effects of climate change. EbA is thus a people-focused approach that sees natural resources as complementing or replacing other adaptation measures. Unlike the traditional approaches in the field of management of natural resources and biodiversity, EbA explicitly places current and future changes in climate and their effects on people and ecosystems at the centre of its endeavours. EbA measures are often relatively cost-effective adaptation options. For example, restoring ecosystems often costs less than technical solutions.

In practice, EbA is usually part of a more comprehensive adaptation strategy and can be proactively integrated into existing planning processes, for example in the field of land use. Concrete measures include conserving or restoring mangroves and coral reefs and protecting coastal zones from fiercer storms and the effects of a rise in sea level. However, EbA measures may also call for difficult decisions, for example when protected areas restrict the use of resources. For that reason, risk assessments, scenario planning and approaches to adaptation management should always be part of the decision-making process.

The German government funds projects that develop strategies for using ecosystem services in adaptation to the effects of climate change. They advise partner countries on integrating the EbA approach into their planning processes and implementing it. Model projects test EbA measures and process and disseminate the results. The experience gained is then fed into the international negotiation processes under the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change.

6.1.3.5. Management of the risks associated with climate change - disaster preparedness, innovative insurance schemes

Extreme weather events are responsible for increased flooding of large areas, cyclones and landslides – especially in developing countries. Countless people lose their lives each year and entire families lose their livelihood. The damage to the economy is vast, and developing countries have few reserves to enable them to cope with and recover from these losses.

Disaster preparedness includes averting the dangers of climate change and limiting the damage. Disaster risk reduction (DRR) measures set the issue in the context of adaptation to climate change. As a signatory to the Hyogo Framework for Action, Germany supports developing countries in their endeavours to take precautions to protect critical infrastructure such as schools, hospitals and power stations. This includes risk-sensitive urban planning, designating danger zones and ensuring that people settle in safe areas.

Innovative insurance schemes that provide cover against extreme weather events can lower risks and provide financial support to people forced to start afresh. Insurance products that are linked to preventive measures for adaptation to climate change can both reduce potential damage in the event of a disaster and insure against any damage that cannot be prevented. For the insurance schemes to work, reliable meteorological data, a legal framework and information sharing between policy-makers and insurance providers have to be in place. Close cooperation between the private sector and governments is intended to give people in affected areas risk management strategies to provide income and food security and opportunities to gain access to loans and employment in times of climate change.

6.1.4. Integrating climate considerations into the planning and development of Germany's international cooperation activities

In 2009, BMZ introduced a Climate Assessment tool to complement Environmental Impact Assessments and ensure that climate change is taken into consideration in all Germany's development cooperation strategies and programmes. On 1 January 2011, these two instruments were replaced by comprehensive guidelines on assessing environmental and climate considerations and incorporating them into the government's bilateral development cooperation activities. Compliance with these guidelines is mandatory for BMZ and the organisations implementing Germany's development policy. Their aim is to ensure that negative impacts on the environment and the climate are reduced or prevented entirely when planning and implementing development strategies and measures. There is also a requirement to analyse potential for improving environmental quality and avoiding greenhouse gases when designing measures and to exploit that potential when implementing them. Finally, the impacts of climate change must be taken into consideration to ensure that the positive effects of the measures are not jeopardised.

In this way, climate considerations are systematically taken into account at the strategic level. At the operational level, climate considerations are assessed and taken into account in greater detail and then integrated into the programmes when they are fleshed out. Implementation of the guidelines was reviewed in 2012. They will be revised to improve their effectiveness and efficiency in 2013.

6.1.5. Table giving an overview of bilateral development-related climate finance

The tables at the end of this chapter give a detailed description of the extent of Germany's development-related bilateral climate finance from 2007 to 2011. For 2007 to 2009, the information is presented to comply with the UNFCCC's 1999 Guidelines for reporting and review by recipient country and sector. From 2010 onwards, the information is depicted in line with the common tabular format adopted at the 18th Conference of the Parties to the United Nations Framework Convention on Climate Change in Doha in December 2012 for the biennial reports to be submitted by Annex I countries (Table 7 (b)). This is described in “Provision of public financial support: contribution through bilateral, regional and other channels in 20XX-3”. It is thus project-specific.

The statistical data covers all development-related projects for which a commitment to provide bilateral climate finance was made in the year in question. Only commitments from the public budget are classified as climate finance.

For 2007-2010, the climate relevance of BMZ projects was calculated by multiplying the total funding volume in a project by either 25%, 50%, 75% and 100%. The percentage used is based on experience and depends on the sector in which the project was implemented (such as agriculture or energy production and supply).

From the 2011 reporting year onwards, the level of climate finance is set on the basis of the climate markers (Rio markers) of the OECD (Organisation for Economic Cooperation and Development). A distinction is made between climate change mitigation-related (Rio marker 2) and climate change adaptation-related (Rio marker 4). The Rio markers are scored differently depending on the project’s objective. If one of the project’s principal objectives is greenhouse gas reduction or adaptation to climate change, the project is given a score of 2 and consequently 100% of the funding is allocated to the particular climate area. If mitigation or adaptation is only a secondary objective, the Rio marker is scored as 1 and only 50% of the funding is allocated to the particular climate area. Projects that receive a 0 score do not make a significant contribution to climate change mitigation or adaptation and therefore do not contain climate-related funding. The total scores for the climate markers awarded for a project may not exceed 2. For example, a project that has “mitigation of greenhouse gases” as its principal objective (score of 2) cannot have “adaptation to climate change" as a secondary objective (score of 1). This rules out the project being counted twice as climate finance (double counting). Projects in the field of forest and biodiversity conservation including REDD+ (Rio marker 1) are also counted as climate finance on the basis of the specific climate markers.

This report shows only the climate-relevant amounts for all reporting years between 2007 and 2011. Consequently, the figures in the tables giving an overview of bilateral development-related climate finance in the Annex to this report show only the funding that is counted as climate finance (25%, 50%, 75% or 100% depending on the project or programme).

The total amounts of bilateral development-related climate finance can be seen in Figure 33. Bilateral development-related climate finance for 2010 is depicted in detail in Table 68Table 68. The overviews of bilateral development-related climate finance in 2007, 2008 and 2009 will be submitted in the first quarter 2014. The detailed tables for 2011 and 2012 can be found in the Biennial Report in the Annex to this report.

Figure 33: Germany's bilateral development-related climate finance

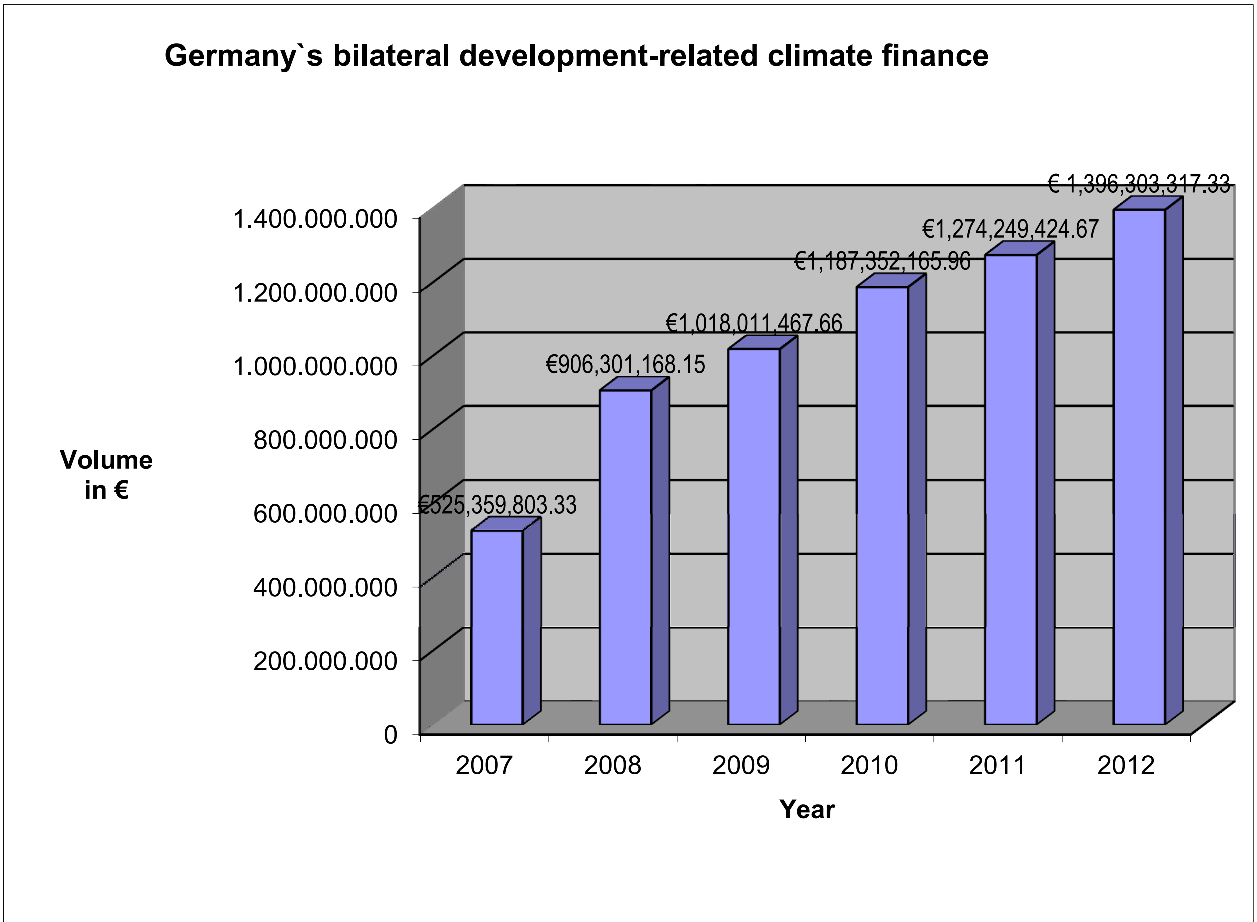


Table 68: Overview of bilateral development-related climate finance in 2010 (in euros and US dollars)

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Region Africa						
Africa regional	Infrastructure Trust Fund for Africa (ITF)	4,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Africa regional	Fast-start finance for adaptation to climate change in Africa	2,100,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Africa regional	Improving the conditions of small-scale cocoa farmers in West Africa	825,000.00	Grant	Adaptation	Agriculture	GIZ
Algeria	integrated water management	1,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Benin	Water supply and sanitation programme PBA III	10,500,000.00	Grant	Adaptation	Water and sanitation	KfW
Benin	Pendjari national park trust fund	10,000,000.00	Grant	Other	Other: Biodiversity	KfW
Benin	Promotion of agriculture	6,750,000.00	Grant	Adaptation	Agriculture	GIZ
Benin	Water supply and sanitation programme	1,500,000.00	Grant	Adaptation	Water and sanitation	GIZ
Burkina Faso	Agricultural development programme	750,000.00	Grant	Adaptation	Agriculture	GIZ
Burundi	Sector programme on water supply and sanitation II b	1,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Burundi	Burundi - Rwanda transmission line	3,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Burundi	Ruzizi-Bujumbura transmission line	15,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Cameroon	Sustainable resource management in Cameroon	10,000,000.00	Grant	Other	Other: Environmental protection	KfW

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Cameroon	Basket finance for the forest sector	25,500,000.00	Grant	Other	Forestry	KfW
Cameroon	Programme to support the implementation of the national forest programme (PSFE)	15,500,000.00	Grant	Other	Other: Environmental protection	GIZ
Commission des Forêts d'Afrique Centrale (COMIFAC)	Sustainable forest management in the Congo basin - TNS environment foundation	20,000,000.00	Grant	Other	Forestry	KfW
Congo basin regional	Sustainable forest management in the Congo basin - regional support for COMIFAC	4,500,000.00	Grant	Other	Other: Biodiversity	GIZ
DR Congo	Biodiversity conservation and sustainable forest management	20,000,000.00	Grant	Other	Other: Biodiversity	KfW
DR Congo	Rehabilitation of the hydropower plant INGA II	40,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
DR Congo	Sector programme on water/sanitation (PROSECO)	5,000,000.00	Grant	Adaptation	Water and sanitation	KfW
DR Congo	Sector programme on water/sanitation (PROSECO)	3,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
DR Congo	Biodiversity conservation and sustainable forest management	7,000,000.00	Grant	Other	Other: Environmental protection	GIZ
East Africa regional	Support for the East Africa Geothermal Initiative	20,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Egypt	Programme to rehabilitate hydropower plants	5,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Egypt	Water supply/sanitation in Upper Egypt	1,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Egypt	Water supply/sanitation in Upper Egypt	10,750,000.00	Loan[1]	Adaptation	Water and sanitation	KfW
Egypt	Renewable energy programme - wind farm in the Gulf of Suez	19,500,000.00	Grant	Mitigation	Energy generation and supply	KfW
Egypt	Energy efficiency programme	2,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Egypt	Egyptian-German committee to promote renewable energy, energy efficiency and environmental protection	3,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Egypt	Water supply and sewage management programme	5,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Egypt	Water sector reform programme	4,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Egypt	Energy efficiency in the water and wastewater sector	2,500,000.00	Grant	Mitigation	Water and sanitation	KfW
Egypt	Promoting investment in environmental protection within the Private Public Sector Industry Project (PPSI II)	2,000,000.00	Grant	Adaptation	Other: Environmental protection	KfW
Egypt	National household waste management programme	1,500,000.00	Grant	Mitigation	Other: waste management	KfW
Ethiopia	Sustainable land management	1,875,000.00	Grant	Adaptation	Agriculture	GIZ
Ghana	Promoting renewable energy	1,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Kenya	Developing the water and sanitation sector - Lake Victoria South	16,500,000.00	Loan1	Adaptation	Water and sanitation	KfW
Kenya	Promoting the private sector in small scale irrigation for agriculture in western Kenya	11,250,000.00	Grant	Adaptation	Agriculture	KfW
Kenya	Programme to develop the water and sanitation sector - Lake Victoria South	500,000.00	Grant	Adaptation	Water and sanitation	KfW
Kenya	Programme to develop the water and sanitation sector	6,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Kenya	Risk management strategies for adaptation to the impacts of climate change in agriculture in the Kenyan highlands	2,250,000.00	Grant	Adaptation	Agriculture	GIZ
Lake Chad basin, regional	Sustainable water management in the Lake Chad basin	2,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Lake Chad basin, regional	Sustainable water management Lake Chad basin	2,000,000.00	Grant	Adaptation	Water and sanitation	BGR
Liberia	West African Power Pool - WAPP	26,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Mauritania	Resource management	6,000,000.00	Grant	Other	Agriculture	KfW
Mauritania	Funding the Banc d´Arguin national park	5,000,000.00	Grant	Other	Other: Biodiversity	KfW

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Mauritania	Programme on management of natural resources	6,600,000.00	Grant	Other	Other: Rural development	GIZ
Mauritania	Sustainable management of fishery resources	750,000.00	Grant	Adaptation	Fisheries	GIZ
Morocco	Solar power plant	10,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Morocco	Integrated water resources management	2,800,000.00	Grant	Adaptation	Water and sanitation	GIZ
Morocco	Advisory input for Morocco's solar plan	3,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Morocco	Adaptation to climate change	287,500.00	Grant	Adaptation	Other: Environmental protection	GIZ
Morocco	Nature conservation and combating desertification	131,250.00	Grant	Adaptation	Other: Environmental protection	GIZ
Morocco	Increasing efficiency in the drinking water supply system	4,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Morocco	Promoting wind energy and other renewables in Morocco (Plan Solaire)	1,500,000.00	Grant	Mitigation	Energy	Investitionsbank Schleswig-Holstein (IB-SH)
Mozambique	Adaptation to climate change in Mozambique des Rio Chiré region that borders Malawi/Mozambique) by setting up a flood warning model in flood disaster-prone areas	300,000.00	Grant	Adaptation	Other: Flood protection	GIZ
Namibia	Renewable energy for the Lower Orange River, Namibia	8,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Niger	Poverty reduction in Tillaberi and Tahoua Nord (LUCOP)	1,500,000.00	Grant	Adaptation	Other: Rural development	GIZ
Nigeria	Expansion of renewable electricity generation	35,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Nigeria	Advising on energy policy in Nigeria	9,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
North Africa regional	Adapting water supply systems to climate change	3,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Sahel zone regional	Sahel Facility	10,700,000.00	Grant	Adaptation	Agriculture	KfW
Sao Tome and Principe	Electrification of rural regions in Sao Tomé	95,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Senegal	Programme to promote rural electrification and sustainable provision of fuels for households	1,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
South Africa	Renewable energy and energy efficiency	20,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
South Africa	Renewable energy programme in Southern African Power Pool (SAPP) III	7,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
South Africa	Open energy efficiency programme	14,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
South Africa	Priority programme on climate and energy	10,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Southern Africa regional	Transboundary water supply - Kunene	2,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Southern Africa regional	Transboundary conservation and use of natural resources in the SADC region (Southern African Development Community) and strengthening capacity and expertise at the Food Security, Agriculture and Natural Resources Directorate (FANR)	5,000,000.00	Grant	Other	Other: Biodiversity	GIZ
Southern Africa regional	Cross-border water management in SADC	6,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Sudan	Development of the urban water and sanitation sector in South Sudan	500,000.00	Grant	Adaptation	Water and sanitation	GIZ
Tunisia	Promotion of renewable energy and energy efficiency	2,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Tunisia	Municipal waste landfill III	1,750,000.00	Loan1	Mitigation	Other: waste management	KfW
Tunisia	Municipal waste landfill III	500,000.00	Grant	Mitigation	Other: waste management	KfW
Uganda	Programme to promote renewable energy and energy efficiency IV	20,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Uganda	Support for the Water and Sanitation Development Facility	10,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Uganda	Programme to develop the water and sanitation sector II	10,000,000.00	Grant	Adaptation	Water and sanitation	KfW

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Uganda	Programme to develop the water and sanitation sector	6,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Uganda	Programme to promote renewable energy and energy efficiency	6,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
West Africa regional	Promoting agribusiness	6,000,000.00	Grant	Adaptation	Agriculture	KfW
Zimbabwe	Municipal water supply and sanitation	2,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Total region Africa		589,963,750.00				
Region Asia /Middle East/Southeast Europe						
Afghanistan	Urban water supply in northern Afghanistan	5,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Afghanistan	Water supply Kabul II	5,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Afghanistan	Using renewable energy to decentralise the electricity supply system	5,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Afghanistan	Connecting northern towns and villages to the grid	30,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Afghanistan	Using renewable energy to decentralise the electricity supply	4,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Afghanistan	Improving the water supply	3,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Albania	400 kV transmission line Albania - Macedonia	5,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Albania	Municipal infrastructure II programme	1,500,000.00	Grant	Adaptation	Water and sanitation	KfW
Albania	Water sector reform	1,500,000.00	Grant	Adaptation	Water and sanitation	GIZ
Albania	Environmental protection programme for Lake Ohrid - sanitation in Pogradec	2,000,000.00	Loan1	Adaptation	Water and sanitation	KfW
Albania	Waste disposal in south-east Albania	2,700,000.00	Grant	Mitigation	Other: waste management	KfW
Armenia	Programme to promote renewable energy and energy efficiency III	6,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Asia	End-user finance for access to clean energy technologies in South and South-East Asia (FACET)	5,000,000.00	Grant	Mitigation	Cross-cutting	UNEP
Asia regional	ASEAN biodiversity centre - biodiversity and climate change	3,200,000.00	Grant	Other	Other: Biodiversity	GIZ
Asia regional	Fast-start finance for adaptation to climate change in Asia	2,700,000.00	Grant	Adaptation	Other: Rural development	GIZ
Azerbaijan	Programme prioritising energy. Component: open programme to promote renewable energy	14,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Azerbaijan	Programme prioritising the environment. Component: climate-friendly waste management	2,000,000.00	Grant	Mitigation	Other: waste management	KfW
Bangladesh	Climate-adapted urban development in Khulna	2,250,000.00	Grant	Adaptation	Other: Urban development and - administration	KfW
Bangladesh	Renewable energy and energy efficiency	2,500,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Bosnia-Herzegovina	Water supply and sanitation BiH II	3,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Bosnia-Herzegovina	Promoting renewable energy	9,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Bosnia-Herzegovina	Energy sector programme V (hydropower)	4,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Cambodia	Renewable energy programme	700,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Caucasus regional	Caucasus Protected Areas Trust Fund (CPAF) II	5,000,000.00	Grant	Other	Other: Biodiversity	KfW
Caucasus regional	Programme prioritising the environment. Component: Transboundary Joint Secretariat	2,500,000.00	Grant	Other	Other: Biodiversity	KfW
Caucasus regional	Programme prioritising the environment. Component: sustainable resource management	250,000.00	Grant	Other	Other: Biodiversity	GIZ
Central Asia regional	Sustainable use of natural resources	750,000.00	Grant	Other	Other: Biodiversity	GIZ

