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