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
China	Switching XPS foam production from F-gases to climate-friendly CO2 technology - Phase II	1,000,000.00	Grant	Mitigation	Industry	GIZ
China	Energy efficiency in Chinese and Indian industry	461,000.00	Grant	Mitigation	Energy	DEG - Deutsche Investitions- und Entwicklungsgesellschaft mbH
China	Climate change mitigation by promoting energy efficiency in buildings	1,500,000.00	Grant	Mitigation	Energy	GIZ
China	Low carbon development achieved through energy efficiency measures in Jiangsu Province	3,000,000.00	Grant	Mitigation	Energy	GIZ
China	Transportation demand management in Beijing – sector-oriented development of urban NAMAs focusing on transportation	2,000,000.00	Grant	Mitigation	Transport	GIZ
China	From halogenated refrigerants to climate-friendly hydrocarbons - showcase production of environmentally sound air-conditioning systems - Phase II	900,000.00	Grant	Mitigation	Industry	GIZ
Fiji, Vanuatu, Solomon Islands, Papua New Guinea	Climate protection through forest conservation in Pacific Island States	4,900,000.00	Grant	REDD+	Forestry	GIZ
India	Promoting low-carbon transport in India	2,000,000.00	Grant	Mitigation	Transport	UNEP
India	Solar mapping and monitoring	1,600,000.00	Grant	Mitigation	Energy	GIZ
India	Research cooperation	5,000,000.00	Grant	Mitigation	Energy	KfW
India	Energy efficiency in public buildings and infrastructure	6,500,000.00	Grant	Mitigation	Energy generation and supply	KfW
India	Indo-German energy programme	500,000.00	Grant	Mitigation	Energy generation and supply	KfW
India	Promoting new and renewable energy (IREDA)	17,981,938.00	Grant	Mitigation	Energy generation and supply	KfW
India	Credit line for demand-side energy efficiency	8,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
India	Adaptation to climate change in rural areas, India (CCA)	375,000.00	Grant	Adaptation	Other: Rural development	GIZ
India	Adaptation to climate change in north-east India	1,000,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
India	Environmental urban development through the National Capital Region Planning Board	8,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Indonesia	Geothermal programme	40,500,000.00	Grant	Mitigation	Energy generation and supply	KfW
Indonesia	Advising on environmental and climate protection policy	875,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Indonesia	Emission reduction programme in cities	4,000,000.00	Grant	Mitigation	Other: Waste management	KfW
Indonesia	Energy efficiency for sustainable tourism in Pangandaran, Indonesia	1,217,000.00	Grant	Mitigation	Energy	United Nations World Tourism Organization-UNWTO
Indonesia	Database for management of climate adaptation information and data	2,090,000.00	Grant	Adaptation	Cross-cutting	GIZ
Indonesia, Brazil, Colombia	Balancing land use management, sustainable biomass production and conservation - a practical multi-stakeholder approach to land use planning for climate change mitigation	2,730,000.00	Grant	REDD+	Forestry, agriculture	World Wide Fund for Nature (WWF)
Indonesia, Thailand, Viet Nam	Vulnerability assessment and adaptation to climate change for water resource management in coastal cities of Southeast Asia	90,000.00	Grant	Adaptation	Other: Coastal Management	Asian Institute of Technology (AIT)
Jordan	Energy efficiency for buildings	10,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Jordan	Water resources management- II	9,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Jordan	Water resources management	6,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Jordan	energy efficiency in the water sector	6,500,000.00	Grant	Mitigation	Water and sanitation	KfW
Kosovo	Municipal water supply and sanitation in Pristina III (Water treatment plant)	3,000,000.00	Grant	Adaptation	Water and sanitation	KfW

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Laos	Integrated rural development in mountainous areas II (RDMA II)	375,000.00	Grant	Adaptation	Other: Rural development	GIZ
Lebanon	Rehabilitation of the drinking water and sanitation system	1,500,000.00	Grant	Adaptation	Water and sanitation	GIZ
Mekong regional	Support for climate change adaptation measures in the Mekong region	625,000.00	Grant	Adaptation	Water and sanitation	GIZ
Mekong regional	Support for the Mekong River Commission for sustainable pro-poor-oriented development of hydropower	2,500,000.00	Grant	Adaptation	Water and sanitation	GIZ
Member States of the Mekong River Commission	Flood prevention and disaster risk management in the Lower Mekong Basin	3,200,000.00	Grant	Adaptation	Cross-cutting	GIZ
MENA	Solar resource atlas for the Mediterranean	1,454,000.00	Grant	Mitigation	Energy	German Aerospace Center (DLR)
MENA	Providing training for integrating the renewable energy networks for supplying electricity in selected newly industrialised countries and developing countries (RE grid system)	1,934,000.00	Grant	Mitigation	Energy	Renewables Academy (RENAC) AG
Middle East regional	Regional cooperation with ESCWA in the water sector in the Middle East	500,000.00	Grant	Adaptation	Water and sanitation	GIZ
Mongolia	Programme energy efficiency II	8,500,000.00	Loan1	Mitigation	Energy generation and supply	KfW
Mongolia	Energy efficiency in grid-connected energy supply	1,700,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Montenegro	Energy efficiency in public buildings	2,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Nepal	Programme to promote energy efficiency and renewable energy	2,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Nepal	Promoting the use of small hydropower	100,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Nepal	Poverty reduction in selected rural areas of Nepal	825,000.00	Grant	Adaptation	Other: Rural development	GIZ
Pacific regional	Adaptation to climate change in the Pacific Island region	750,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Pakistan	Programme of investment for medium-scale hydropower projects in Khyber-Pakthunkwa	4,500,000.00	Grant	Mitigation	Energy generation and supply	KfW
Palestinian Territories	Water programme	1,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Philippines	Sustainable management of natural resources (environmental sector programme) II	1,300,000.00	Grant	Other	Other: Environmental protection	GIZ
Philippines	Forest and climate protection on Panay	1,950,000.00	Grant	Adaptation	Forestry	GIZ
Philippines and India	Cities in Asia develop climate sensitive adaptation plans	1,640,000.00	Grant	Adaptation	Cross-cutting	ICLEI European Secretariat GmbH
Serbia	Promoting local authority investment in energy efficiency and environmental measures	3,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Serbia	Biomass heating power station	2,500,000.00	Grant	Mitigation	Energy generation and supply	KfW
Serbia	Environmentally sound coal quality management to improve energy efficiency	4,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Serbia	Advising on energy efficiency	2,500,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Southeast Europe regional	Regional Climate Change Programme	750,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Southeast Europe regional	Open Regional Fund for South East Europe – Energy Efficiency	3,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Timor-Leste	Promoting rural development	2,437,500.00	Grant	Adaptation	Other: Rural development	GIZ
Turkey	Efficient and environmentally-friendly use of animal waste in Turkey	2,500,000.00	Grant	Mitigation	Energy	GIZ
Turkey	Credit programme for climate protection	5,000,000.00	Grant	Mitigation	Cross-cutting	KfW
Ukraine	Local authority climate protection programme II	5,000,000.00	Loan1	Mitigation	Energy generation and supply	KfW
Ukraine	Energy efficiency in buildings	1,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Viet Nam	Support to the building of a Renewable Energy Agency (REDO)	3,000,000.00	Grant	Mitigation	Energy	GIZ
Viet Nam	Exploring mechanisms to promote high biodiversity REDD: piloting in Viet Nam	933,371.00	Grant	REDD+	Forestry	SNV Viet Nam

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Viet Nam	Innovative financing for building community resilience to climate change in coastal Viet Nam	1,230,000.00	Grant	Adaptation	Agriculture, forestry	SNV Viet Nam
Viet Nam	Promoting biodiversity as adapting action to the impacts of climate change in Bac Lieu Province	3,500,000.00	Grant	Adaptation	Agriculture, forestry	GIZ
Viet Nam	O Mon combined cycle gas turbine power plant (O Mon IV)	12,500,000.00	Grant	Mitigation	Energy generation and supply	KfW
Viet Nam	Poverty reduction in rural areas/cooperation with IFAD	1,500,000.00	Grant	Adaptation	Other: Rural development	GIZ
Viet Nam	Integrated coastal and mangrove forest protection for climate change adaptation in the Mekong provinces	875,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Viet Nam	Poverty reduction in rural areas	300,000.00	Grant	Adaptation	Other: Rural development	GIZ
Viet Nam	Environmental protection and management of natural resources in Dak Nong Province	400,000.00	Grant	Other	Other: Biodiversity	GIZ
Viet Nam	Improving ground water protection	2,000,000.00	Grant	Adaptation	Water and sanitation	BGR
Viet Nam	Programme to promote sustainable forest management, trade in and marketing of key forest products	1,250,000.00	Grant	Mitigation	Forestry	GIZ
Yemen	Integrated water resources management (IWRM) - geoenvironmental information and groundwater monitoring	2,000,000.00	Grant	Adaptation	Water and sanitation	BGR
Total region Asia/Middle East/Southeast Europe		377,798,809.00				
Region Latin America/Caribbean						
Andean regional project	Climate programme 2010 CAF	14,000,000.00	Grant	Mitigation	Other: Environmental protection	KfW
Andean regional project	Adaptation to climate change in the Andean region	75,000.00	Grant	Adaptation	Agriculture	GIZ
Brazil	Solar WM 2014 Brazil, BNDES	10,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Brazil	Open programme 4 E (Eletrobras)	10,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Brazil	Amazon Fund	3,000,000.00	Grant	Other	Other: Environmental protection	KfW
Brazil	Solar-hybrid microturbine systems for cogeneration in agro-industrial electricity and heat production (SMILE)	1,700,000.00	Grant	Mitigation	Energy	German Aero-Space Centre (DLR)
Brazil	Monitoring of climate-relevant biodiversity in protected areas in consideration of reduction and adaptation measures	3,500,000.00	Grant	REDD+	Forestry	GIZ
Brazil	Refrigerator recycling programme - Phase II	900,000.00	Grant	Mitigation	Industry	GIZ
Caribbean regional	Caribbean Challenge Initiative	10,000,000.00	Grant	Other	Other: Biodiversity	KfW
Caribbean regional	Support for institutional structures to promote renewable energy and energy efficiency in the Caribbean	4,500,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Caribbean regional	Transboundary integrated watershed management for the Rio Libon (formerly Caribbean Bio-Corridor)	3,375,000.00	Grant	Adaptation	Other: Biodiversity	GIZ
Caribbean regional	Poverty reduction through sustainable use of natural resources in the Rio Artibonito transboundary watershed	975,000.00	Grant	Adaptation	Other: Rural development	GIZ
Caribbean regional	Renewable energy Caribbean (CREDP/GIZ)	750,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Central America regional	Conservation of marine resources in Central America II (Marfund)	5,000,000.00	Grant	Other	Other: Biodiversity	KfW
Central America regional	Maya natural forest	2,000,000.00	Grant	Other	Other: Biodiversity	GIZ
Central America regional	Tropical forest protection and water shed management in the Trifinio region	4,000,000.00	Grant	Other	Other: Biodiversity	GIZ
Chile	Implementing fast-track climate finance - development of proposals for Nationally Appropriate Mitigation Actions (NAMAs)	281,369.96	Grant	Mitigation	Cross-cutting	Ecofys Germany GmbH
Chile	Energy efficiency and cogeneration in public hospitals (pilot project)	1,100,000.00	Grant	Mitigation	Energy	GIZ

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Colombia	Nature reserves	15,000,000.00	Grant	Other	Other: Biodiversity	KfW
Colombia	Renewable energy and energy efficiency	10,000,000.00	Grant	Mitigation	Energy generation and supply	KfW
Colombia	Environmental protection in local authorities	1,250,000.00	Grant	Adaptation	Other: Environmental protection	KfW
Colombia	Environment programme	750,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Costa Rica	Protection of marine and coastal biodiversity through capacity building and adaptation to the impacts of climate change	3,500,000.00	Grant	Adaptation	Other: Coastal Management	GIZ
El Salvador, Mexico, Costa Rica, Panama	Climate change governance capacity: building regional and nationally-tailored ecosystem-based adaptation in Mesoamerica	2,510,000.00	Grant	Adaptation	Cross-cutting	International Union for Conservation of Nature (IUCN)
Guatemala	Improving the management of protected areas - Life Web	10,000,000.00	Grant	Other	Other: Biosphere protection	KfW
Latin America regional	Fast Start finance for adaptation to climate change in Latin America	700,000.00	Grant	Adaptation	Other: Environmental protection	GIZ
Latin America regional / Caribbean	Climate protection and energy in Latin America and the Caribbean (advisory services to IDB)	3,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Mexico	German-Mexican Climate Change Mitigation Alliance	3,000,000.00	Grant	Mitigation		GIZ
Mexico	Climate change and protected area management	4,000,000.00	Grant	REDD+	Forestry	GIZ
Nicaragua	Drinking water supply and sanitation Granada	2,250,000.00	Loan1	Adaptation	Water and sanitation	KfW
Nicaragua	Sustainable management of natural resources and strengthening of entrepreneurial competences (MASRENACE)	187,500.00	Grant	Adaptation	Other: Rural development	GIZ
Nicaragua	Program to improve the efficiency of the drinking water supply and the sewage treatment in Nicaragua	3,000,000.00	Grant	Adaptation	Water and sanitation	GIZ
Paraguay	Sustainable management of natural resources	375,000.00	Grant	Adaptation	Other: Rural development	GIZ
Peru	Sanitation in provincial towns and cities	4,000,000.00	Grant	Adaptation	Water and sanitation	KfW
Peru	Sector reform programme - environment	6,000,000.00	Loan1	Other	Agriculture	KfW
Peru	Promoting tropical conservation areas PROFONANPE III	10,000,000.00	Grant	Other	Other: Biodiversity	KfW
Peru	Apurímac irrigation programme-project II Andahuaylas	1,000,000.00	Grant	Adaptation	Agriculture	KfW
Peru	Sectoral reform programme on municipal water management IV	5,000,000.00	Loan1	Adaptation	Water and sanitation	KfW
Peru	Programme sustainable rural development	800,000.00	Grant	Other	Other: Rural development	GIZ
Peru	Drinking water supply and sanitation PROAGUA	3,250,000.00	Grant	Adaptation	Water and sanitation	GIZ
Peru	Support of the development of a national REDD system in Peru	6,300,000.00	Grant	REDD+	Forestry	KfW
Peru	Facilitation of the Peruvian tropical rainforest programme "Conservando Juntos“	3,000,000.00	Grant	REDD+	Forestry	GIZ
Peru	Insurance for small loans in the agricultural sector for adapting to the effects of climate change	2,000,000.00	Grant	Adaptation	Agriculture	GIZ
Total Region Latin America/ Caribbean		176,028,869.96				
Region global						
Global	Public-private partnership (PPP) programme for climate protection	2,000,000.00	Grant	Mitigation	Energy	DEG - Deutsche Investitions- und Entwicklungsgesellschaft mbH
Global	Advancing UNFCCC negotiating process through preparatory workshops for negotiators from developing countries	500,000.00	Grant	Mitigation	Cross-cutting	UNEP
Global	National climate finance institutions support programme	2,444,000.00	Grant	Mitigation	Cross-cutting	UNEP
Global	Global Climate Partnership Fund (GCPF)	10,000,000.00	Grant	Mitigation	Cross-cutting	KfW

Country/ region	Project/programme title	Climate-relevant amount of funding in euros	Financial instrument	Type of support	Sector	Implementing organisation
Global	PREVENT – providing support to delegations from Least Developed Countries (LDCs) and Small Island Developing States (SIDS) for the post-2012 negotiations - Phase II	800,000.00	Grant	Adaptation	Cross-cutting	Potsdam Institute for Climate Impact Research (PIK)
Global	Adaptation Fund Network	547,679.00	Grant	Adaptation	Cross-cutting	Germanwatch
Global	Sectoral study on climate and refrigeration technology in developing countries and the development of methods and instruments for identifying reduction potential and implementing NAMAs	1,935,000.00	Grant	Mitigation	Industry	GIZ
Global	Gender in adaptation and low-carbon development. Raising awareness, building capacity, supporting national and international policy-making.	451,339.00	Grant	Adaptation	Cross-cutting	GenderCC - Women for Climate Justice
Global	Facility for climate friendly transport technologies and actions	1,500,000.00	Grant	Mitigation	Transport	GIZ
Global	Consultancy and investment fund for ozone protection (Ozone Fund)	1,975,000.00	Grant	Mitigation	Other: Environmental protection	GIZ
Global	Energy policy in development cooperation	1,000,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Global	Sustainable biodiversity fund	6,000,000.00	Grant	Other	Other: Biodiversity	KfW
Global	International water policy and infrastructure	390,000.00	Grant	Adaptation	Water and sanitation	GIZ
Global	Convention project to combat desertification	161,250.00	Grant	Adaptation	Other: Environmental protection	GIZ
Global	Sustainable use of resources in agriculture	2,493,750.00	Grant	Adaptation	Agriculture	GIZ
Global	Policy advice on sustainable use of hydropower	330,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Global	Agricultural policy and food security programme	2,340,000.00	Grant	Adaptation	Agriculture	GIZ
Global	Programme on networks and knowledge management for rural development	195,000.00	Grant	Adaptation	Agriculture	GIZ
Global	Technology cooperation in the energy sector	2,170,000.00	Grant	Mitigation	Energy generation and supply	GIZ
Global	Other climate finance channeld through private institutions/ Welthungerhilfe	637,019.00	Grant	Other	Cross-cutting	see project title
Global	Other climate finance channeled through churches	2,700,000.00	Grant	Other	Cross-cutting	see project title
Global	Other climate finance channeld through political instutitions	1,879,800.00	Grant	Other	Cross-cutting	see project title
Global	Sustainable waste and closed cycle management concepts	490,000.00	Grant	Mitigation	Other: waste management	GIZ
Global	Support for international forest-related programmes (IWRP)	400,000.00	Grant	Other	Forestry	GIZ
Global	Support for climate protection measures in developing countries	220,900.00	Grant	Adaptation	Other: Environmental protection	GIZ
Total region global		43,560,737.00				
Total climate finance		1,187,352,165.96				

1 These relate to ODA eligible, highly concessional loans with a 40 year duration, 10 non-repayment years and 0.75% interest rate

An overview of bilateral development-related climate finance for 2011 can be found in the Federal Republic of Germany’s first Biennial Report (Biennial Report, 2014).

6.2. Multilateral cooperation

6.2.1. The Global Environment Facility (GEF)

The Global Environment Facility (GEF) is a financial mechanism of the United Nations Framework Convention on Climate Change and finances the incremental costs of climate change mitigation activities in developing countries that benefit the global environment. Germany is a voting member of the GEF Council. Germany pledged €347 million in the GEF Trust Fund's fifth replenishment period (2010-2014). A total of 40% of that sum was earmarked for the climate change funding category itself and for climate-related projects within other funding categories. Germany's contribution accounts for 13.5% of GEF's funding, making it the third largest donor after the United States and Japan.

Table 69: Germany's contributions to the Global Environment Facility (GEF)

Germany's contribution 2010 – 2014	Annual average 2010 – 2014	Annual average 2010 – 2014 climate change [1]
€347 million	€86.75 million	€34.7 million

[1] This comprises funding for the climate change category and for climate-related projects within other funding categories.

Source: BMZ

As part of the Bonn Agreement of July 2001 implementing the United Nations Framework Convention on Climate Change and the Kyoto Protocol, two new funds for climate change activities were created under the GEF: the Least Developed Countries Fund (LDCF) and the Special Climate Change Fund (SCCF). They are described in greater detail in 6.2.2. and 6.2.3 below.

6.2.2. Least Developed Countries Fund (LDCF)

The LDCF finances climate change adaptation activities in countries defined as Least Developed Countries (LDCs) by the UN. German pledges total €115 million, which makes it the largest donor in the LDCF (as at March 2013). The LDCF finances the development of National Adaptation Programmes of Action (NAPAs) as agreed by the international community, thus supporting LDCs in building adaptation capacities. It also finances specific project activities to implement the Programmes of Action.

6.2.3. Special Climate Change Fund (SCCF)

The SCCF finances projects and programmes in the field of adaptation to climate change and technology transfer in developing countries. Funding these issues complements the environmental funding for climate change activities within the GEF Trust Fund. The SCCF takes a broader based approach than the LDCF in that it is open to all developing countries. Germany concentrates its support for the SCCF on adaptation to climate change. Germany's pledges to SCCF total €60 million, which makes it the largest donor in the SCCF (as at March 2013).

6.2.4. World Bank climate investment funds (CIFs)

In 2008, the World Bank set up climate investment funds to enable developing countries and emerging economies to finance transformational climate change mitigation and adaptation activities. At their 2009 summit in Toyako, Japan, the G8 countries announced that they would contribute USD 6 billion to the new funds. Contributions totalling USD 7.6 billion have been pledged to date. Germany's contribution is €550 million. Together with funds from the World Bank, regional development banks and the private sector, the funds are scheduled to make approximately an additional USD 43 billion available by 2013 for climate change mitigation and adaptation activities in developing countries and emerging economies.

One of the CIFs is the Clean Technology Fund (CTF), which currently has a budget of over USD 5 billion. It finances larger programmes to scale up technologies that reduce greenhouse gases in advanced developing countries. The aim is to save 1.6 billion tonnes of CO^2. Germany is the fourth largest donor to this fund, contributing €500 million.

The Strategic Climate Fund (SCF) consists of a number of programmes, notably the Pilot Program for Climate Resilience (PPCR). Developing countries that are particularly affected by climate change and least developed regions are supported with grants for adaptation programmes. Germany supports the PPCR with €50 million.

6.2.5. Adaptation Fund

The Adaptation Fund (AF) was set up under the Kyoto Protocol to support developing countries that are particularly vulnerable to the negative effects of climate change in financing concrete climate change adaptation projects and programmes. Often it is the very countries that play no role – or only a very minor role – in causing climate change that are obliged to adapt to its effects. The most vulnerable countries emit little CO_2, but are increasingly having to deal with the negative effects of climate change. The German government paid €10 million into the Adaptation Fund from a heading within BMU's budget in 2010, thus supporting adaptation projects worldwide.

6.2.6. Forest Carbon Partnership Facility (FCPF)

The FCPF is a multilateral learning and financing facility within the REDD process; it is currently made up of 18 donors and 36 forest countries. Another 13 countries have applied for membership. The World Bank plays three different roles in the FCPF: trustee, secretariat and delivery partner. Germany was an initiator of the FCPF (2007 G8 summit at Heiligendamm) and is the second largest donor after Norway, with pledges totalling €140.4 million (of which €130.4 million from BMZ and €10 million from BMU).

The FCPF consists of two funds:

- The Readiness Fund, which finances studies, training and consultation with stakeholders amongst other things. The German contribution to date (BMZ): €40.2 million
- The Carbon Fund, which will test results-based payment systems for emission reductions (tonnes of CO_2) for which evidence of avoided deforestation can be provided. The exact conditions/criteria are still to be determined. To date the only country that has been selected as a candidate is Costa Rica; other potential candidates are Viet Nam, Nepal, Indonesia, Colombia, Mexico, DRC, Ethiopia, and Ghana. Germany's contributions to date: BMZ: €90.2 million, BMU: €10 million.

6.2.7. Green Climate Fund (GCF)

The Green Climate Fund (GCF) was established by the Conference of the Parties to the UNFCCC in Cancun (COP 16) and operationalized at COP 17 in Durban. The GCF complements existing bilateral and multilateral instruments and is an important new building block in international climate finance architecture. The idea is for the GCF to provide financial support to developing countries to enable them to keep their development as low-carbon as possible and to protect themselves against the effects of climate change. Germany is one of the world's largest providers of climate finance (second only to Japan). Germany will also have to make substantial contributions in view of the fund's potential financial size (USD 100 billion a year from 2020 is scheduled to be mobilised for climate finance, a significant proportion of which is to be channelled through this fund). In 2012, Germany contributed USD 282,000 or €216,426,27 towards setting up the Interim Secretariat and administrative costs (transferred from the Transitional Committee trust fund) and will contribute a further €785,000 in 2013.

6.2.8. Transfer of climate technology

One of the decisions taken by the Parties to the Framework Convention on Climate Change at the climate negotiations in Cancun at the end of 2010 was to set up the Technology Mechanism. It consists of a policy arm, the Technology Executive Committee (TEC), and an operational arm, the Climate Technology Centre and Network (CTCN).

CTCN forms the basis for more intensive cooperation in the field of climate-relevant technologies, both for reducing greenhouse gases and for adapting to climate change. It also aims to improve networking opportunities. CTCN has been operational since early 2013. It is managed by the United Nations Environment Programme (UNEP); UNEP's cooperation partner is the Gesellschaft für Internationale Zusammenarbeit (GIZ).

All signatories to the Framework Convention on Climate Change were called upon to set up a contact point known as a National Designated Entity (NDE) for the CTCN. The federal government appointed the responsible division at BMWi (Division IVC2) as Germany's National Designated Entity. It serves as the first point of contact for all enquiries about German technology and for queries from German companies and investors. In 2012, BMWi established a working group on climate technology transfer (AKT), which is intended to accompany the political work on climate technology transfer on a cross-departmental basis and involve industry and the scientific community.

The German government played an active role in the establishment of the Technology Mechanism overall, providing TEC's vice-chair/chair since 2011.

6.2.9. Cooperation in conjunction with other multilateral institutions

Table 70: Contributions to multilateral institutions

Multilateral institutions	2010	2011	2012
1. World Bank			

Multilateral institutions	2010	2011	2012
Forest Carbon Partnership Facility (FCPF) Adaptation Fund 2. International Finance Corporation	€37.0 m €10.0 m -	€12.0 m --- -	€17.0 m --- -
3. African Development Bank			
4. Asian Development Bank			
5. European Bank for Reconstruction and Development			
6. Inter-American Development Bank			
7. United Nations Development Programme - specific programmes Thematic Trust Fund for Support to Energy and Environment for Sustainable Development	 €5.0 m		
8. United Nations Environment Programme - specific programmes Trust Fund for Ecosystem-Based Adaptation UNEP Collaborating Center for Climate and Sustainable Energy Finance	 €10.0 m €0.75 m	 --- €0.75 m	 ---
9. UNFCCC - Supplementary Fund	€4.887 m	€3.446 m	€3.446 m
10. Green Climate Fund			€0.216 m
11. Other Montreal Protocol on Substances that Deplete the Ozone Layer IPCC UNFCCC	 €8.746 m €0.294 m €1.691 m	 €7.890 m €0.294 m €1.799 m	 €7.553 m €0.294 m €2.112 m

Contributions to multilateral climate finance are accounted in the form of disbursements;
Source: BMZ

In the case of multilateral organisations, general contributions to increasing the capital and specific climate-related contributions paid by member states to multilateral development banks (MDBs) are included in the DAC statistics. The DAC statistics do not currently contain a country-by-country breakdown on how the MDBs use funding for climate-related activities. In the case of the World Bank, data on Germany can be calculated only indirectly on the basis of the German contribution to the International Development Association (IDA). In IDA15 (2008-2011) this was USD 1,931.73 million (7.11% of the total volume) and in IDA16 (2012-2014) USD 1,860.80 million (6.01%).

6.3. Examples of projects

6.3.1. Examples of projects on adaptation to climate change

<u>Global – Inventory of Methods for Climate Adaptation</u>

The Inventory of Methods for Climate Adaptation is a global project implemented by GIZ GmbH and the Potsdam Institute for Climate Impact Research (PIK) in 2011 under the International Climate Initiative. It provides decision-makers in partner countries with a tried-and-tested inventory of methods for identifying, analysing and prioritising adaptation needs and measures. It supports the management of climate-related data and promotes the establishment of a South-South exchange network for adaptation stakeholders. In this way, the project supports local stakeholders in making strategic decisions on adaptation to climate change. The project also supports the development of methods for verifying the effectiveness of adaptation measures. The project will continue to work with the ministries responsible in Grenada, India, Indonesia, Mexico, Philippines, South Africa, and Tunisia until May 2013. It has a budget of €2,479,000.

Mauritania – national adaptation planning

Seventy percent of Mauritania's land surface is desert. In recent decades, decreasing precipitation, droughts, spreading desertification and increasing scarcity of freshwater resources have started to threaten the food security of this sparsely populated country in the Sahel desert. The anticipated rise in sea level is also endangering the people living in the country's coastal zone and the habitats that are essential to preserving biodiversity.

Mauritania submitted its first National Adaptation Programme of Action in 2004. It is now one of the first countries to be revising its plan. German development cooperation organisations have been supporting it in this since 2011. Experts at GIZ GmbH are advising the national coordinator on refining the National Adaptation Programme of Action to become a more long-term and strategically oriented approach (NAP) and on promoting local community management of forest and pasture resources. The latter has already led to a discernible improvement in vegetation cover in the intervention regions. Despite periodically declining precipitation, better management methods have still brought about an improvement in resource stabilisation. The project is currently running from 2011 to 2013 with a funding volume of €11.5 million. The political partner is the Mauritanian Ministry of Environment and Sustainable Development.

6.3.2. Examples of projects to reduce greenhouse gases

Morocco – Support for the Moroccan Solar Plan

In the Solar Plan it presented in 2009, the Moroccan government indicated its wish to become a committed partner in the transition to a sustainable electricity supply system. The aim is to build five solar power stations with a total capacity of 2,000 MW. They would be able to provide 18% of the country's annual electricity production.

The German government is a key partner in Morocco's ambitious plans. It is supporting a pilot project in Ouarzazate, contributing to the financing for construction of a 500-MW solar thermal power station. The contract for the first phase was signed on 19 November 2012 in the presence of the Moroccan king. The German government is involved in both bilateral and multilateral support for the project. The main source of multilateral support for this project is the Clean Technology Fund (CTF). BMZ is the fourth largest donor here and, in conjunction with the World Bank and African Development Bank, is working with the Moroccan partner. The funding volume is €700 million in the form of a concessionary loan, plus multilateral contributions to the Clean Technology Fund.

Thailand - National Energy Efficiency Plan as a Core Element of an Emissions Reduction Strategy

This project is being funded by the International Climate Initiative and implemented by GIZ. The project supports the Thai Government in developing and carrying out specific measures and instruments for implementing its National Energy Efficiency Plan in industry and the building sector. One of the main activities involves improving the data pool on sector-specific energy consumption and savings, with a view to identifying potential for increasing efficiency, creating new incentive systems, strengthening energy management and establishing optimised standards and labelling systems. The project partners are also developing and trialling nationally appropriate mitigation actions (NAMAs). With co-financing from the European Union, the policy advice can be flanked by concrete pilot measures for improving energy efficiency in small and medium-sized enterprises (SMEs) in the automotive supply industry. The project runs from 2012 to 2015 with a funding volume of €3 million.

6.3.3. Examples of REDD+ projects

Indonesia – REDD in Indonesia

The Indonesian-German forests and climate change programme was commissioned by BMZ and is being jointly implemented by the Indonesian Ministry of Forestry, GIZ and KfW. The technical cooperation component involves advising on the development of strategies and a regulatory framework for implementing REDD+ and supports forest administration reform, which has shifted responsibility for managing the forests to decentralised government structures. The idea is that forests should be managed on the basis of long-term management plans rather than simply by awarding licenses. What are known as open access areas of forest that were not licensed and regulated in any way are now properly managed, there are better checks on concession holders and access and use rights have been made easier for local communities.

The components of the project implemented by KfW development bank as part of Germany’s financial cooperation concentrate on implementing REDD+ activities. The focus of the demonstration activities is on promoting sustainable land use by village communities living in the forest and on the edge of the forest, supporting community forests, promoting sustainable management practices in private-sector run forest concessions and supporting nature conservation activities. There are plans to extend the project to protected areas in Sumatra, Sulawesi and Kalimantan. Germany’s contribution is €16.8 million for technical support (2009-2014) and €20 million in investment between 2011 and 2018 (first phase).

Colombia - piloting a nested REDD+ mechanism for success-based payments at national, provincial and project level in Colombia

With the support of IKI, the Winrock International Institute for Agricultural Development in Colombia is carrying out a project entitled Piloting a Nested REDD+ Mechanism for Success-based Payments at National, Provincial and Project Level in Colombia. The main tasks of the project, which began in early 2013, are to carry out a first higher-level technical assessment to identify regions and administrative sub-units that are at risk and develop subnational reference levels. The project will run until the end of 2016 and is being carried out in conjunction with the Ministry of Environment and Sustainable Development (MADS) and the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM). It has a funding volume of €1,453,568.

7. Research, development and systematic observation

Germany has a long tradition of using science and technology in the service of sustainability. The framework programme of the Federal Ministry of Education and Research (BMBF) entitled Research for Sustainability, which was adopted by the federal cabinet in mid-2004, sees sustainability as a driver of innovation in government, business and society and as such translates the government's National Sustainability Strategy of April 2002 into research funding policy. The new framework programme – Research for Sustainable Development – was published in 2010, setting the current priorities in sustainability research. The federal government has almost doubled its budget for funding sustainability research projects compared with 2005.

Within the federal government, the Federal Ministry of Education and Research (BMBF) and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) fund research on renewable energy. Research on sustainability, including global change, is mainly funded in Germany by BMBF and the German Research Foundation (DFG). Funding is awarded either to specific projects or entire institutions. In the institutional field, funding for climate research extends to various institutes within the Helmholtz Association of German Research Centres (HGF), the Max Planck Society (MPG), the Fraunhofer-Gesellschaft (FhG) and the Leibniz Association (WGL).

BMBF and DFG are also advised on scientific questions related to global change by the German National Committee on Global Change Research (NKGCF), which coordinates Germany's participation in researching global environmental change within a number of cross-programme initiatives, including the Earth System Science Partnership (ESSP), Future Earth and the four associated international research programmes on global change (World Climate Research Programme (WCRP), International Geosphere-Biosphere Programme (IGBP), International Human Dimensions Programme on Global Environmental Change (IHDP) and the international research programme on biodiversity DIVERSITAS)). NGKCF sees one of the main priorities of its work as being to develop cross-sectoral, interdisciplinary and integrative research policies. The German Committee for Sustainability Research in Future Earth (DKN Future Earth) will replace NKGCF in 2013 and be available as an advisory body and national contact partner for international developments and activities within Future Earth. The committee's main task is to play a role in designing Future Earth's development process. DKN Future Earth helps to identify socially relevant research topics within what are known as co-design processes (dialogue among science, society and research funding bodies), devise integrative research and bring together and network German researchers working in natural and social sciences.

Germany's potential to make an integrated contribution to climate change science is vast: its research landscape and scientific infrastructure are among the world's best in the field of climate and sustainability research and environmental and energy technologies. German companies sell products and services that are absolutely state of the art in terms of environmental and energy technology.

With its High-Tech Strategy for Climate Protection, the federal government is pursuing a new research approach, which has been broadened to include funding for innovation. The lead agency is BMBF. In addition to the research-related government departments, other implementation-oriented sectoral departments will also for the first time play a role in translating into practice the insights gained from research, including in areas that are of key importance for the future, such as carbon-neutral, energy-efficient towns and cities that are adapted to climate change, and sustainable mobility (BMVBS). The High-Tech Strategy is monitored by a research union, a broad range of actors from science, business and politics, which since 2007 has provided backing for a comprehensive, interdisciplinary climate research strategy. As an integral element of the High-Tech Strategy for Germany, it sets the course for ultramodern energy and resource-saving options. The key fields of action are:

- Expanding the knowledge base to support climate change mitigation and adaptation activities
- R&D and demonstration projects that improve the technological prospects for climate change mitigation and strengthen German industry in this key international market of the future
- Making knowledge about climate change and its effects more accessible for decision-making processes in business and politics
- Assuming worldwide responsibility through international dialogue and cooperation
- Working towards reconciling the objective of mitigating climate change with that of achieving economic growth and prosperity
- Developing integrated and creative corridors for action by linking research findings with practical opportunities for implementing them

In this way, the High-Tech Strategy for Climate Protection links into the targets of other strategies for dealing with climate change, such as the Energy Concept, the Mobility and Fuels Strategy and the German Strategy for Adaptation to Climate Change – DAS – (see Chapter 5).

In 2011, the German government presented its 6th energy research programme, “Research for an environmentally sound, reliable and affordable energy supply,” which sets out the basic principles and priorities of its funding policy for the next years. It is described in detail in Chapter 7.4.1. In addition to contributions designed to drive down costs and achieve supply reliability in implementing Germany’s Energiewende*,* or transition to a new energy era, it also includes considerable efforts to mobilise private-sector research capacities and capital to speed up innovation processes for climate change mitigation and make products and services ready for the market as soon as possible. In addition to the energy research programme, a number of innovation alliances were launched, as part of the High-Tech Strategy for Climate Protection, for example.

7.1. Climate system, variability and interactions in the Earth system

A systematic link between modelling and observation is crucial to achieve further progress towards understanding the climate system and in particular its variability and the interactions between the components of the Earth system. To ensure that the measurement data is highly informative, the German government is therefore focusing on continuous long-term observation of processes in the atmosphere, the oceans and on land. In addition, detailed investigation of key processes is made possible, for example, by the modern research aircraft HALO and POLAR 5, Neumayer III Antarctic research station, and the research ship Maria S. Merian. Their in-situ and remote sensing observation techniques complement routine global recording of the key parameters of the global climate system. Innovative aerospace technology can help monitor compliance with environmental protection conventions and provide the data needed to improve predictions about climate change and its effects.

Germany participates in international research programmes through numerous projects funded by BMBF: the World Climate Research Programme (WCRP), International Geosphere-Biosphere Programme (IGBP), Global Earth Observation System of Systems (GEOSS), Global Monitoring for Environment and Security (GMES, COPERNICUS), and the UN's policy on marine protection (e.g., RIO+20).

Germany is already taking the lead in Europe on climate research and Earth observation from space. German missions such as the TerraSAR-X radar satellite, the RapidEye optical satellite system and the EnMAP satellite, which is already in an advanced stage of development, monitor global phenomena such as the state of the polar ice, the major continental glaciers, deserts, rain forests and oceans. From 2017, the French-German MERLIN satellite project will measure the global distribution of methane - a highly significant greenhouse gas - in the atmosphere. The European Space Agency's Climate Change Initiative (ESA CCI) will also make a significant contribution to standardising global climate data. Germany finances about a third of this European programme. With France and Germany as lead countries, the second and third generation of the European weather satellite systems METOP and MeteoSat respectively are being developed. They will be launched at the end of the decade. Finally, the European Earth Observation Programme Copernicus is making a significant contribution to monitoring the climate system and forecasting the effects of climate change. Five satellite families (Sentinels) are currently being built and will go into long-term service in 2014. Six special services will supply data products on climate issues on a routine basis. Here again, Germany is playing a leading role in the European alliance.

7.1.1. Atmosphere

Monitoring the atmosphere is part of the remit of Germany's National Meteorological Service (Deutscher Wetterdienst – DWD). To this end, it operates extensive observation networks, which include conventional meteorological and climatological observation stations as well as a network of weather radars (see section 7.2.1.1).

Optimised, synergetic use of data from all the observation systems will be achieved through the process of data assimilation as a component of numerical weather forecasting systems. This approach can also be used with model-based re-analyses in order to achieve a consistent description of atmospheric parameters over longer periods of time. The European Centre for Medium-Range Weather Forecasts (ECMWF), which Germany is involved in, uses this approach for the global atmosphere. A higher spatial resolution can be achieved using regional re-analyses. This approach is currently being trialled at the Hans Ertel Centre for Weather Research, which is part of Germany's National Meteorological Service, the Deutscher Wetterdienst (DWD), and is located at Bonn University. Developments to improve decadal climate predictions and projections are taking place at a number of German research institutions (see section 7.1.5).

7.1.2. Marine and polar research

BMBF's framework programme Research for Sustainable Development (FONA) and the High-tech Strategy in the climate/energy field set the framework for marine research and polar research activities.

Marine research activities are based on five main areas:

- Oceans as part of the Earth's climate system
- Structures and functions of marine ecosystems
- Exploration and sustainable use of marine resources
- Research on integrated management of coastal zones and adaptation to climate change
- Research and observation technology

In line with the framework programme Research for Sustainable Development, BMBF's marine science activities focus predominantly on the following key regions: German coasts, Southern Africa, Asia and the North Atlantic.

The polar research priorities are:

- Ocean circulation and climate dynamics
- Processes and interaction in the Arctic climate system
- Polar ecosystems and glacier regions under the influence of climate change
- Substance cycles, particularly the carbon cycle

In line with the framework programme Research for Sustainable Development (FONA), the polar activities concentrate on the Arctic as a key region. One focus is the opportunities and risks associated with the increasing commercial use of the Arctic.

With its marine and polar research activities, the German government contributes to implementing its internationalisation strategy, in particular the general goals of taking international responsibility in tackling global challenges and strengthening cooperation with developing countries in the fields of education, research and development. Particularly noteworthy in this context is its cooperation with Russia, China, Indonesia, South Africa/Namibia and Israel.

As a contribution to international observation programmes, the Federal Republic of Germany provides about 50 drifters per year for the international Argo programme. Since 2008, the Argo project, which was originally funded by BMBF, has qualified for operational funding, which it receives from BMVBS. With its activities, BMBF also supports the development and implementation of national and European policies, such as the EU's marine, Arctic and environment policies and, in particular, measures to comply with the European Marine Strategy Framework Directive (MSFD).

BMBF plays a key role in the European Joint Programming Initiative on Healthy and Productive Seas and Oceans, and in ERA-Nets BONUS and SeasEra. The aim of these activities is to pool national and EU capacities with a view to creating a solid basis in marine science to ensure sustainable use of marine resources, predict the effects of climate change on the sea, and develop adaptation strategies.

BMBF's funding for marine research projects totalled €22 million in 2012 and €1 million for polar research projects. BMVBS supports marine research with €0.6 million for the ARGO drifters.

7.1.3. Hydrological cycle

The global water cycle is a key element in the climate system. To achieve sustainable management of ecosystems it is essential that, in attempting to address questions of the availability, quality and distribution of water in different climate zones, the causes and effects of global changes in the water cycle are precisely understood.

Research on the impacts of global change on the water cycle carried out by BMBF's GLOWA programme has provided key findings on this. The programme was launched in 2000 and concluded in 2012. GLOWA's aim was to develop integrated strategies for sustainable and forward-looking management of water and water bodies on a regional scale, taking into account the way global ecosystems work and socio-economic conditions. Using case studies of varying complexity in different river basins, an interdisciplinary and transdisciplinary examination was undertaken to explore the core issues and detailed parameters of global changes in the water cycle with regard to water availability and quality and distribution of water resources.

Based on different climate zones, GLOWA's different programmes looked at a number of different river basins (Draâ in Morocco, Ouémé in Benin, Volta, Danube, Elbe and Jordan). The following core issues were of key scientific significance:

- Natural and anthropogenic climate and precipitation variability and its influence on the global water cycle
- Interactions among the water cycle, biosphere and land use and the impacts of changes in land use
- Water availability and use conflicts: population trends, 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

One of GLOWA's main priorities was also to directly involve regional decision-makers in the individual projects. This was and still is crucial to ensuring that findings can actually be applied in practice and to underpinning acceptance of the options for action developed in the regions under consideration.

Research projects such as GLOWA depend on quantitative observation data sets on precipitation that are reliable and globally homogenous, such as those supplied by GPCC. For that reason, GPCC has referenced and documented the portfolio of its data products using what are known as digital object identifiers. In a separate study, it has re-quantified the global indicators for precipitation as one of the key elements in the global water cycle based on one of the world's most comprehensive archives of historical data on land surface precipitation. Current participation in BMBF's MiKlip DAPACLIP project and in the ERA-CLIM2 re-analysis project in EU-FP7-SPACE Call has made it possible to develop and publish new screened data products based on daily precipitation data, which can be used for drought warning systems, amongst other things. New global precipitation products based on new combinations of satellite-aided and in-situ observation have been developed and published as a result of these projects.

Addressing the challenges recognised and described above calls for new conceptual approaches and more particularly innovative technologies. To this end, in the climate energy section of its High-Tech Strategy 2020, the German government has established a key line of action with the framework programme Research for Sustainable Development. The main feature of this programme is the way it links basic and application-oriented research. The programme therefore focuses on the sustainable water management sector with its strong growth potential, along with resource and energy efficiency.

BMBF's funding for water issues has been consolidated in its Sustainable Water Management (NAWAM) research priority since 2011. Five categories of issue are addressed in NAWAM, and specific funding guidelines for them are scheduled to be published in the next years. The categories are Water and Energy, Water and Food, Water and Health, Water and the Environment, and Water in Urban Regions. BMBF provides a total of €200 million in funding for NAWAM. In the water and energy category, for example, BMBF 2012 has published funding guidelines entitled "Concepts and Technologies for Energy and Resource Efficient Water Management (ERWAS)" and intends to support 12 collaborative projects with €27 million in funding from 2014 onwards.

The solutions ERWAS is seeking to develop aim to achieve a more efficient and economical use of energy. However, at the same time, they also intend to build on sustainable energy production that makes better use of available resources (such as the energy content of wastewater). If the German water industry were to harness all the available potential, it would be able to achieve about a 7% share in electricity production and thus make a significant contribution to the national climate protection strategy.

7.1.4. Land surface and land use

Scientific interest is increasingly focusing on the interactions among land use, ecosystem services and climate change. This is because global change and its different manifestations and consequences impact on land use in most regions of the world. Climate change has been identified as one of the major drivers. However, we do not know enough about how changes in climate actually impact on natural and cultivated landscapes. That is at least partly because it is often difficult to trace perceptible changes in the landscape back to individual factors. We still do not understand enough about how climate change and changes in ecosystems and different forms of land use are connected.

It will become increasingly important to find the right balance between adaptation and climate change mitigation strategies in the future. Agricultural activities, for example, are not only affected by climate change; they also directly contribute to greenhouse gas emissions – especially CH_4 and N_2O – and therefore to climate change. Furthermore, emissions of NH_3 indirectly interfere with the thermal and material balance of the Earth's atmosphere: NH_3 emissions lead to the formation of secondary aerosols, which could have a significant influence on the radiation balance. They contribute to the eutrophication of natural and near-natural ecosystems and to indirect emission of N_2O. In the case of natural soils, nitrogen inputs from the atmosphere and, in the case of agricultural soils, inputs connected with cultivation and fertilisation promote mineralisation of organic components and cause CO_2 emissions that – unlike other CO_2 emissions from agriculture – are not "carbon neutral". On the other hand, organic carbon can also be fixed in soils and forests by the accumulation of humus. The carbon accumulation that can be achieved through appropriate management tailored to the individual site allows these soils to act as carbon sinks.

The funding measure on sustainable forestry (2004-2010), which has now ended, and involvement in the ERA-Net WoodWisdom-Net's transnational calls for research and development proposals addressed the challenges, uncertainties and conflicting goals in the forestry and timber industry. The results have helped to shape structural changes in the forestry industry, contributed to adaptation to the globalisation of markets and triggered precautionary measures for the future, such as the forestry and timber industry's adaptation to changes in climate.

Within the ongoing funding activity on sustainable land management (2008-2016), a knowledge base and forward-looking land management strategies for the future are being developed for Germany and Europe, Asia, Africa and South America. A key feature of sustainable land management is that it brings together a great many disciplines such as spatial planning, energy provision, agriculture, water management, urban development and forestry. Representatives of these disciplines and users are involved in the process. The aim of the funding measure is to support regions in developing sustainable land management systems. In a transdisciplinary approach, researchers and practice-based partners are working to achieve a better understanding of the interactions among land management, climate protection and ecosystem services. Specific recommendations for action, technologies and system solutions have been developed and implemented locally in conjunction with the relevant interest groups as examples of best practice. The research is being carried out in particular in regions where climate protection is highly relevant or which are witnessing dramatic changes as a result of land use and climate change. The funding measure is part of the framework programme Research for Sustainable Developments (FONA) and contributes to the implementation of the German government's sustainability strategy and its climate change targets. BMBF invests a total of €72 million in the funding area for work exploring interactions between land management and the climate and ecosystem services from 2010 to 2016.

Sustainable land management - Innovative system solutions for Sustainable Land Management is a funding area that concentrates its research activities on integrated urban and rural development. Its aims are to enhance regional value added and optimise energy and materials flows between urban and rural areas. The projects focus on developing and implementing new, sustainable and practicable approaches for regions in Germany facing different challenges. To do this, it is vital to understand which factors – including climate change and demographic changes – influence land use and what the interdependencies are. Typical questions include how energy, environmental, agricultural and structural policies, settlement and transport trends interact. From 2010 to 2016, BMBF is investing a total of 44 million in this funding area.

7.1.5. Modelling and prediction

Predictions about both short-term and long-term climate trends are extremely relevant for society. Since climate modelling is currently the only instrument available for attempting to predict the future climate, it is of key importance to make the modelling results more conclusive.

Climate prediction is based on complex numerical climate models that simulate the global atmosphere and ocean circulation as accurately as possible. The German Climate Computing Centre (DKRZ), which was set up in 1987 with financing from BMBF, offers computing capacity for these models to other German research organisations. A new supercomputer was installed there in 2009 to enable complex scenarios for future global and regional climate models to be calculated efficiently. The supercomputer performs model calculations with a higher resolution as well as calculation runs using models that are better able to simulate the physical processes in the climate system. In this way, uncertainty about how the conditions of life on Earth are likely to develop in the future can be limited somewhat – at least with regard to the climate system. DKRZ coordinates the European Climate Computing Network (ECCN), which consists of all major climate computing centres in Europe, including the Hadley Centre and Météo France. DKRZ and the Hadley Centre are jointly coordinating the model calculations being performed for IPCC.

DKRZ is already performing climate simulations using models such as ECHAM5 and even ECHAM6, which was developed in conjunction with the Max Planck Institute for Meteorology in Hamburg and is used for IPCC's assessment reports, for example. Simulations using coupled atmosphere-ocean circulation models make it possible to study climate variability and to detect climate "signals" in the "noise" of climate variability. The focus was and remains to detect the anthropogenic "fingerprint" in climate observations since the beginning of the industrial revolution. The available experimental data (from data networks, measuring campaigns, paleoclimatology and remote sensing) are used to validate the models; conversely, models are used in reconstructing and interpreting the past and present state of the climate. The European Centre for Medium-Range Weather Forecasts (ECMWF), which Germany is part of, currently operates the world's most comprehensive data assimilation system. It is used in the EU ERA-CLIM project (and successor projects) to perform a global analysis for the 20th century. DWD is taking part in this project.

Regional climate modelling, which – by contrast with global climate modelling – also enables predictions to be made about possible climate trends in specific regions such as individual Länder, has been a firm part of the German research landscape since the 1990s. Work is ongoing to refine the REMO (Regional Climate Modelling), COSMO-CLM (COSMO model in Climate Mode) and WRF (weather research and forecasting) models and to make long-term climate forecasts and projections. Various working groups from Germany use these models to contribute climate projections for Europe and other regions to the international CORDEX project (Coordinated Downscaling Experiment).

To be able to put efficient and specific precautionary measures in place, two time scales are of particular importance:

a) The medium-term scale for the next decade. The aim for this decadal time frame is to take forward the economics of adaptation policy and identify and implement early actions.

b) The long-term scale for the second half of the century. Here the aim is to plan and implement adaptation measures to deal with the most extreme effects of climate change in connection with the EU's proposed two-degree target.

More in-depth work has already begun, especially on attempts to further quantify uncertainty and to achieve higher spatial and time resolutions. Basically, there are two different sources of uncertainty: aleatory uncertainty resulting from the high degree of complexity, dynamic instability and non-linearity of the climate system, and epistemic uncertainty resulting from a lack of knowledge or inadequate description of the climate system, the fact that measurements available do not provide complete coverage of the Earth, the large mesh size used in the model or – in the case of some physical processes – the lack of process understanding. The uncertainties resulting from assumed emissions scenarios also become increasingly relevant over longer time scales.

To reduce aleatory uncertainty, methods for creating ensembles that are tailored to individual questions are being explored. Research using decade-long time scales is being carried out within the MiKlip (decadal climate prediction) funding priority. It aims to develop a model system – based on the Earth system model (MPI-ESM) used at the Max Planck Institute for Meteorology in Hamburg (MPI-M) – to forecast the changes in climate and associated extreme weather events that can be expected on a time scale of up to 10 years (see section 7.5.1). The forecasting system takes into account both anthropogenically induced climate change and natural variations in climate on a regional and global scale. The climate predictions achieved in this way and a comprehensive assessment of forecast quality will create the framework needed to improve the capacity of industry and society to adapt to future climate fluctuations.

DWD is currently working in conjunction with MPI-M to prepare for the introduction of an operational global seasonal prediction system using the MPI-ESM model system. This will expand the multi-model forecasting system EUROSIP, which is coordinated by the European Centre for Medium-Range Weather Forecasts (ECMWF). The aim of this German contribution to EUROSIP is to deliver a pre-operational forecast in 2014.

To reduce epistemic uncertainties, further improvements are being made to the mathematical methods used in the models and to the description of the sub-scale processes (parameterisation) in the climate models. The latter is particularly necessary in view of the steady decrease in grid width in the models. Processes that have previously been neglected – such as the carbon cycle, dynamic vegetation and dynamic trends in sea ice – are also being included in the model.

HD $(CP)^2$ is a funding measure looking at cloud and precipitation processes and their implication for climate prediction. It was established to carry out climate research using higher time and spatial resolutions. Its aim is to develop a climate model that can be used to physically model cloud formation processes, development of precipitation and precipitation processes. This will advance how we deal with climate change and in particular with adaptation to the extreme weather associated with it. A sound scientific basis created in this way will make it possible to identify more reliable measures for mitigating climate change, estimating its effects and drawing the necessary conclusions for mitigation and adaptation.

CLOUD is another funding measure that is designed to clarify the physical connections between cloud formation and the effects on the climate. The CLOUD project, which is being conducted at CERN (particle accelerator, European Organization for Nuclear Research), aims to provide a well-founded and quantitative understanding of the possible links between galactic cosmic rays (GCR) and the Earth's climate. The CLOUD consortium is studying the influence of GCR on atmospheric chemistry, aerosol particles and clouds, in order to identify the possible role the Sun plays in climate change.

MACC is a project that has now ended which was funded by the European Commission and carried out at EZMW with the involvement of numerous German research institutions. Its work included developing a global analysis and prediction system for key greenhouse gases and aerosols. The system, which was developed for operational use, can continuously determine the global distribution of trace gases and aerosols that have an impact on the climate, as well as their sources and sinks.

DWD and MPI-M are collaborating closely to pool expertise in the field of global modelling and develop ICON (Icosahedral Non-hydrostatic General Circulation Model), a next-generation weather forecasting and climate model. ICON is a non-hydrostatic general model that offers the possibility of using local zoom functions for particular regions.

The available experimental data (from data networks, measuring campaigns, paleoclimatology and remote sensing) is used to validate the models. Conversely, models are used in reconstructing and interpreting the past and present state of the climate. For example, a project being conducted at HErZ (Hans Ertel Zentrum für Wetterforschung) is participating in a regional re-analysis for Europe.

7.2. Observation and data management

7.2.1. Systematic observation

There is still a strong need for observations of the state and development of each individual component in the climate system and for information on systems and structures – both natural and those used by people – which are affected in general terms by climatic or global changes. Germany is therefore continuing to increase its support for the Global Climate Observing System (GCOS).

Earth observation systems are used to acquire this kind of information using in-situ and remote sensing observation techniques. Remote-sensing methods include ground-, air-, water- and space-based systems. A full picture can be achieved only when insights from all the observation systems are integrated. To describe the state of the climate system and how it is developing, it is particularly crucial to measure internationally defined ECVs (essential climate variables) as completely as possible and with reliability over long periods of time. A more detailed description of Germany's contributions to the Global Climate Observing System can be found in a separate report, which is available in English only (National GCOS Report[89]).

A report on German climate observation systems also provides the first complete overview of ongoing activities and programmes in Germany to measure essential climate variables or ECVs in the country (Deutscher Wetterdienst, 2012).

The national GCOS coordinator – an office which has been set up at Deutscher Wetterdienst (DWD), Germany's national meteorological service – acts as an interface between the national institutions and the GCOS programme's organisation and arranges annual GCOS meetings to improve cooperation among the participating institutions. The national GCOS coordinators for Germany, Austria and Switzerland or-

[89] Germany's report on global climate observation systems.

ganised a meeting for their three countries in 2012, which is now to become an annual event.

Many of the observation systems mentioned below can be classed in terms of content or organisation both as research systems and as routine operational observation systems, which makes it difficult to make a clear distinction between them and makes overlaps in content unavoidable.

Many German institutions such as DWD, the Federal Maritime and Hydrographic Agency (BSH), university institutes and major research institutes continue to participate to a great extent in international monitoring networks observing the atmosphere (WWW, World Weather Watch Programme, and GAW, Global Atmosphere Watch – both WMO programmes), the oceans (GOOS, Global Ocean Observing System) run by IOC (Intergovernmental Oceanographic Commission of UNESCO) and land surfaces (GTOS, Global Terrestrial Observing System) run by FAO (Food and Agriculture Organization). All the climate observation components of these systems together make up GCOS. WMO, IOC, the International Council for Science (ICSU) and the United Nations Environment Programme (UNEP) support the GCOS programme with a joint secretariat at WMO in Geneva.

7.2.1.1. Atmosphere

DWD’s statutory duties include monitoring the atmosphere. The Alfred Wegener Institute for Polar and Marine Research (AWI) also carries out activities in this field, as do the Länder in the specific field of chemical ECVs. In addition to traditional in-situ measuring methods, remote-sensing techniques such as ground-based radar are used for monitoring precipitation, and satellite-aided systems are used for identifying different ECVs. To fulfil its remit, DWD operates extensive observation networks, which – alongside traditional meteorological and climatological observation stations – also include a network of weather radars. In addition to the continuous operation of these observation networks, it also carries out extensive quality assurance and archiving activities.

Germany has a long tradition of in-situ meteorological observations. It began to systematically collect climatological data back in the late 19th century, but it was not until after reunification in 1990 that a uniform standard was used for collecting and archiving the data. The increased use of automatic stations means that data is now available in a time resolution of 1 to 10 minutes. The number of stations operated by DWD depends on the particular ECV. It currently has 1,930 observation stations for precipitation (as at 1 March 2013).

To increase the time frame for usable climate data, DWD has – since 2005 – been making great efforts as part of a climate data digitalisation project (KLIDADIGI) to digitalise historic data that is currently available only on paper or other non-electronic media. DWD also participates actively in international exchanges of meteorological and climatological data. With its two meteorological observatories in Lindenberg and on Hohenpeissenberg mountain, DWD is involved in a scientific study of atmospheric processes that also contribute to understanding the climate system.

DWD runs a number of stations as national reference stations where traditional and automated measuring systems are operated in parallel in order to identify systematic differences between the two. The stations were chosen for location (North Sea, North

German Plain, uplands, highlands) and for the quality and length of the observation series already available.

DWD and AWI participate in the GCOS Surface Network (GSN) with four stations and one station respectively. In conjunction with the Japan Meteorological Agency, DWD operates a centre for monitoring the availability and quality of the data provided by the GSN stations.[90] DWD also operates the Commission for Basic Systems (CBS), one of nine CBS Lead Centres for GCOS in the world, on behalf of WMO (World Meteorological Organization).

DWD and AWI also participate in the GCOS Upper Air Network (GUAN) with one station each. On behalf of WMO, DWD runs the Lead Centre for the GCOS Reference Upper Air Network (GRUAN), which includes coordinating quality assurance of the radiosonde measurements in GRUAN worldwide. GRUAN is a subset of the GUAN stations that carries out observations to a particularly high standard. DWD also makes other contributions to GCOS and to WMO's World Climate Research Programme (WCRP).

DWD's two meteorological observatories play a particularly important role, carrying out extensive long-term monitoring of physical and chemical processes in the atmosphere. All data is subject to strict quality control. Germany (AWI) has also been responsible for operating the World Radiation Monitoring Centre (WRMC) since the beginning of 2008.

Satellites have become an indispensable source of the information needed to identify and evaluate changes in the climate system. They provide continuous data quickly and with blanket coverage, including in regions where coverage by other measuring systems is poor. Germany is the major partner in all the European satellite programmes connected with climate monitoring that are run by ESA, the EU and EUMETSAT. Germany also uses the satellites that are part of its national space programme to contribute to the climate observation system and operates the World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT), for example, at DLR. Planning and operation of meteorological satellites in Europe is carried out by the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) in Darmstadt. Germany, represented by DWD, is the largest partner in EUMETSAT and is closely involved in decisions on ongoing and proposed fleets of satellites. One of the focuses of EUMETSAT's programme is climate monitoring. It has two long-term satellite systems, MSG (Meteosat Second Generation), which is geostationary, and MetOp (Meteorological Operational satellite), which is in polar orbit. They make an important contribution to establishing long-term atmospheric observation for climate monitoring, using instruments that previously could be made available only for short periods of time on research satellites.

To provide satellite products for different groups of applications, EUMETSAT has built up a network of thematic application facilities known as Satellite Application Facilities (SAFs). Their purpose is to develop and archive application-based satellite products and deliver them on an ongoing basis.

The development and generation of specialist products for observing the climate system are carried out jointly by EUMETSAT and the partners in the European Consortium CM-SAF (Satellite Application Service for Climate Monitoring), which is operated

[90] http://www.gsnmc.dwd.de

by seven national meteorological services in Europe, with DWD as lead agency. CM SAF has broadened the focus of its activities in recent years and now also delivers high-calibre, regional and global long-term climatologies of satellite-derived parameters (such as on solar and thermal radiation, population, humidity distribution and precipitation). CM SAF, working on behalf of EUMETSAT and headed by DWD, occupies a leading position in Europe.

HALO (High Altitude and Long Range Research Aircraft) has taken aircraft-based atmospheric research to a new level. The aircraft was built by Gulfstream for DLR and, following extensive test phases, has now been delivered and is available for use in Germany's research programmes. DLR in Oberpfaffenhofen has lead responsibility for operating HALO. HALO is able to reach altitudes as high as the lower stratosphere, so the German and international scientific community can carry out studies of unprecedented quality. HALO's main research priorities include areas that are of key importance for the climate and the occurrence of extreme weather events, such as studies on precipitation formation and transport of humidity and cloud water, atmospheric self-cleaning processes and chemical and dynamic processes in the transition zone between the troposphere and stratosphere. German environmental and climate researchers have already carried out numerous missions.

7.2.1.2. Oceans

Germany's contributions to observation of oceanographic ECVs are shared by numerous institutions that support the Global Ocean Observing System (GOOS). They include the Federal Maritime and Hydrographic Agency (BSH), the Alfred Wegener Institute for Polar and Marine Research (AWI), ZMAW (Center for Marine and Atmospheric Sciences at Hamburg University), DWD, GEOMAR Helmholtz Centre for Ocean Research, IUP-Bremen and others. Research vessels (such as Polarstern) and merchant ships, as well as drifting and anchored buoys and remote-controlled vessels, are used as measuring platforms. Some of the activities are supported by research funds and some are part of commercial activities. For example, Germany provides about 50 ARGO drifters a year and within WMO's VOS (Voluntary Observing Ships) programme equips a fleet of about 720 merchant ships with meteorological instruments (as at 1 July 2013). The Federal Maritime and Hydrographic Agency is lead agency in coordinating oceanographic observations and for GOOS.

7.2.1.3. Land surfaces

Numerous national institutions are also involved in observing terrestrial ECVs. Germany contributes to the Global Terrestrial Observing System (GTOS), the climate components of which are part of GCOS. For example, the global data and product centres for runoff (Global Runoff Data Centre, GRDC, housed in the German Federal Institute of Hydrology – BfG) and precipitation (Global Precipitation Climatology Centre, GPCC, based at DWD) make valuable contributions to the Global Terrestrial Network for Hydrology (GTN-H) and the Global Terrestrial Network for River Discharge (GTN-R). Germany also contributes to the GTN for glaciers (GTN-G) and permafrost (GTN-P). DWD also carries out observations of plant phenology. However, there is no central coordination point for GTOS in Germany, and the GTOS Secretariat, which is financed by FAO, is currently not staffed.

7.2.1.4. Multi-source remote sensing observation systems

Satellites offer unique advantages in identifying and assessing changes in the climate system. They provide continuous data quickly and with blanket coverage, including for regions where coverage by other measuring systems is poor. A number of parameters can only be determined using satellites. Germany is the largest partner in all the European satellite programmes run by ESA, the EU and EUMETSAT, which are connected with climate monitoring.

Experimental (Earth Explorer) satellites, such as SMOS and CryoSat-2, which were part of the ESA Earth observation programme, have been of key importance in studying processes within the climate system. In 2010, ESA also launched a major new Climate Change Initiative (www.esa-cci.org), which explicitly includes generating ECVs from satellite data and in particular ensures that the ESA archives of satellite data are scientifically processed and used. Germany has made a disproportionately higher contribution to this programme and plays a leading role. German institutions such as DWD, DLR, and IUP Bremen have assumed responsibility for deriving atmospheric GCOS variables in this context.

With the Copernicus/GMES programme (Global Monitoring for Environment and Security) jointly initiated by ESA/EU, Europe is ensuring long-term continuity for many other climate-related observations, especially satellite observations. The first phase of the third part of the ESA programme was adopted at the end of 2012 and will complete the development of the GMES Space Component by about 2020. The EU is responsible for operating the systems and setting up the services. Alongside GALILEO, the Copernicus/GMES System is Europe’s most important contribution to the Global Earth Observation System of Systems (GEOSS).

Germany makes further contributions to observing the climate system with input from its national space programme. Data provided by the German radar satellite TerraSAR-X has been used since 2007 to detect ice sheets, for example, as well as many other climate parameters . The TanDEM-X mission is used to generate a global elevation model that is an important basis for many climate-related issues.

The record high output of carbon dioxide caused by burning fossil fuels and changes in land use in recent years has led to a rapid rise in CO_2 in the atmosphere (see report by the Global Carbon Project 2007). CO_2 monitoring will therefore also become an important task for Earth observation systems (such as the Integrated Carbon Observation System ICOS[91]).

7.2.2. Data and information management

A range of different information systems is available in Germany to assist users in searching for data using data catalogues and meta-databases, in some cases with direct online access. Coordinating and harmonising the establishment of environmental information systems is the responsibility of the Standing Committee on Environmental Information Systems (StA UIS) of the Joint Working Party of the Federal Government and the Länder on Climate, Energy, Mobility - Sustainability (BLAG KliNa). The central access point for Geo Data Infrastructure Germany (GDI-DE) is Geoportal Germany (www.geoportal.de) and the Geodata Catalogue.de search facility which is

[91] http://www.icos-infrastructure.eu/

integrated into it. It was developed and is operated by the Federal Agency for Cartography and Geodesy (BKG) on behalf of the GDI-DE steering committee composed of representatives of the federal government and the Länder. In terms of organisation and implementation, it is already achieving at national level what the European Spatial Data Infrastructure (ESDI) is aiming for at European level and what GEOSS is seeking to achieve at global level: provision of a central search facility for researching and using distributed geodata and geo services.

Sharing environmental data in Germany is regulated by the Spatial Data Access Act (Geodatenzugangsgesetz) of 10 February 2009, in the version of 7 November 2012, Federal Law Gazette (BGBl) I, p. 2289). The timetable for sharing data follows the provisions of the European INSPIRE Directive.

GeoPortal Germany, which is constantly being expanded, gives access to information systems connected with geoinformation. A selection of these systems is described below.

The Federal Maritime and Hydrographic Agency (BSH) collects oceanographic data acquired by German institutions in the German Oceanographic Data Centre (DOD). The Marine Environmental Data Base (MUDAB) is a joint project between the Federal Environmental Agency (UBA) and the central database in the monitoring programme for the marine environment of the North Sea and Baltic, which is jointly run by the federal and Länder governments.

The Deutscher Wetterdienst (DWD) runs the National Climate Data Centre (NKDZ), which contains the meteorological observations from the various networks of monitoring stations in the Federal Republic of Germany and the statistical parameters derived from them, along with time series dating back to the 18th century. Data on special physical/chemical issues is collected at the meteorological observatories. International data centres with global datasets also provide data, which is added to this national data. They include GPCC with global precipitation analyses, CMSAF with climate monitoring products and satellite-based climatologies and the Global Collecting Centre (GCC), which provides global maritime data. The Climate Data Centre (CDC) at DWD has created a central portal providing access to all this data.

In addition to the national climate archive, DWD also collects and archives the international data collected under WMO’s World Weather Watch programme and disseminated by the Global Telecommunication System (GTS). In conjunction with the Japan Meteorological Agency (JMA), Deutscher Wetterdienst also runs a centre that monitors the availability and quality of climate data from stations in the GCOS Surface Network (GSN) (see section 7.2.1.1). DWD deals with precipitation data and JMA with temperature. With external support in the field of atmospheric physics, the Federal Environment Agency (UBA) is setting up one of three centres worldwide for data quality assurance and control within Global Atmosphere Watch (GAW).

The German Climate Computing Centre (DKRZ) acts a supraregional service centre, carrying out climate simulations and operating the technical facilities needed to process, analyse and share relevant data. To improve sharing of climate-related model data, DKRZ is part of a system of national and international databases available to German and other European partners. This means that this climate model data can be accessed by both scientific institutions and major research institutes in Germany.

Paleoclimate databases are run by the Alfred Wegener Institute for Polar and Marine Research (with the PANGAEA information system, which includes the paleoclimate database PKDB at Hohenheim University) and GFZ.

The German Environmental Information Portal (PortalU) provides central access to environmental data in public organisations and institutions. It is jointly run by the federal government and Länder governments and is managed – both in terms of content and technically – by the Coordination Center PortalU at the Lower Saxony Ministry of Environment and Climate Protection. A number of databases at the Federal Environment Agency and the Federal Agency for Nature Conservation (BfN) are directly connected:

- The Environmental Research Database UFORDAT
- The library catalogue (OPAC, including the environmental literature database ULIDAT)
- The Joint Substance Data Pool of the German Federal Government and the German Federal States (GSBL)
- The German Environmental Specimen Bank (UPB)
- The Federal Environment Agency's environmental data catalogue
- BfN's literature database DNL-Online

Other examples of information systems providing data on the state of the environment in Germany are the landscape information systems of the Federal Agency for Nature Conservation (LANIS), relevant information systems at the Federal Office for Agriculture and Food (BLE) and the various information systems of the Länder.

The Soil Information System at the Federal Institute for Geosciences and Natural Resources (BGR) is maintained in close collaboration with the geological offices of the Länder (Staatliche Geologische Dienste, SGD). It contains and shares nationwide data on soil. The data is used in virtually every supraregional and national development and advisory project related to land use and changes in land use. It is updated and quality assured on an on-going basis and harmonised with other countries in Europe under international agreements.

Germany has the following data and information systems relating to international activities:

DLR's Applied Remote Sensing Cluster stores, manages and analyses satellite remote-sensing data. The DLR institutes that belong to the cluster are involved in numerous national, European and international activities related to sharing satellite-based climate variables. They include data systems as part of relevant soil segments, such as ERS-1/2 and METOP, a World Data Center for Remote Sensing of the Atmosphere (WDC-RSAT), and the development of algorithms for climate variables. Users can obtain DLR's products on the Internet at DLR-EOWEB.

International data centres for data relevant to the global water cycle have been set up in Germany as part of WCRP (both of them key components of GCOS and GEOSS):

- At the Deutscher Wetterdienst (DWD), the Global Precipitation Climatology Centre (GPCC) which provides global precipitation analyses for climate monitoring and climate research

- At the German Federal Institute of Hydrology (BfG), the Global Runoff Data Centre (GRDC)

Central archives of data collected worldwide have been established, including one for marine research at the GEOMAR Helmholtz Centre for Ocean Research as part of IGBP's core project JGOFS, and one for paleontological data at the Alfred Wegener Institute for Polar and Marine Research (AWI). Under the WCRP core project WOCE, data assimilations (dynamic interpolation of data using global models) are performed at a Special Analysis Centre (SAC) at the Max Planck Institute of Meteorology (MPI-Met) and in conjunction with the Federal Maritime and Hydrographic Agency (BSH).

Further information can be found in the book entitled *Die deutschen Klimabeobachtungssysteme. Inventarbericht zum Global Climate Observing System (GCOS)*, published in 2013 by the Deutscher Wetterdienst (DWD).

7.3. Climate impact research

Findings from climate impact research, which investigates the interactions among climate change, on the one hand, and natural and human systems on the other (socioeconomic systems) create the scientific basis for specific climate change adaptation measures. They also form the basis for evaluating the risks associated with human influence on the climate system and therefore for setting mitigation goals.

BMBF's DEKLIM climate research programme has laid important groundwork in this area. We do not yet have sufficient understanding of the basic principles of some highly complex processes to be able to reliably simulate them in climate models. Observation data is often not sufficiently detailed. In other cases, more efficient methods need to be found to enable the processes to be adequately taken into account in computer models. To improve this knowledge base, new observation methods and systems are constantly being established and research to achieve a better understanding of the underlying processes is being done by BMBF, DFG and the major research institutions, including, for example, the Max Planck Institute for Meteorology and the Helmholtz Climate Initiative REKLIM, a consortium of nine research centres within the Helmholtz Association. The new BMBF funding measure on clouds and precipitation processes in the climate system promises to reduce systemic uncertainties. It will seek to acquire new insights about cloud and precipitation processes through better observations and high-resolution simulations. In the past, only statistical estimates were possible in this area. The $HD(CP)^2$ programme simulates cloud formation and precipitation processes and also offers an unprecedented degree of detail. This produces new and considerably more reliable insights, which are needed for climate projections, and thus helps both industry and society to prepare appropriately for the challenge posed by climate change.

BMBF and BMVBS are supporting the further development of the regional climate models COSMO-CLM (CLM Community) and REMO with the aim of improving their suitability for use as input datasets for high-resolution model simulations to assess the impact of climate change. To make it possible to identify the full scope of future climate trends, there are plans to further develop ensemble analyses as a basis for probabilities, including all available regional climate simulations for Germany based on the new IPCC RCP scenario (representative concentration pathways).

Within the priority area looking at global change and the water cycle (GLOWA), the primary aim was to find solutions to exceptional challenges arising from the regional effects of global changes to the environment resulting from how water resources are used and managed. To this end, scientifically sound, integrative strategies to safeguard the availability, quality and distribution of water were developed within a funding measure which ran until 2012. They took into account interactions among global ecosystems and socio-economic conditions resulting from climate and precipitation variability, influences on the water balance and water availability associated with the interaction between biosphere and land use, and use conflicts.

The Potsdam Institute for Climate Impact Research (PIK) was established in 1992 to work on climate impact research issues. Natural and social scientists develop interdisciplinary insights, which in turn create a robust foundation for decisions in politics, business and civil society. The key methodological approaches used at PIK are system and scenario analyses, quantitative and qualitative modelling, computer simulation and data integration. PIK is involved in numerous national and international collaborations.

Furthermore, in 2009, BMBF and the state of Brandenburg founded the Potsdam Institute for Advanced Sustainability Studies e.V. (IASS). The institute takes an integrated approach to transdisciplinary and international research into climate change, the components in the Earth system and sustainability. Its aim is to translate scientific knowledge into an integrated view of sustainability, centred around interdisciplinary and transdisciplinary approaches. Against this backdrop, insights from the natural sciences and engineering as well as the humanities and social sciences are integrated into the development of adaptation and mitigation strategies. IASS's mission is to promote science and research on global sustainability, train young scientists and foster an exchange of scientific information and dialogue involving the research community, politics, business, society and the arts. IASS's remit is to address sustainability issues scientifically and present them in such a way that the insights gained can create the foundation for the imminent processes of societal change and for impartial policy advice. The institute is actively involved in cutting-edge research and is supported by members of the Alliance of Science Organisations in Germany and its institutions. IASS seeks to establish partnerships with selected universities and other research institutes to intensify research collaboration throughout the world. One of the institute's key tasks is to stimulate strategic dialogue with representatives from business, politics, society and the arts and to communicate scientific knowledge to society. A network of national and international cutting-edge research institutions is being built. Partnerships with the Potsdam Institute for Climate Impact Research (PIK) and the German Research Centre for Geosciences (GFZ) ensure that IASS is an integral part of the centre of scientific excellence that Potsdam has become.

Predictions about the scope of possible future climate change, in both a spatial and a temporal sense, accompanied by information about the associated probability, provide an important foundation for adaptation research and decisions that need to be taken in that context.

In developing a model system for predicting climate trends, BMBF is creating the methodological foundation for decadal climate prediction (MiKlip; see also section 7.1.5). The aim is to develop reliable predictions with time scales of up to ten years for the climate in Central Europe (and Africa), including its extremes as influenced by natural climate fluctuations and anthropogenic climate change . These time scales play a key role in planning processes, especially in business. BMBF is currently implementing this funding measure on decadal climate prediction. This activity is incorporated into cooperation with European countries within a Joint Programming Initiative entitled Connecting Climate Knowledge for Europe (JPI Climate).

In many cases, a robust analysis of climate impacts for regions, sectors, businesses or national economies is now an integral part of and starting point for adaptation research, which makes use of approaches and methods from research on climate systems and climate impact (see also Chapter 7.5).

7.3.1. Ecosystems and biodiversity

Ecosystems and biodiversity are severely affected by the impact of climate change and at the same time play a key role in the global carbon cycle. To obtain robust conclusions about the biosphere's long-term reaction to climate change and the interactions among climate change, ecosystems and the biosphere, terrestrial ecosystem research studies the structure, functioning and dynamics of representative ecosystems such as forests, savannahs, rivers and lakes, agricultural landscapes and urban-industrial landscapes. Marine research studies marine ecosystems (see below). Ecosystem research provides important information about the vulnerability of vital ecosystems to climatic changes. At the same time, it also explores the possibility of using and managing ecosystems sustainably in order to improve people's lives, especially in the face of the problems presented by global change. The idea is to integrate knowledge gained in a range of different fields in order to recognise potential risks as soon as possible, develop options for action and work with local interest groups to implement them.

Project-specific funding has been allocated, for example, to projects within the funding priorities Biodiversity and Global Change or BIOLOG, and Biosphere Research – Integrative and Application-Oriented Model Projects – BioTeam. A current funding priority is Sustainable Land Management – Module A: Interactions Among Land Management, Climate Change Mitigation, and Ecosystem Services. They support regions that are particularly severely affected in developing sustainable land management systems. Projects are also being funded within ERA-Net BiodivERsA.

Institutional funding for ecosystem and biodiversity research studying the effects of climate change is given to several institutes within the Helmholtz Association of German Research Centres (HGF), the Max Planck Society (MPG), the Fraunhofer-Gesellschaft (FhG) and the Leibniz Association (WGL). In the Helmholtz Association, this research is being carried out in the Earth and Environment research field, in particular within the “Geosystem: the Changing Earth”, “Marine, Coastal and Polar Systems” and “Terrestrial Environment” programmes. The Leibniz Association carries out research in areas as biodiversity, oceans and lakes, and environment and energy. Other important institutions in Germany that work on the interactions between climate change and ecosystems include:

- Bayreuth Center of Ecology and Environmental Research (BayCEER)
- Biodiversity and Climate Research Centre, Frankfurt (BIK-F)
- German Centre for Integrative Biodiversity Research (iDiv)
- Ecology Centre, Kiel (ÖZK)

- Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas,Forestry and Fisheries
- Julius Kühn Institute, Federal Research Centre for Cultivated Plants

7.3.2. Coastal regions

Coastal and marine ecosystems have always been subject to constant change – sometimes very rapid change. Above and beyond the familiar, natural degree of change, anthropogenic changes have been become increasingly evident over recent decades. These changes are occurring on all levels right through to global shifts in atmospheric transports, global warming and rising sea levels.

It is considered a certainty that use levels will continue to rise in the future and that – combined with new types of use – will increase the pressure on the marine environment and its resources. At the same time, it is to be expected that the effects of anthropogenic climate change will become evident. Even now, changes in the ecosystem functions of coastal waters are beginning to be seen, although not enough is known about the underlying causes, and their full impact has not yet been recorded. It is difficult to predict future trends on that basis.

The framework programme Research for Sustainable Development (2010-2015) names the German coast as one of the four key regions in the world for Earth system research in which the effects of global climate change are manifesting especially quickly and/or are especially palpable. BMBF is stepping up project funding in this field of research.

This is based among other things on the Coastal Research Agenda for the North Sea and Baltic Sea (2010- 2020). The Agenda's overarching aim is to develop and constantly improve a scientific base for ecosystem-oriented and sustainable management of coastal resources. This aim is expressed in four guiding principles:

- New knowledge about using and conserving the ecosystem services provided by the German coastal systems in the light of changes in use and climate change
- Improving the ability to predict/estimate the effects of global change on coastal ecosystems
- Creating the foundations needed to establish sustainable infrastructure in coastal regions
- Research to facilitate evidence-based implementation of integrated marine policy at national and EU level

BMBF's coastal waters research portfolio includes other areas besides the activities taking place under the Coastal Research Agenda:

- The multinational Baltic Sea research funding network – BONUS – which comprises the eight riparian countries and is supported by the EU Commission
- Funding activities of the Coastal Engineering Research Council (KFKI)
- Bilateral coastal research cooperation with selected industrialised and emerging economies (Russia in Arctic coastal waters, Israel, Indonesia, China and South Africa in conjunction with Namibia and Angola)
- Collaboration as part of the Trilateral Wadden Sea Cooperation

With its coastal waters research activities, Germany is supporting a number of international research programmes: the World Climate Research Programme (WCRP), Land-Ocean Interactions in Coastal Zones (LOICZ), International Geosphere-Biosphere Programmes (IGBP), and UN marine policy (e.g., RIO+20). It also makes substantial contributions to implementing and further developing national and European policies, such as EU marine and environmental policy, especially with regard to complying with the European Marine Strategy Framework Directive (MSFD).

7.4. Energy and mitigation research

7.4.1. Energy research – overview

In 2011, the German government set out the broad lines and priorities of its funding policy for the next years in its 6th Energy Research Programme entitled "Research for an environmentally sound, reliable and affordable energy supply". This programme constitutes an important step towards implementing the Energy Concept of 28 September 2010, which underpins the government's intention to make the transition to the renewable energy age. The aim is for Germany to become one of the world's most energy-efficient and environment-friendly economies with competitive energy prices and a high level of prosperity.

To achieve these goals, the government has added a new strategic approach to its energy and climate policy. It focuses on better funding for research and development in the area of sustainable energy technologies. The federal government's 6th Energy Research Programme forms the basis for this. It is a joint programme of the Federal Ministry of Economics and Technology (BMWi), the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of Food, Agriculture and Consumer Protection (BMELV) and the Federal Ministry of Education and Research (BMBF). Lead agency in developing it was the Federal Ministry of Economics and Technology.

The 6th Energy Research Programme was guided by the government's Energy Concept of 28 September 2010, which was updated to reflect the re-evaluation of nuclear energy following the earthquake and tsunami in Japan on 11 March 2011 and the major nuclear incidents it caused. According to the cabinet decision of 6 June 2011, the government's aim is to speed up the transition to the renewable energy age even further and, in the process, guarantee a reliable, affordable and environmentally sound energy supply in Germany. The Energiewende, or energy revolution, is a challenge of the highest order for politicians and society. Achieving it without scientific expertise is inconceivable.

In its funding for research and development in the energy sector, the federal government is setting a new emphasis in four key respects:

- Setting a strategic focus: the funds available to the government departments to support research and development will be concentrated more specifically on those technologies and on technology systems that are important if the country is to transition to a sustainable energy supply as the government intends. The following areas are thus of central importance: renewable energy, energy efficiency, energy storage technologies and grid technology, integrating renewables into the energy supply and the interaction of these technologies within the system as a whole.

- Cross-departmental collaboration: in selected fields that are important for Germany's future energy supply, the government departments concerned will develop joint funding initiatives. Close and well-coordinated collaboration offers several advantages: existing core competences can be better consolidated, synergistic advantages can be exploited and the concentrated deployment of funding makes it possible to achieve the necessary technological breakthroughs. BMWi, BMU and BMBF have already launched joint funding initiatives in the field of energy storage systems and future grid structures. A further initiative on solar building design – energy-efficient cities is set to follow. Other sectoral ministries, such as the Federal Ministry of Transport, Building and Urban Development, play an important role in cross-departmental collaboration at the interface between research and innovation.
- International cooperation: nowadays, technological developments must be evaluated from a global perspective. The German government translates this principle into action by improving international cooperation in the field of energy research. It is of particular importance here to foster better connections among the research work within the European Union. International cooperation is of key importance to Germany since its economy is geared to the global markets. In discussions with the business and scientific community, the government will review how international collaboration on research and development of modern energy technologies can be improved and adapted to the new challenges.
- Consultation and coordination: an accelerating trend towards differentiation and specialisation is a key feature of energy research activities in Germany. In view of these developments, the Coordination Platform for Energy Research will be expanded and strengthened. The idea is to create as much added value as possible for the "research euro" provided by public funds. The Coordination Platform is designed to improve collaboration between the federal government and the Länder and with European funding institutions.

The 6th Energy Research Programme is the result of a comprehensive consultation process. It has been coordinated with the research activities of the private sector, scientific institutions and energy research in the Länder. The programme's general thrust incorporates coordination with the EU's research activities and with partner countries in the International Energy Agency (IEA). Germany has good basic research, an efficient scientific/technical infrastructure and outstanding industrial energy research. The above-average involvement of German partners in the EU Research Framework Programme and the fact that international auditors give the Helmholtz Association's research programmes ratings of good to excellent testifies to this.

The German government funds research and development of technologies connected with energy in numerous different programmes. All these measures are part of its High-Tech Strategy. The centrepiece of the government's funding for technology is the Energy Research Programme. It sets the general direction of the government's energy research policy.

Two complementary instruments, which also interact, are used to support research and development: project funding and institutional funding.

The federal government's 6th Energy Research Programme attaches particular importance to setting a new direction in project-oriented funding for research and development of modern energy technologies. This makes it more likely that Germany will be able to respond flexibly and achieve rapid success in modernising its energy supply and making the transition to the renewable energy age.

A key feature of the way research and development in the field of energy will be funded in the future is the close collaboration among the ministries responsible within the federal government based on the specific sectoral programmes:

- The main priorities of BMWi's project funding in the area of non-nuclear technologies cover the entire energy chain, focusing in particular on energy-optimised building design; energy-efficient cities; energy efficiency in industry and the trade, commerce and service sectors; energy storage systems and grids, including electromobility, power station technologies and CO_2 capture, which are key elements of electricity management; fuel cells/hydrogen and systems analysis. BMWi's project funding for research into nuclear safety and final disposal concentrates on maintaining and expanding scientific expertise in these areas. The Helmholtz Association receives institutional funding from BMWi for energy research, with funding going to the German Aerospace Center (DLR) for research into combustion technology, solar energy and systems analysis.
- In the field of renewable energy, BMU funds strategically focused, broad-based research and development in wind energy, photovoltaics, geothermal energy, thermal solar energy, solar thermal power stations, hydropower and marine energy. Funding is also given as a priority to projects that – as part of general research on renewable energy – contribute to achieving the transition to a renewable energy system.
- BMELV's project funding covers a range of technologies for using bioenergy, including solid, liquid and gaseous forms of energy. One of BMELV's key priorities is institutional funding for the Deutsches Biomasseforschungszentrum (DBFZ).
- BMBF is active in the field of basic research. Its project funding prioritises photovoltaics, bioenergy, wind energy and energy efficiency. To identify long-term options for action, BMBF also funds research into nuclear fusion. BMBF provides funding for young scientists in the field of research into nuclear safety, waste disposal and radiation. This ensures that Germany maintains the capacity needed in this field. BMBF is also responsible for key research in the Helmholtz Association's energy department, which makes an important contribution to Germany's status as a centre of research excellence.

Along with the 6th Energy Research Programme, BMBF's funding priority BioEnergie 2021 also aims to achieve a marked increase in the biomass share in the energy mix. It funds projects at universities and non-university research institutions that collaborate with private-sector partners to develop new processes for converting biomass and to optimise energy crops. A total of €50 million in funding was made available over a period of five years.

Increased use of products from biomass, especially in the field of energy supply, promotes sustainability and sustainable cycles. Re-using biomass products in a closed-loop system and conserving natural resources are an integral part of this. Another key element – in the case of sustainable heat production, for example – is climate-neutral combustion, where the amount of carbon dioxide emitted does not exceed the level that was bound within the plants during their growth period. There are good environmental arguments for this, and it also benefits national economies in terms of agricultural, energy, economic and social policy. Rural areas in particular can benefit significantly from the opportunity to supply renewable energy sources.

7.4.2. Key technologies and cross-cutting technologies for climate protection

Research and development in the field of key technologies plays a crucial role in addressing the challenges presented by climate change. They improve climate protection in numerous applications. For example, new high-tech materials make for lighter vehicles, more powerful batteries and more environmentally sound buildings. Developments in microsystems and ICT have improved the control and therefore the energy efficiency of production facilities and energy installations. The following key technologies and cross-cutting technologies are funded through BMBF programmes and measures:

- Information and communication technologies (ICT 2020 - Research for Innovation Programme)
- Photonics (Photonics Research Germany funding programme)
- Production technologies (such as Resource-efficient production funding priority)
- Material technologies (WING – Materials Innovations for Industry and Society)
- Biotechnology (Biotechnology framework programme)
- Nanotechnologies (Action Plan Nanotechnology 2015)
- Microsystems technology (Microsystems Technology framework programme)
- Innovative services (Innovation With Services programme)

Innovation alliances and funding for traditional collaborative projects with partners from research and industry are important instruments in this area. Innovation alliances are a new instrument in research and innovation policy. These strategic collaborations between science and industry are tailored to a particular application or future market. Innovation alliances achieve a special kind of economic leverage. The goal is to attract five euros from industry for each euro provided by the government. Climate research and energy are key areas for innovation alliances. The following innovation alliances have been set up in those fields:

- Organic photovoltaics (OPV) (energy production/photovoltaics): the aim is to improve the efficiency of solar cells made of organic materials and increase their service life so that they can become an inexpensive alternative to today’s solar cells.
- OLED initiative (energy efficiency/lighting): organic light-emitting diodes convert electricity into light extremely efficiently and can be manufactured as thin, pliable films.
- CarbonNanoTubes (InnoCNT) (climate/chemistry): the aim is to transfer and make use of the outstanding properties of carbon nanotubes. In particular, applications in energy technology (such as fuel cells, energy storage systems, wind power and solar cells) and environmental technologies (such as desalination) are being studied.

- Lithium-ion battery (LIB 2015) (energy storage/automobiles, renewable energy): the aim is to develop a new generation of high-performance batteries for use in electric or hybrid vehicles and for storing energy as part of renewable energy systems.
- Photovoltaics: the aim is for photovoltaic systems to be competitive without subsidies, i.e. to achieve grid parity.

Funding measures in the traditional area of collaborative research were instigated to address resource efficiency in industrial processes, building services and transport engineering. The aim is to significantly improve the efficiency of industrial processes at all stages of the value chain, while at the same time reducing the volume of resources used and lowering the energy consumption of buildings and transport infrastructure. The funding measures that do this within WING include Materials for Resource-Efficient Industry and Society – MatRessource – and New Materials for Urban Infrastructure – HighTechMatBau.

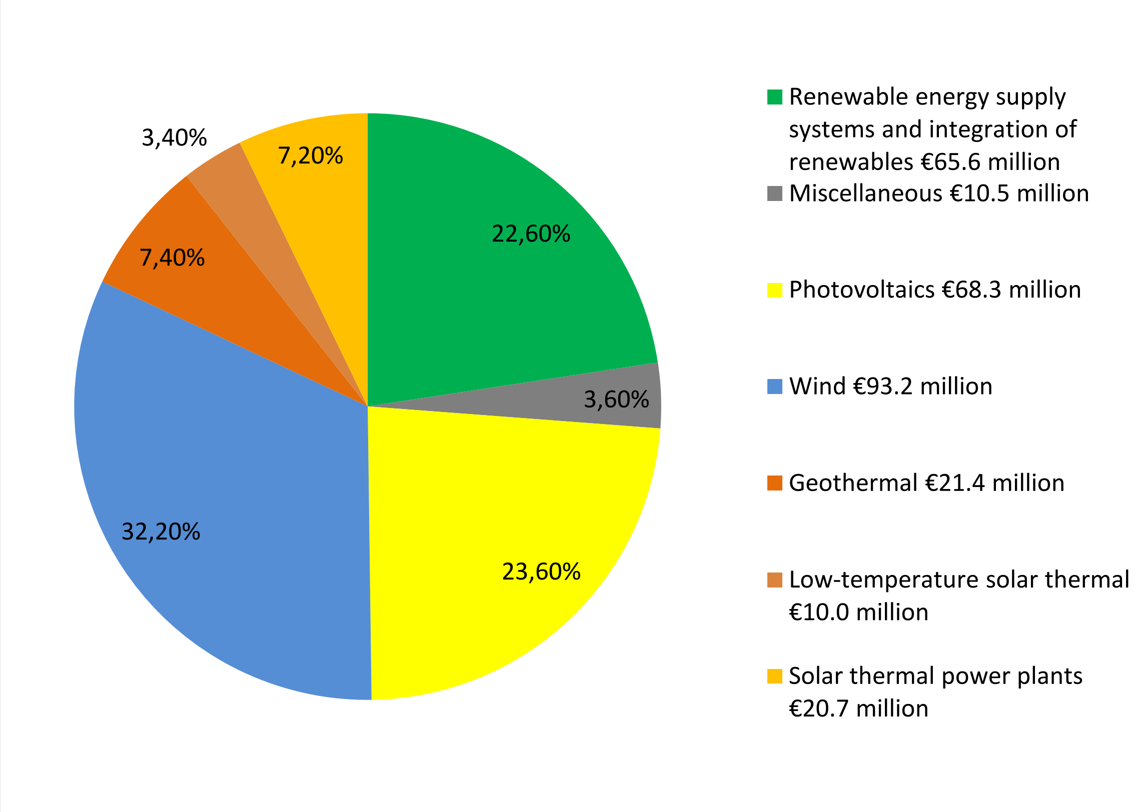
7.4.3. Research on renewable energy

Germany is switching its energy supply to a system that is based on renewables and is environmentally sound, reliable and affordable. The challenges for the next years involve achieving this transition at a cost to society as a whole that is as low as possible and reorganising the energy supply systems using smart technology.

Research funding from the Federal Environment Ministry (BMU) research funding makes an important contribution towards addressing these challenges. BMU is increasing its project funding for renewable energy to support the transition and continuing to focus on applications-oriented research and development (R&D). The spectrum of subjects ranges from generation technologies (wind, solar, geothermal) through to technologies that are key to making the transition to an energy supply system based on renewables, i.e. primarily grids and storage systems. Funding goes to outstanding high-calibre projects that contribute to switching to an energy mix based predominantly on renewables, further lowering the costs of renewable energy, increasing the competitiveness of German companies in these global markets that will be of key importance in the future and making the technologies more environmentally sound and nature-friendly. Where appropriate, BMU collaborates with other federal ministries to pool research funding for cross-cutting issues.

BMU supported research and development projects in the field of renewable energy with a total of €153 million in 2012. This equates to an increase of €32.5 million over 2010 and is three times as much as in 2004. This rise in funding made it possible to significantly increase the number of new projects approved in 2012 and the volume of funding: BMU approved 370 new projects with a total funding volume of almost €290 million – which makes the funding for newly approved projects more than twice as high as in 2010 and almost four times as high as in 2004.

Figure 34: Breakdown of new projects approved in 2012 by funding priority



All areas benefited from the increase in funding. In view of the key role in energy policy played by technological solutions for expanding and upgrading the grid, smart solutions to balance energy supply and consumption and important medium and long-term energy storage systems, BMU is continuing to expand its SystEEm funding priority (Renewable energy supply systems and integration of renewable energy).

Prices and margins in the wind energy sector are set to decrease in the foreseeable future. This makes it all the more urgent to ensure that technologies retain their leading edge – for example, with regard to grid characteristics, rotor blades and drive technology. BMU therefore supports a number of large-scale test rigs for components such as rotor blades, nacelles and support structures at major testing facilities, which are unparalleled in the world. At the RAVE (Research at Alpha Ventus) conference in May 2012, the insights gained by BMU's research initiative of the same name became obvious with regard to driving down cost, reliability and ecological impacts.

The photovoltaics industry is currently undergoing a process of consolidation. In this difficult phase it makes most sense to focus funding on very application-related, practice-oriented collaborative projects in which industry is closely involved. In addition to this kind of project, forerunner projects at institutes with an implementation horizon of more than five years are also important elements in research funding.

Other areas where funding has been expanded are geothermal energy, solar thermal power stations and low-temperature solar thermal. These research priorities have further backing from the programme to fund research and development in the area of optimising climate-friendly technologies for the utilisation of biomass for energy and basic research on renewable energy.

7.4.4. Mitigation in industrial processes and products - integrated environmental protection

In the field of action concerned with sustainability strategies for industry and business, which is part of BMBF's framework programme Research for Sustainability, not only the area specifically dedicated to climate protection strategies but also others exploring, for example, where action is needed and the value chains associated with them, resource-intensive production systems, and key technologies in the transition to a new energy system can make a direct or indirect contribution to mitigating climate change.

Instead of taking remedial action, a preventive and integrated approach to environmental protection is often more effective and far-reaching. This involves considering not only technical aspects but also the legal and social environment and the demand side – with a view to achieving industry-related sustainability. The technology-oriented component of funding for research on the green economy is designed to optimise integrated environmental protection in production processes and products and to create closed loops, so that product and production-related emissions (waste gases, solid waste, waste water) are prevented and the use of resources and energy in manufacturing, using and disposing of products is minimised from the outset.

The Concepts for Sustainability in Industry and Business funding priority and, in particular, the Innovative Technologies for Resource Efficiency funding measure also contribute to mitigating climate change within the framework programme Research for Sustainability.

Within the funding priority concerned with Concepts for Sustainability in Industry and Business, bionics also plays a key role in developing innovative approaches. Bionics uses nature's vast repertoire of ideas to achieve innovative solutions for applications-oriented, usually technical, challenges. Bionic approaches often make it possible to lower energy and material consumption, including in areas in which conventional methods have thus far permitted only small steps towards improving the status quo. The funding measure launched entitled BIONA – Bionic Innovations for Sustainable Products and Technologies – was launched in 2006 and primarily funded projects which, by transferring energy and resource-saving principles from nature's pool of ideas, make valuable contributions to achieving a green economy and industry-related climate protection. The funding measure ended in 2012.

BMBF's SME Innovative funding initiative, which was launched in 2007, also contributes to sustainability and climate change mitigation. This initiative aims to strengthen the innovation potential of small and medium-sized enterprises (SMEs) in the field of cutting-edge research and to make BMBF's research funding more attractive for them. One of the seven fields of technology currently being funded under the SME Innovative initiative is concerned with resource and energy efficiency and climate change mitigation. Within this focus area, all topics are eligible for support under the funding measure, which targets innovative SMEs in any industry. Within the funded projects on resource and energy efficiency, SMEs – working alone or in collaboration with other companies or research institutions – develop specific contributions to sustainable use of resources.

Another of BMBF's funding priorities is "klimazwei": as a result of climate-related research that has been conducted to date, policymakers, the business community and society can draw upon a huge storehouse of knowledge to guide their actions. The logic of the framework programme Research for Sustainability adopted by the German government in mid-2004 dictates that this knowledge should now be turned into action. The funding measure entitled Klimazwei - Research for Climate Protection and Protection from Climate Impacts aims to do exactly that. It takes a two-pronged approach consisting of complementary strategies that seek to:

- Prevent or reduce climate impacts caused by human activity that are harmful for society and the environment
- Adapt to climate change and extreme weather events (see section on adaptation to climate change)

Achieving the national emissions reduction target entails considerable expenditure for German industry within the European Emissions Trading Scheme. The mitigation topics funded by klimazwei therefore cover a broad spectrum of implementation-oriented research to support companies in taking the initiative in areas covered by emissions trading. The projects are in areas such as transport and logistics, information and communications and industrial production and processes.

The funding measure concentrates on the development of new technologies, processes and strategies with which a marked reduction in the emission of greenhouse gases can be achieved. These gases are carbon dioxide and all other climate-relevant gases as defined under the Kyoto Protocol. The project funding was available between 2006 and 2012.

Technologies for Sustainability and Climate Protection – Chemical Processes and Use of CO_2 is a funding programme in which future scenarios showing possible trends in CO_2 concentrations in the atmosphere clearly demonstrate that strategies to prevent energy-based CO_2 emissions will not be sufficient on their own to halt climate change. Additional measures to reduce greenhouse gas emissions have to be considered instead, such as using CO_2 as a resource. This calls for new climate-friendly technologies to:

- Use CO_2 as a resource
- Reduce greenhouse gas emissions from production processes by using functional liquids as an additive in synthesis, processing and production
- Increase energy efficiency in production through improved equipment and process engineering
- Encourage innovations from within the chemical industry as a basis for developments on CO_2 separation and activation in other industries

Thirty-three research projects are being funded in this area between 2009 and 2016, with funding totalling €100 million.

7.4.5. Mobility and climate change mitigation

The German government’s third transport research programme on Mobility and Transport Technologies came into force in 2009. The programme, for which the Federal Ministry of Economics and Technology (BMWi) is the lead agency, comprises three strategic priority areas: Intelligent Logistics, Mobility in the 21st Century and Intelligent Transport Infrastructure. The programme concentrates not only on technical and non-technical aspects of road and rail transport, but also on energy-related and environmental aspects, as well as cross-cutting issues such as sustainable organisation of urban transport. A great number of the research and development projects funded make a direct or indirect contribution to meeting climate change targets. At the same time, the targets specified by the federal government's High-Tech Strategy 2020 are also met in the project on Sustainable Mobility, which is a key area for the future.

A funding priority on future-oriented logistics networks and freight transport aims to help reduce road traffic by shifting freight transport to more environmentally sound modes such as rail and waterways and optimising vehicle loads for maximum efficiency. Another funding priority entitled From Door to Door – a Future-Oriented Public Transport Initiative aims to make public transport a stronger and more attractive option for entire journeys. This will involve providing seamless information on transport connections for travellers. A number of transport management projects (such as the large-scale project entitled UR:BAN) promote innovative approaches that incorporate user-friendly driver assistance systems and smart network management to organise road traffic more efficiently and at the same time reduce pollutant emissions.

In addition to the third transport research programme, the government's electromobility programme, which was adopted in 2011, also plays a role in achieving climate targets. The aim is have a million electric vehicles on the road in Germany by 2020. Automobile manufacturers, suppliers, energy suppliers and ICT companies are working together within the National Platform for Electric Mobility (NPE) to achieve this goal. Further strategies for an alternative energy supply in the transport sector are being explored within the National Hydrogen and Fuel Cell Technology Innovation Programme, which is part of the federal government's Mobility and Fuels Strategy.

Apart from the endeavours to introduce alternative drive systems, transport research also continues to work on optimising conventional drives (combustion engines, for example), where potential for improvement is estimated at 20-30%. This would further reduce consumption of fossil fuels.

7.4.6. Carbon capture and storage

In the power station sector and in energy-intensive industries with high process-related CO_2 emissions, carbon capture and storage (CCS) can be regarded as an option for achieving the target of reducing CO_2 by 80-95%. CCS technology is currently still in the development stage, and its economic and technical feasibility has therefore not yet been tested on a commercial scale. Similarly, the question of whether it could have a harmful impact on humans and the environment has not been examined conclusively. Only research and demonstration projects that meet the highest environmental and safety standards can supply answers to these questions.

Developing CCS technology further hinges on an exploration of all the issues that could arise with permanent geological storage. It is possible only if the research investigates and assesses possible risks and long-term safety without attachment to any particular outcome. Research on geological CO_2 storage has been funded since 2005 under the special Geotechnologies programme, which is part of the framework programme Research for Sustainable Development (FONA).

BMBF has a two-pronged funding strategy. It funds two types of research, one which seeks to answer basic questions about geological CO_2 storage, irrespective of particular location, and the other which explores and operates specific test storage facilities.

Within the research dealing with basic issues, BMBF is funding 12 projects in 2013 with a volume of almost €13 million. BMBF currently contributes about €12 million to research for specific locations (research storage facility at Ketzin, Brandenburg). Funding for research projects on geological CO_2 storage will be largely completed when the special Geotechnologies programme is concluded at the end of 2014.

Within its energy research funding programme, the Federal Ministry of Economics and Technology (BMWi) funds applications-oriented research and pilot projects on CO_2 capture in the power station sector. Pre- and post-combustion and oxyfuel processes are being investigated, along with individual processes connected with integrated gasification combined cycle (IGCC) power plants. Research is also being carried out to establish whether CO_2 could have a corrosive effect on materials used to transport it.

7.5. Effects of climate change and adaptation to climate change

7.5.1. Achieving better estimates of future climate trends

Predictions of the range of climate change that might be expected in the future – both spatially and in terms of time – and predictions about their likelihood form an important basis for adaptation research and for assessing the risks associated with climate change and therefore the benefits of mitigation activities. Two projects are being carried out to supplement the basic elements mentioned in the German Strategy for Adaptation to Climate Change and the current state of knowledge as described in Annex H.1. to the Adaptation Action Plan. They are designed to allow conclusions about future climate trends to be drawn:

- BMVBS (DWD) and BMBF are involved in further developing regional climate models and probabilities for possible climate developments. The regional climate models COSMO-CLM (CLM Community) and REMO are being further developed with the aim of continuing to improve their suitability for use as input datasets for high-resolution model simulations for assessing the impact of climate change.
- With the development of a climate prediction model, BMBF is creating the methodological basis for decadal climate prediction (MiKlip) (2011 – 2015). The aim is to develop reliable predictions with time scales of up to 10 years for the climate, including its extremes, as influenced by natural climate fluctuations and anthropogenic climate change for Central Europe (and Africa). These time scales play a key role in planning processes, especially in business. BMBF is currently implementing this funding measure on decadal climate prediction. This activity is incorporated into the cooperation with European countries within a Joint Programming Initiative entitled Connecting Climate Knowledge for Europe (JPI Climate).

Researchers (especially the Max Planck Gesellschaft) and DWD are also working together to develop a model platform for a new global climate model (successor to ECHAM). In parallel to this, BMBF will also explore the field of key uncertainties in climate modelling as part of its project funding programme.

Improving climate change impact assessments and vulnerability identification

A climate change impact assessment for Germany was last produced in 2005. It evaluated Germany's vulnerability for the first time. A strict distinction is made here between the terms "vulnerability" and "climate impact", which are often used interchangeably in professional circles. Within the Adaptation Action Plan, the term "vulnerability assessment" always includes a consideration of adaptive capacities. However, quantifying adaptive capacities still presents a methodological challenge and is therefore mostly replaced by expert opinions. This is just one example of the uncertainties that have to be dealt with in the German Strategy for Adaptation to Climate Change. An up-to-date, cross-sectoral vulnerability assessment for Germany, produced in compliance with uniform standards, is needed to support policy decisions about how the German Strategy for Adaptation to Climate Change should be further developed – including questions such as prioritisation of climate risks and the need for action – and for an evaluation of successful adaptation activities. A number of key projects on vulnerability identification and assessment for Germany have begun. They incorporate expertise from a range of government departments and sectoral agencies, a process which has been facilitated by developing existing cooperation into a vulnerability assessment network. They are described below.

A nationwide vulnerability assessment for Germany will be carried out by 2014 as part of a vulnerability network comprising higher federal authorities. It began with an analysis of existing regional and sectoral climate impact studies and vulnerability assessments. Since the existing studies are very heterogeneous and patchy, an additional nationwide assessment will be produced; it will cover all sectors and be based on a standardised, cross-sectoral method.

At the same time, a project conducted by the Federal Environment Agency is analysing Germany's vulnerability resulting from different processes of socioeconomic change. The impacts of climate change are simulated using process models and taking electricity and timber production as examples. The impacts of climate change are compared with non-climate processes of change: the impact of foreign trade structure on raw material supplies is investigated using network analysis and the development of social coherence as a factor of demographic trends is analysed.

Various climate change impact assessments and vulnerability assessments specific to particular fields of action supplement and back up the vulnerability studies that are cross-departmental and cover all fields of action and add to the results of KLIWAS (see Chapter 5.2) and the seven regional KLIMZUG projects (see below). BMBF is reviewing the need for research on climate change and security of supply. An exploratory study was carried out to review the research needed to systematically address how security of supply can be guaranteed for society under climate change conditions. The following vulnerability and climate impact studies for specific fields of action are already being conducted or are planned:

<u>Human health</u>

Since 2011, various projects have been initiated by the Federal Ministry of Health (BMG)/Robert Koch Institutes (RKI) and BMU/UBA. Key issues for climate impact studies include climate-related trends in morbidity and infectious diseases (in particular, vector-transmitted diseases, i.e. diseases transmitted by animals), new health risks (for example, posed by the oak processionary moth) and evaluation of existing national information systems as a factor in reducing vulnerability.

Soil

BMU/UBA are conducting projects to study the effects of climate change on soil erosion caused by wind, on the trafficability of arable soils, including the risk of compaction, and on changes in the organic carbon content of soil.

Business, industry, and small and medium-sized enterprises

Since 2011, the Federal Ministry of Economics (BMWi) has instigated a number of projects in which a study of extreme weather events triggered by climate change plays a central role. For example, a research project began in November 2012 which will identify and evaluate specific risks and effects of climate change on Germany's infrastructure and value chains in exposed manufacturing industries. The aim is to create a tool that can be used to identify where companies may need to adapt and offer options to help them make decisions.

Real estate

In 2011, the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), was commissioned by the German government to develop a geoinformation system (GIS-ImmoRisk) to assess the risks of future climate impacts in Germany. The system will help land and property owners to assess climate risks. The first step towards this goal was taken in 2013 when ImmoRisk was released. This is a tool that permits snapshot risk assessments for extreme weather events at 15 sites based on existing datasets. Work to develop GIS-ImmoRisk on this basis will begin in 2014.

Spatial planning

A model project on spatial development strategies to address climate change, which ran from 2010 to 2013 in eight model regions, identified and evaluated climate impacts on the basis of regionally specific circumstances and methods. A standardised consistent methodology, which was used across the country, was described in a climate impact assessment methodology handbook published in autumn 2013. The handbook is a regional planning tool with three levels of intensity.

Urban planning

One of the outcomes of an experimental housing and urban development programme addressing urban strategies and potential for tackling climate change (StadtKlimaExWoSt) was that an analysis was carried out in nine model local authorities to establish how climate change affects them. An urban climate pilot with a vulnerability module guides small and medium-sized local authorities through a series of menus enabling them to access existing knowledge and estimate for themselves how vulnerable they are to climate change. (www.klimastadtraum.de -> Stadtklimalotse)

Tourism

While BMWi has investigated the effects of climate change on tourism and shifts in demand, carrying out a project to evaluate possible adaptation measures in various sectors, including tourism (2010/2011), BMU will be the lead agency identifying the effects of climate change on various types of landscape that are important to the tourism industry. It will process the data obtained from model cases in order to create a basis for environmentally sound spatial planning for tourist destinations.

Transport

The Federal Ministry of Transport, Building and Urban Development and the Federal Railway Authority (BMVBS/EBA) will investigate the effects of climate change on rail infrastructure and rail transport, ascertain the vulnerability of this mode of transport and develop appropriate adaptation activities.

The BMVBS/KLIWAS research consortium (BfG, DWD, BAW, BSH) are investigating the effects of climate change on waterways and navigation in a programme finishing at the end of 2013; it also developed and evaluated adaptation options (see Chapter 5.2).

7.5.2. Applied adaptation research

In the field of applied adaptation research, the German government funds scientific studies on adaptation to climate change and publicises the research findings. In many cases, federal government agencies and experts – including those from Länder agencies and the scientific community – share information.

Since mid-2011, BMBF has been financing cross-sectoral projects on the economics of climate change, which – from a primarily national economic perspective – formulate action-oriented adaptation models and activities and approaches to estimating the costs, risks and opportunities associated with low-carbon growth and development models for German society. Since 2010, the Federal Environment Agency (UBA) has been conducting a project to develop an integrated economic evaluation of economic instruments to promote adaptation to climate change. In an UBA project which began in 2012, instruments and measures for adaptation to climate change are analysed and evaluated, including from a national economic perspective. The projects that are part of BMBF's KLIMZUG funding priority (on managing climate change in the regions for the future) work in a cross-sectoral way. The aim is to develop innovative climate change adaptation strategies for seven selected model regions in Germany, based on local circumstances in each region. This, in turn, should make it possible for anticipated climatic changes to be taken into account in regional planning and development processes. In this way the programme not only drives forward the development and use of new technologies, processes and strategies for climate change adaptation in regions, but can also strengthen their competitiveness in the long-term.

To that end, networks designed to be workable in the long term will be established to bring together the private and public sector, the scientific community and civic society stakeholders at regional and local level. The networks create the necessary capacity to take action in the regions to adapt to changing conditions on the basis of the specific circumstances of each region and with the involvement of local decision-makers.

BBSR was commissioned by the federal government to carry out a number of model spatial planning projects within KlimaMORO and within the StadtKlima and ImmoKlima research fields that are part of its experimental housing and urban development programme (ExWoSt). Twenty-five model and pilot projects studied transferable and integrated climate change mitigation and adaptation strategies used in regional planning and urban development practice and the housing and real estate industry. Further research on climate impacts and risk assessment (ExWoSt ImmoRisk) has also been carried out since 2011. The findings and products can be accessed on the programme's portal at www.klimastadtraum.de.

Expertise from the social sciences and humanities has also been incorporated into the discourse: BMBF's interdisciplinary funding initiative on the social dimensions of climate protection and climate change helps to enhance competence in the social sciences and the humanities in the field of climate research by increasing understanding of the social causes and effects of climate change and supporting the design of climate change mitigation and adaptation policies. In a cross-sectoral perspective, UBA is conducting two projects to investigate how people's ideas of a climate-resilient society could contribute to refining the German Strategy for Adaptation to Climate Change, and what pathways towards that climate-resilient society might look like. This was made more specific using the possibilities open to climate-resilient regions. The importance of infrastructure in achieving a climate-resilient society is stressed in this context. Another UBA project has evaluated the options for action open to spatial planners and sectoral planners to adapt settlement patterns and infrastructure to climate change in a way that is accessible for practitioners. It has also summarised them in a practical guidance document. Two other UBA projects also focus on supporting practitioners: a project on good practice in climate change adaptation in Germany compiles knowledge on adaptation for stakeholders at regional and local authority level and identifies examples of good practice with the aim of supporting adaptation in business and individual behaviour. A project to empower local authorities focuses on which factors and conditions have a decisive influence on adaptation capacity in local authorities in Germany. Against this backdrop, the project develops proposals and support services for systematically building capacity for adaptation to climate change at the local level. Communication is becoming increasingly important, particularly in applied adaptation research. For that reason, one UBA project is looking at communication on extreme events, with the aim of providing appropriate information for each target group to strengthen people's ability to take their own precautionary measures. It will also develop indicators for successful communication that promotes this and will translate it into a campaign tailored to the needs of different target groups.

Human health

In addition to studies of climate change impacts, BMG/RKI and BMU/UBA, to some extent supported by BMBF, fund projects in areas such infectious diseases, vector-transmitted diseases, allergies and people's weather sensitivity.

BMELV/JKI are conducting a programme of action to combat the non-native *Ambrosia artemisiifolia* or common ragweed. Measures are being developed to prevent its invasion and to inform the public about its dangers and the preventive action they can take to counteract it.

Agriculture

Conserving genetic resources in gene banks creates a basis for breeding programmes designed to support adaptation to climate change, improve resistance to pests and increase efficiency in terms of nutrients and water. For that reason, BMELV is committed to this work, which it sees as a long-term task. It works on it in conjunction with the Länder and NGOs.

Biodiversity

BMU/BfN will take their biodiversity and climate change research priority into a second phase. Since 2011, they have been developing adaptation strategies to protect species diversity and create protected areas in order to reduce the loss of climate-sensitive species of flora and fauna and identify recommendations for how to manage the Natura 2000 network of protected areas in a way that is appropriate to climate change. UBA has been carrying out a project to safeguard ecosystem integrity in climate change in this context since 2011; the project is scheduled to continue.

7.6. Socioeconomic research on the causes and effects of climate change

7.6.1. Cross-cutting research on renewable energy and transformation of the energy supply system

Both BMU and BMBF fund projects on cross-cutting issues related to renewable energy and transformation of energy supply system.

BMU supports research on achieving the transition to an energy supply system based on renewables. This hinges on adapting the regulatory framework of the electricity system and to some extent making fundamental changes. Electricity generation from renewable energy technologies is for the most part decentralised and fluctuating. Added to that, far more stakeholders are involved in producing electricity, providing storage capacities or making an attempt to pool demand. Cross-cutting research in the field of renewable energy focuses on developing concepts for electricity markets to implement the aims associated with this major restructuring of Germany’s energy system.

Since March 2013, BMBF has funded around 30 projects within its Social-Ecological Research (SÖF) and Economics for Sustainability (WiN) programmes, which monitor and support an environmentally sound and socially acceptable transformation of the energy system towards renewable energy. The total funding volume is €28 million. The funding measure focuses on three research priorities:

- Presenting and evaluating options for developing the energy system
- Analysing the conditions needed for society to accept the transformation and promoting active public participation
- Governance of the transformation process

Most of the planned projects are designed to cover the different priority areas and look – at least incidentally – at different forms of civic participation. About a third of the projects explore all three priority research areas. For example, they work in conjunction with local authorities to test which forms of informal participation processes could help to make planning permission procedures for major infrastructure projects – such as on local storage of electricity from renewable energy – run more smoothly, more quickly and in a way that is on solid legal ground. They also factor the energy consumption and production behaviour of private households into the conventional energy management models. New roles for consumer groups – as investors, for example – and for energy suppliers – as managers of distributed energy systems – are also being analysed. Working in collaboration with policymakers, business and civic society, academics are trying to identify incentives that could motivate people to change their behaviour and move towards a low-carbon lifestyle. A number of projects are concerned with the idea of social justice, such as how to take into account low-income sectors of the population. Possibilities for decentralised financing of technical innovations are also being analysed, and ways of supporting key stakeholders locally are being sought.

This funding measure aims to play a role in managing the move to a new energy era at local level and to propose solutions that are both academically well founded and relevant to practice.

7.6.2. Socio-ecological research

The primary objective of the socio-ecological research funding priority is to work with practitioners to develop strategies and options for actions to implement the national sustainability strategy. It deals with problems that arise in the relationships between people and their natural and social environment. It investigates the options for shaping these relationships, taking an interdisciplinary approach. The importance of giving equal weight to insights about the social and scientific dimensions of sustainability is stressed.

Climate-relevant socio-ecological research is part of the funding initiative concerned with environmentally friendly and socially acceptable transformation of the energy system (see section 7.6.1) and also part of:

- Projects that are financed under the funding priorities entitled From Knowledge to Action - New Paths towards Sustainable Consumption, Social Dimensions of Climate Change and Climate Protection, and Economics for Sustainability (see Chapter 7.6.3)
- Projects being carried out by junior socio-ecological research groups

Twelve collaborative projects with a direct connection to energy/climate have been financed in the Social Dimensions of Climate Change and Climate Protection programme with a total funding volume of €9.1 million since 2010. Their key concern is to increase understanding for the social causes and effects of climate change and at the same time design climate change mitigation and adaptation measures in way that avoids social exclusion and promotes acceptance. The aim of the funding measure is also to motivate the social sciences to become more involved in looking at climate change and possible options for action. Specifically, the projects deal with the following issues:

- Developing recommendations on designing the emissions trading schemes in Europe, the USA and Japan in a way that is socially and environmentally acceptable
- Investigating the causes of rebound effects, quantifying them and identifying appropriate measures

- Studying potential, strategies and instruments for low-carbon lifestyles in zero-emissions cities
- Developing scenarios for the prevalence of changed patterns of behaviour and attitudes in the light of climate change
- Developing proposals for improving how society deals with climate change at local authority level
- Empowering immigrants in Germany to become involved in climate protection
- Studying the complex interdependencies between climate-induced environmental changes and population movements
- Examining the options for decarbonisation in developing countries and emerging economies

In the From Knowledge to Action - New Paths towards Sustainable Consumption programme, six collaborative projects with a direct connection to energy/climate have been financed since early 2008 with a total funding volume of €5.4 million. They deal with the following issues:

- Developing policy instruments to promote electricity savings
- Removing obstacles to consumers acting in a climate-friendly way
- Developing feedback instruments using smart meters to promote sustainable electricity consumption
- Developing an integrated policymaking and advisory approach for energy-efficient modernisation of buildings
- Analysing the choices households make with regard to sustainable energy consumption in residential buildings
- Analysing changes in the behaviour of users of public buildings
- Developing an intervention instrument to promote energy-efficient user behaviour

Since 2010, five junior research groups working on socio-ecological research with a direct connection to energy/climate have been financed with a total funding volume of €8.5 million. They looked at the following issues:

- Analysis of the conflicts, potential and risks associated with biofuels, their transnational interconnections and socio-ecological interactions
- Evaluation of sustainability criteria for biofuels within existing certification schemes
- Developing strategies and instruments for sustainable production and use of biofuels
- Analysing factors that hinder or promote adaptation to climate change for selected public utility companies
- Investigating commercial and political instruments for developing, evaluating and implementing adaptation measures
- Investigating the challenges for spatial planning posed by the specific characteristics of climate change

- Identifying conditions that determine success and factors involved in establishing and managing policies for local authorities and regions providing all energy (electricity and heat) on the basis of renewables

7.6.3. Economic aspects of climate change

In BMBF's Economics for Sustainability funding priority the German government is focusing on economics approaches to tackling climate change. Examples of issues dealt with in the projects include:

- Developing an integrated evaluation, allocation and optimisation model for a national emissions management scheme
- Developing recommendations for climate policy based on an analysis of long-term investment decisions in the electricity sector
- Assessing the potential and limitations of bioenergy within a sustainable energy concept
- Investigating strategic options open to the automobile industry for migrating to low-carbon drive technologies
- Developing a market design for sustainable regional electricity markets
- Analysing the choice of allocation rules in international climate negotiations and their effects

BMBF is engaged in dialogue with the finance industry with a view to finding ways of stimulating investment in resource and energy efficiency, further developing renewable energy sources and encouraging adaptation activities. Linking into that, banks, reinsurers and investors in Germany have formed a climate change finance forum, which seeks to:

- Play an active role in Germany's transition to a new energy era and low-carbon economy, so that innovation and investment can be mobilised
- Advise on policy regarding the development of an enabling environment, defining research and innovation policy, funding programmes, Germany's adaptation strategy, and the development of new forms of national and international public-private partnerships

A project on Climate Change, Financial Markets and Innovation (CFI) (www.cfi21.org) is academically evaluating the climate change finance forum and providing coordination support. The question at the heart of the CFI project is how research and innovation on climate protection can be better linked with the finance industry's structures and working practices. As part of this accompanying research, the Sustainable Business Institute at the European Business School (EBS) is working with several partners from universities and economics research institutes to:

- Identify what scope for action the finance industry has, what its needs are and the obstacles it faces when financing innovations in the field of climate change mitigation
- Analyse the information needs – particularly within the insurance industry – with regard to changing climate-induced risks

The CFI project produces academic studies and analyses that are closely linked with the questions and issues that arise in practice. The project also supports dialogue processes within the finance industry and between the finance industry and policy-makers.

The economics of climate change funding priority

As climate change accelerates, the discussion about its economic dimensions is intensifying. Practicable approaches are sought that can be used to reliably estimate the costs, risks and opportunities associated with climate change mitigation and adaptation. Governments, businesses and the public need secure foundations to be able to reliably plan and finance preventive measures. Climate economics research is of great significance here. Within the economics of climate change funding priority, BMBF is funding 27 projects with a total of €15.5 million. The research projects began in 2011 and 2012.

Climate economics research studies things such as the effects of different emission pathways and evaluates their economic, social, environmental and technological implications. Important questions it addresses are: what costs must we expect for climate change mitigation and adaptation? Which climate protection instruments make economic sense? On what principles can efficient, effective and equitable climate change agreements be negotiated?

The funding priority therefore focuses on:

- Impacts and costs of climate change
- Design and effectiveness of climate policy measures and instruments
- International climate negotiations and regimes
- Adaptation to climate change
- Energy resources and climate-friendly energy supply

7.7. Institutional research landscape

Weather and climate research in Germany is already a well-developed field. Over ten university institutions, the Max Planck Institutes for Meteorology (Hamburg), Biogeochemistry (Jena) and Chemistry (Mainz), various centres that belong to the Helmholtz Association (HGF) and institutions within the Leibniz Association (WGL) conduct world-class climate research with the support of the German Climate Computing Centre (DKRZ).

There are plans for non-university research that is financed or co-financed through institutional funding (HGF, MPG, FhG, WGL) to be more closely linked with the research funding organisations and for their collaboration with universities to be funded.

The mission of the Helmholtz Association (HGF) is to pursue the government and society’s long-term research objectives and preserve and enhance the resources that sustain life. To this end, it identifies and tackles issues concerning society, science and industry by carrying out strategic cutting-edge research programmes in six areas: energy, Earth and the environment, health, key technologies, the structure of matter, and aeronautics, space and transport.

A number of Helmholtz Centres contribute their expertise in the research area that is of relevance here, Earth and the environment:

- Alfred Wegener Institute for Polar and Marine Research (AWI)
- German Aerospace Center (DLR)
- Forschungszentrum Jülich (FZJ)
- Karlsruhe Institute of Technology (FZK)
- Helmholtz Centre for Infection Research (HZI)
- Helmholtz Centre Potsdam - German Research Centre for Geosciences (GFZ)
- Helmholtz-Zentrum Geesthacht Centre for Materials and Coastal Research (HZG)
- Helmholtz Zentrum München - German Research Center for Environmental Health – (HMGU or HZM)
- Helmholtz Centre for Environmental Research Leipzig – UFZ

The Helmholtz Association's Earth and the Environment research field examines the basic functions of the Earth system and the interactions between nature and society. It is divided into the following programmes related to climate change:

- Geosystem: the changing Earth
- Marine, coastal and polar systems
- Ocean and deep sea systems
- Atmosphere and climate
- Terrestrial environment

The work focuses on expanding and linking up long-term observation systems, building scientific expertise and capacity, providing an internationally competitive research infrastructure, improving models and forecasts and transferring results to society. A particularly important goal is to develop recommendations for action to ensure that the Earth's resources are used sustainably without destroying the very foundations on which life depends. An important component of the work is to establish and operate infrastructure such as the HALO research aircraft and the TERENO network. The latter involves constructing terrestrial observatories in four selected regions in Germany. COSYNA is a project to create a long-term observation system for the German North Sea, which will later be extended to Arctic coastal waters.

To meet the challenges, the Earth and Environment research field will continue to pool the capacities of the participating centres within shared research portfolios. This strategy will lead to new alliances and facilitate the expansion of Earth observation and knowledge systems as well as integrated modelling approaches. The aim is to help society to cope with the complex challenges brought about by changes in the Earth system. The incorporation of the GEOMAR Helmholtz Centre for Ocean Research Kiel into the Helmholtz Association has significantly expanded its research spectrum.

The activities of the framework programme are linked up with HGF's research programmes – in particular with Earth and environment, energy and key technologies –

in such a way that allows HGF to contribute infrastructure services and research that is designed to be longer term and broad based.

The Earth and Environment research field explores key themes in projects that cut across the different research fields to make systematically generated knowledge accessible for policymakers and society as a whole. The key themes include Earth observation, climate research, mineral resources, bioeconomics, geoenergy and resource-efficient and climate-adapted cities.

Within the Leibniz Association (WGL), a whole series of other institutes also enrich the German climate research landscape with their scientific, technical and socioeconomic expertise:

- German Institute for Economic Research (DIW) Berlin: political sustainability strategies and measures, analysis of energy markets and renewable energy
- Leibniz-Institute of Atmospheric Physics (IAP) Kühlungsborn: physics of the middle and upper atmosphere
- GEOMAR Helmholtz Centre for Ocean Research Kiel: ocean circulation and climate dynamics, marine biogeochemistry, marine ecology
- Ifo Institute – Leibniz Institute for Economic Research at the University of Munich: environmental economics research, analysis of climate and energy policy instruments and markets
- Leibniz Institute for Tropospheric Research (IfT) Leipzig: tropospheric research, chemical changes in trace substances, exchange of substances in the atmosphere, aerosols - interactions with clouds and radiation
- Kiel Institute for the World Economy (IfW): international climate policy, environmental policy instruments, sustainable development
- Leibniz Institute for Baltic Sea Research (IOW) Warnemünde: Baltic Sea research, transport and transformation processes in the sea, marine communities and material cycles, changes in marine ecosystems
- Halle Institute for Economic Research (IWH): new technologies and resource efficiency
- Potsdam Institute for Climate Impact Research (PIK) Potsdam: climate impact research, systems analysis, global change and natural systems, global change and social systems
- Rheinisch-Westfälisches Institut für Wirtschaftsforschung (RWI), Essen: evaluation of environmental and energy policy instruments
- Leibniz Centre for Agricultural Landscape Research (ZALF) Müncheberg: agricultural and landscape research
- Centre for European Economic Research (ZEW), Mannheim: economic analysis of environmental - especially energy and climate - policy instruments

The Fraunhofer-Gesellschaft (FhG) focuses its research on all fields of engineering. It is applications-oriented and works closely with industry. FhG's contribution to mitigating climate change and its effects stems mainly from its work on restructuring the energy industry. The main issues the Fraunhofer Energy Alliance works on include development of efficiency technologies, use of renewable energy sources and, more recently, developing technology to pave the way for more electromobility. This group, which has 18 member institutes, also works on building-service technologies, smart energy grids and storage and microenergy technology. The members are the following Fraunhofer Institutes:

- Building Physics (IBP), Stuttgart
- Chemical Technology (ICT), Pfinztal
- Factory Operation and Automation (IFF), Magdeburg
- Interfacial Engineering and Biotechnology (IGB), Stuttgart
- Integrated Circuits (ISS), Erlangen
- Integrated Systems and Device Technology (IISB), Erlangen
- Advanced System Technology (AST), Illmenau
- Ceramic Technologies and Systems (IKTS), Dresden
- Manufacturing Engineering and Automation (IPA), Stuttgart
- Physical Measurement Techniques (IPM), Freiburg, Kaiserlautern
- Silicate Research (ISC), Würzburg
- Silicon Technology (ISIT), Itzehoe
- Solar Energy Systems (ISE), Freiburg
- Fraunhofer-Center for Sustainable Energy Systems (CSE), Cambridge, USA
- Systems and Innovation Research (ISI), Karlsruhe
- Environmental, Safety and Energy Technology (UMSICHT), Oberhausen
- Mechanics of Materials (IWM), Freiburg, Halle
- Wind Energy and Energy System Technology (IWES), Bremerhaven, Kassel
- Climate Service Center (CSC). The need for knowledge about climate change and its effects has steadily risen. This knowledge is crucial if society, politicians and industry are to take resolute action and limit the negative consequences for people, the environment and future generations. Research is tasked with closing the gap between research-related insights and practice-oriented application of those insights. With this aim in mind, BMBF has funded the establishment of the Climate Service Center (CSC). With €20 million in funding over five years, it supports the establishment of an institution that offers appropriate assistance in interpreting climate data and scientific insights and responds to the specific information needs of its clients.

7.8. International cooperation

Climate research and climate policy are probably the best examples of how policy frameworks are no longer created at national level alone. The German government has therefore made a firm commitment to assuming global responsibility, which it sees as crucial to implementing the principle of sustainable development.

7.8.1. Funding programme on Research for Sustainable Megacities of Tomorrow

Cities take up 2% of the Earth's land surface. They are responsible for three-quarters of global energy consumption and demand for fossil fuels. About 78% of global CO_2 emissions and 85% of total anthropogenic greenhouse gas emissions occur in cities. The World Bank estimates that cities account for 80% of the imminent growth in developing countries and emerging economies. Businesses and urban populations benefit from this growth, but it also poses new challenges: cities are responsible for providing technical infrastructure (such as housing, transport, energy and water) and social infrastructure (such as health systems, schools and jobs) and for maintaining, replacing and financing it.

The funding programme on Research for Sustainable Megacities of Tomorrow focuses on energy and climate-efficient structures in urban growth centres. It seeks to demonstrate that economic growth and climate protection are not mutually exclusive. It also gradually involves emerging economies and developing countries in international efforts to mitigate climate change.

This requires a comprehensive, action-oriented and needs-based approach. Environmental, economic and social aspects of developing energy and climate-efficient structures in urban growth centres are taken into consideration, and interdisciplinary research is carried out on them as part of a cohesive, long-term policy.

Nine bilateral transdisciplinary teams of researchers for Lima (Peru), Casablanca (Morocco), Addis Ababa (Ethiopia), Gauteng (South Africa), Tehran/Karaj/Hashtgerd (Iran), Hyderabad (India), Ho Chi Minh City (Viet Nam) and Urumqi, Shanghai/Fengxian and Hefei (China) are working on mitigation and adaptation strategies and ways of implementing them. The areas covered are water management, transport/mobility, energy supply/energy management, construction/housing /urban planning, waste management, urban agriculture, and resource conservation. Planning instruments, guidelines and adapted technologies are needed.

7.8.2. Regional Science Service Centres for Climate Change and Adapted Land-Use in Africa

The aim of this activity is to specifically support emerging economies and developing countries in southern and western Africa in building their own expertise and capacity in applications-oriented research and development on adaptation to climate change and in developing and implementing adapted land management systems (e.g. systems for managing water availability, land use and ecosystem services). BMBF has started to build up regional science service centres for climate change and adapted land use in Africa in cooperation with African partner countries. In the next five years, BMBF will invest up to €100 million in the construction and initial operation of the centres. Currently ten countries in Western Africa and six countries in Southern Africa are actively involved in the preparations with the aim of taking over full responsibility for operation in the long run. The centres will focus on application-oriented research and at the same time advise public and private decision-makers in their region. Provision of training for young researchers from African countries will be another important task.

7.8.3. Funding programme on International Partnerships for Sustainable Technologies and Services for Climate Protection and the Environment (CLIENT)

In 2010, the Federal Ministry of Education and Research (BMBF) launched a funding programme entitled CLIENT (International Partnerships for Sustainable Technologies and Services for Climate Protection and the Environment). The aim of this funding measure is to use exemplary projects to create and expand international partnerships that will research, develop and implement environmental technologies and services to mitigate climate change, as well as to trigger developments on lead markets.

With this funding measure, BMBF is acknowledging the increasing significance of the major emerging economies Brazil, Russia, India, China and South Africa (BRICS) and Viet Nam. BMBF funds best-practice projects in the research, development and implementation fields in those countries through CLIENT. The call for proposals focuses not only on technological aspects and innovative services but also on socio-economic issues such as good governance and early involvement of relevant stakeholders. BMBF has earmarked up to €60 million for this funding programme for a time frame of 2010 to roughly 2017. At the first Chinese-German government consultations in June 2011, an agreement was reached with the Chinese research ministry to carry out a joint research and innovation programme on clean water, on the basis of which water projects with China will be carried out.

7.8.4. Integrating research activities into international programmes

BMBF promotes the integration of German global change research into international programmes and enables the scientists involved to participate in them at the national level and be involved in organising international cooperation. The funded institutions include the international secretariats of IHDP, IGBP (Stockholm) and DIVERSITAS (Paris), the secretariat of the ESSP Global Water Systems Project and the START secretariat in the United States.

The German IPCC coordination office, which was set up by BMBF and BMU, works to feed the results of German climate research into the IPCC process and the Fifth Assessment Report. The work of Professor Ottmar Edenhofer, co-chair of IPCC Working Group III, is assisted by funding a technical support unit, housed at the Potsdam Institute for Climate Impact Research.

BMBF provides €500,000 per annum to develop the United Nations University Institute for Environment and Human Security (UNU-EHS), which was founded in Bonn in 2003. UNU-EHS is one of more than ten research and training centres of the United Nations University located around the world.

7.8.5. Joint Programming Initiative Connecting Climate Knowledge for Europe (JPI Climate)

JPI Climate aims to create applications-oriented instruments to aid decision-making in the field of adaptation to climate change. It seeks to close critical gaps in knowledge in key areas of climate research and to structurally support climate research in providing findings that are of practical use for policy, planning and investment decisions. This includes a European model system for decadal climate prediction, better understanding of variability and extreme events and analysis of transformation processes triggered by climate change. Integrated decision-making tools will be developed to facilitate systematic evaluation of the impact of strategic decisions. The Joint Programming Initiative is a collaborative platform involving 14 EU Member States. Germany currently chairs JPI and hosts the JPI Climate Secretariat.

8. Education, training and public awareness

8.1. Schools

Many concepts, projects and teaching resources that were created and refined, particularly during the UN Decade of Education for Sustainable Development, address climate protection through a broad range of different topics. Education for Sustainable Development helps people to acknowledge that dealing with climate change is a key issue for the future, understand how the global mechanisms interact and learn about the options for action and choices that each individual has.

Sustainable development must be supported with carefully directed educational activities, and climate protection offers an excellent way into the subject. Climate protection is an accessible and up-to-date example of sustainable development, which is ideal for developing and nurturing technical, scientific – and social – problem-solving skills (scientific literacy).

8.1.1. BMU's Education Department

Printed educational resources

Since 2004, BMU's Education Department has been developing educational resources on climate protection specially designed for different age groups.

Online educational resources

In addition to printed lesson resources, BMU's Education Department has provided an online service for teachers entitled the Environment in the Classroom since September 2011. Every two weeks, this Internet portal takes a current environmental topic that has been selected on sustainability criteria and presents it in a way that is suitable for the classroom. Topics regularly include climate-related issues such as drought in the United States, the versatile role of moorlands in protecting the climate or taking a climate-friendly holiday.

Several interactive learning modules based on the printed resources are also available. They are designed for self-guided learning. A variety of quizzes at www.bmu.de/bildungsservice offer a fun way of learning about topics such as climate, drinking water, sustainable consumption, biodiversity and the environment and health. And, last but not least, by the third quarter of 2015, BMU's Education Department will make current cinema films that are suitable for use in the classroom available free of charge to all educational film hire services and public media centres. They include "Our Earth", "Our Oceans" and "HOME".

8.1.2. Climate action programme for schools and educational institutions

The most comprehensive funding programme for climate protection for schools and educational institutions has been running since December 2008, supported by BMU's National Climate Initiative. It aims to raise awareness of the challenges posed by climate change among teachers and students, give them the skills they need, motivate them to seek solutions and harness the significant potential for reducing CO_2 in schools and educational institutions.

The projects:

- Through the project ‘Solarsupport to make renewable energy visible, which is now in its second phase, 400 schools with photovoltaic systems have received a display screen, data logger and educational resources. The aim is to enable teachers to incorporate the panels into their lessons.
- As part of the ‘Aktion Klima! Mobil’ project, 500 schools have instigated climate change projects by linking up with others in their local community. They receive a mobile toolbox with resources to support their activities. This is the successor to the successful Aktion Klima project, under which over 3,000 schools were equipped with a “climate box” containing energy measuring equipment and teaching resources.
- The ‘SoKo Klima’ project helps children and adolescents to participate in local planning procedures that have a bearing on climate protection.

8.2. Vocational and professional education and training

8.2.1. Climate change in vocational and professional education and training

Within Germany’s dual training system, aspects of environmental protection, sustainability and climate change-related skills are included in all the relevant training regulations. The Federal Ministry of Economics and Technology (BMWi) is officially responsible for issuing these regulations; it does so in consultation with the Federal Ministry of Education and Research (BMBF).

All newly created or revised occupations in the trade/technical and commercial/administrative fields that are recognised as requiring official qualifications follow the principle of integrated action contexts and contain at least one element in their job descriptions that relates to environmental protection. In addition, environmental protection is included in the training curricula. For example, environmental occupations and those in the chemistry and pharmacy field include relevant aspects of sustainable development under the “responsible care” part of the job description. Commercial occupations in the tourism and travel industry include special qualifications in sustainability and the environmental aspects of tourism.

A new subject dealing with systems and high voltage technology is being introduced in areas such as automotive mechatronic engineer training, with a view to making sure the industry in Germany is equipped to tackle the challenges of electromobility. Electromobility is an area that will become increasingly important in the future and is currently the focus of many research and development projects and model trials. Activities in the field of vocational training policy as it relates to electromobility focus on skills needed in the trades and industrial occupations.

The expansion of renewable energy affects all sectors that use renewables to generate energy.

Existing occupational training curricula now incorporate skills and knowledge in the field of renewable energy, ensuring a broad skills base in this field. Climate change is also injecting new impetus into vocational training in the civil engineering and construction industry – new build, conservation and upgrading. The German KOMZET network consists of 14 building and energy competence centres nationwide. They collaborate closely to ensure that the technological developments are directly implemented in practice and are incorporated into the vocational training schemes.

Ground-breaking progress has been achieved with regard to “green skills”. Education in sustainable development has found its way into other occupational fields as a result of restructuring, for example in the industrial electrical and metalworking occupations and in the sanitation and heating or cooling and air conditioning fields. Continuous professional development schemes offer numerous upskilling opportunities.

As part of a scheme to modernise occupational profiles, the Federal Institute for Vocational Education and Training is developing implementation tools for trainers to enable them to pass on the latest developments in curricula to young people. The Federal Institute for Vocational Education and Training constantly researches the question of how the vocational education and training system can actively support the spread of new technologies in the manufacturing industry. In particular, it is exploring how changes in training needs resulting from technical innovation can be identified as soon as possible and how their importance for vocational and professional training and education can be systematically evaluated.

Germany’s dual training system is more hands-on than virtually any other vocational and professional training system in the world. The majority of the training takes place on the job, with trainees being directly involved in the manufacturing process or services. This guarantees that the training curricula contain up-to-date elements on environmental soundness, resource conservation, sustainability and climate change. The fact that trainees regularly attend classes at vocational colleges in addition to their on-the-job training ensures that the climate-related skills taught are generally applicable and not just specific to a given company.

8.2.2. Training programmes

Three projects concerned with vocational training and higher education information are currently running under the climate action programme for schools and educational institutions (see section 8.1.2):

Green Day, which has taken place on 12 November each year since 2012, aims to give young people the opportunity to learn about occupational fields and degree courses in the climate protection field and get them interested in career opportunities in these areas.

A project on climate change in youth workshops and manufacturing colleges aims to make providing education on energy matters a firm element of vocational and professional training. Youth workshops support disadvantaged young people in making the transition from school to working life.

The information portal studygreenenergy.de, which will provide a database with over 300 degree courses from the end of 2013, gives guidance on the numerous different courses in the field of renewable energy and energy efficiency.

In the next funding period, which runs from 2014 to 2020, the European Social Fund (ESF) aims, in accordance with the EU 2020 Strategy, to help promote the transition to a low-carbon economy that can resist climate change and is resource-efficient and environmentally sound. BMU is planning a programme to contribute to this goal, dealing with work in the context of the green economy. One of its aims is to match up stakeholders with training measures and needs, especially in the skilled trades.

An initiative has been launched to support small and medium-sized enterprises in taking practical action towards implementing Germany's Energiewende or transition to a new energy era. It is supported by the Federal Environment Ministry, Federal Ministry of Economics and Technology, the Association of German Chambers of Commerce and Industry (DIHK) and the German Confederation of Skilled Crafts (ZDH). Its aim is to harness the potential for energy saving within companies and to improve their energy efficiency. It offers companies practical help in the form of dialogue, information and training, and puts them in touch with local contact partners. This project's public awareness work ranges from regional dialogue events to online information and advisory services (www.mittelstand-energiewende.de).

8.3. Informing and educating the public

The German government has an ongoing programme of public awareness activities (including information campaigns) on resource efficiency, climate change, and the country's transition to a new energy era.

8.3.1. Campaigns to promote the new energy era

In 2011, the German government launched an umbrella campaign on the Energiewende, which literally means "energy revolution", to coincide with the UN climate talks in Durban (COP 17). A number of adverts in print and online media publicised information about activities connected with this transition to a new energy system and about the government's information service and funding possibilities. Since autumn 2012, the campaign has continued on a broad base with the logo "Energiewende made in Germany". The government ran a campaign with the slogan "High time something changed!" in winter 2012/2013, for example. It used outdoor advertising nationwide to raise awareness for the new energy policy and stress its importance. Another element of the campaign was a series of publications entitled "Energiewende".

The Energiewende campaign has included a drive to conserve electricity since autumn 2012. It aims to motivate private households in Germany to identify where they can save energy and act on that information. An important element in the campaign is an online advisory and information service on energy saving. The federal government runs advertisements in daily and weekly newspapers and online media to make the public aware of the service.

The electricity saving campaign was extended in 2013 to include school students as a target group. The initiative entitled "Schulen zeigen Flagge für die Energiewende" (Schools backing the energy transition) aims to motivate school students to hold action days and project weeks on electricity saving and get their parents and therefore private households involved.

Since November 2012, the government has been running a campaign entitled "Ja zum Netzausbau! Damit die Energiewende gelingt". (Say yes to upgrading the grid: the success of the energy transition depends on it). It uses advertisements, cinema spots and online media to raise public awareness for the fact that the transition to a new energy system will not be possible unless the power grid is upgraded and expanded. Detailed information on different aspects of the energy transition is provided in a newsletter entitled Energiewende. Two series of entertaining videos entitled "Energiereporter" and "Menschen des Netzausbaus" explain to the general public important issues connected with the energy transition such as smart grids, inter-seasonal storage facilities and public participation. They are backed up by further information in the form of videos, brochures and flyers about the numerous advisory services and funding opportunities available for increasing energy efficiency.

8.3.2. Monitoring report

The monitoring process entitled "Energy of the future" enables the energy transition and developments on the energy markets to be closely and continuously observed. Monitoring Reports are jointly prepared by the Federal Government on an annual basis and then adopted by the cabinet. They provide information about implementation of the measures proposed in the government's Energy Concept and progress towards its aim to achieve a reliable, affordable and environmentally sound energy supply. A detailed progress report, published every three years, provides an opportunity for more in-depth analyses.

8.3.3. National Climate Initiative

The German government's National Climate Initiative has instigated and funded numerous projects since 2008 to reduce greenhouse gas emissions, use energy more efficiently and promote renewable energy. Many of the projects offer opportunities for active participation and achieve a high degree of visibility. In this way, they contribute to informing and educating the public and raising awareness. The projects in the innovative individual project category are particularly geared to proactive external communication. The public awareness activities of the National Climate Initiative (NKI) are linked to general information on national and European climate protection. This takes the form of a website, for example (www.klimaschutz.de), and publications such as "Klimaschutz und Wachstum" (Climate protection and growth), "100 per cent climate action" and "Klimaschutz in Schulen und Bildungseinrichtungen" (Climate action programme for schools and educational institutions).

The large number of projects funded in the local authority category and the fact that they are nationwide makes them an excellent basis for dialogue and public participation. The website www.klimaschutz.de/kommunen run by the service and competence centre for local authorities and climate protection provides information and examples of best practice to local authorities wishing to take action.

8.3.4. International Climate Initiative

The International Climate Initiative (IKI), which the federal government set up in 2008, supports activities in developing countries and emerging economies and transition countries. A key element in the International Climate Initiative's public awareness activities is its website at www.bmu-klimaschutzinitiative.de/international. Brochures and events back up the website.

8.3.5. Energy Efficiency Export Initiative

The aim of this government initiative is to support companies in setting up, expanding and stabilising their exports of energy-efficient products and services from Germany over the long term. "Energy Efficiency - Made in Germany" was created as an umbrella brand to promote the spread of energy-saving technologies worldwide. The initiative has its own website at www.efficiency-from-germany.info/, which is backed up by brochures, newsletters and events.

8.3.6. Renewable Energies Export Initiative

The government's Renewable Energies Export Initiative supports German companies in the renewable energy industry in establishing themselves successfully on international markets. Promoting the global spread of renewable energy technologies in this way makes an active contribution to mitigating climate change. The initiative's website at www.exportinitiative.bmwi.de/ is backed up by brochures, newsletters and events.

8.3.7. Mittelstandsinitiative Energiewende

In October 2012, the federal government, in conjunction with the Association of German Chambers of Commerce and Industry (DIHK) and the German Confederation of Skilled Crafts (ZDH), launched this initiative to support small and medium-sized enterprises in taking practical action towards implementing Germany's Energiewende, or transition to a new energy era. Its aim is to harness the potential for energy saving within companies and to improve their energy efficiency. The initiative offers companies practical help in the form of dialogue, information and training and puts them in touch with local contact partners.

8.3.8. Renewable energy

In addition to the website at www.erneuerbare-energien.de, which provides constantly updated information, the federal government makes its renewable energy activities accessible to a broad audience through a range of publications. They include publications on all aspects of renewable energy (such as its effect on jobs, research and cost/benefit analyses), and an annual publication entitled "Renewable energy sources in figures" contains extensive technical information on trends in renewable energy in Germany. Explicit information on greenhouse gas emissions avoided by using renewable energy is also provided. The website www.erneuerbare-energien.de backs this up with diagrams and tables on renewable energy use in the form of presentations.

8.3.9. Market incentive programme for renewable energies – renewable heat

The federal government's market incentive programme for renewable energies (MAP) is a key instrument for promoting renewable energy in the heat sector. Depending on the type and size of system, it awards either investment grants or low-interest loans with repayment grants. A range of high-visibility activities provide information on MAP's current funding conditions.

For example, in 2011 and 2012 the government published two flyers: "Heizen mit erneuerbaren Energien" (Heating with renewable energy) and "Energiewende mitgestalten – Heizung auf erneuerbare Energien umstellen und staatliche Förderung erhalten" (Help shape the energy transition – get a government grant to switch to renewable heating), which were inserted in a number of journals with high print runs. In 2012, these public awareness activities were backed up by an online media campaign on MAP and adverts in the print media – to draw attention to current funding conditions and motivate people to use renewable energy to heat their homes.

8.3.10. Electromobility

Electromobility based on batteries and fuel cells helps reduce dependence on oil-based fuels in the individualised mobility sector. Provided the vehicles are charged using renewable electricity, they permit carbon-free mobility. The German government has contributed to the success of this new technology by creating an innovation-friendly environment. This includes, for example, changes to the Energy Industry Act (EnWG) and the Act to Liberalise Metering (WettbMesswSGG). Under funding programmes such as the showcasing electromobility programme (Schaufenster Elektromobilität), innovations in four selected regions are developed, field tested and demonstrated to the public. The National Hydrogen and Fuel Cell Technology Innovation Programme (NIP) is designed to prepare products and applications that are based on hydrogen and fuel cell technology for market launch.

The federal government has also launched programmes on specific issues which can be used to fund innovations. They include refining energy storage systems and battery research, developing alternative drive systems and integrating elements of this kind into the overall value chain. Technologies for charging infrastructure were made market ready under the information and communication technologies for electromobility programme.

The federal government advertises its electromobility activities to the public under the slogan "Renewably mobile – market-ready solutions for climate-friendly electric mobility". Its website at www.erneuerbar-mobil.de, various brochures and Internet film clips – and also events and trade shows (such as HannoverMesse MobiliTec) – provide the general public with information. The public awareness activities aim to convey the core issues involved in electromobility and showcase research and demonstration projects funded under the renewably mobile (Erneuerbar mobil) programme.

8.3.11. Climate-friendly mobility

The German government is committed to achieving greater mobility with less harm to health, the environment and the climate. It therefore ran an image and consumer information campaign for pedestrian and cycle traffic in 2009 and 2010, funded by the National Climate Initiative (NKI) and entitled “Kopf an: Motor aus. Für null CO_2 auf Kurzstrecken” (Switch your brain on and your engine off. Zero carbon for short trips). Target group-specific consumer advice, posters, adverts, radio and cinema spots and the website www.kopf-an.de were used to motivate people to leave their cars or motorcycles at home for short trips and cycle or walk instead to avoid causing greenhouse gas emissions.

The campaign targeted those sectors of the population that have made little or no use of these kinds of mobility and strengthened existing activities at local authority level to promote non-motorised mobility. Competitions were held to select the towns and cities in which to run the campaign. They also indirectly promoted cycle traffic in numerous towns and cities, not just those that won the competition.

8.3.12. Resource efficiency

From 2011 to 2013, the federal government, in conjunction with the Association of German Engineers (VDI) and its resource efficiency centre (Zentrum Ressourceneffizienz), launched an information campaign to encourage companies to see resource efficiency as an opportunity to gain a competitive edge. It was financed by the National Climate Initiative. The campaign used its website at www.das-zahlt-sich-aus.de, adverts in newspapers and trade journals, posters, publications, a touring exhibition and a comprehensive advisory service to target decision-makers in small and medium-sized enterprises in particular.

Each year the federal government, in conjunction with the German Mineral Resources Agency, runs a competition for the German Resource Efficiency Award, with the aim of establishing the importance of resource and material efficiency and its impact more firmly in industry. Resources and raw materials account for 43% of costs in the manufacturing industry – the largest block of costs. Consultations to date have confirmed that there is often a vast potential for savings in that area for that very reason. “Go efficient” is an innovation voucher that small and medium-sized enterprises can use to obtain advice on improving their resource and raw material efficiency. Both the German Resource Efficiency Award and the go efficient innovation voucher are publicised in online media and through flyers and brochures.

The idea is to help companies increase their resource efficiency, while lowering production costs and safeguarding their competitive advantages. The campaign seeks to raise awareness for greater resource efficiency, provide information and arguments and demonstrate options for action.

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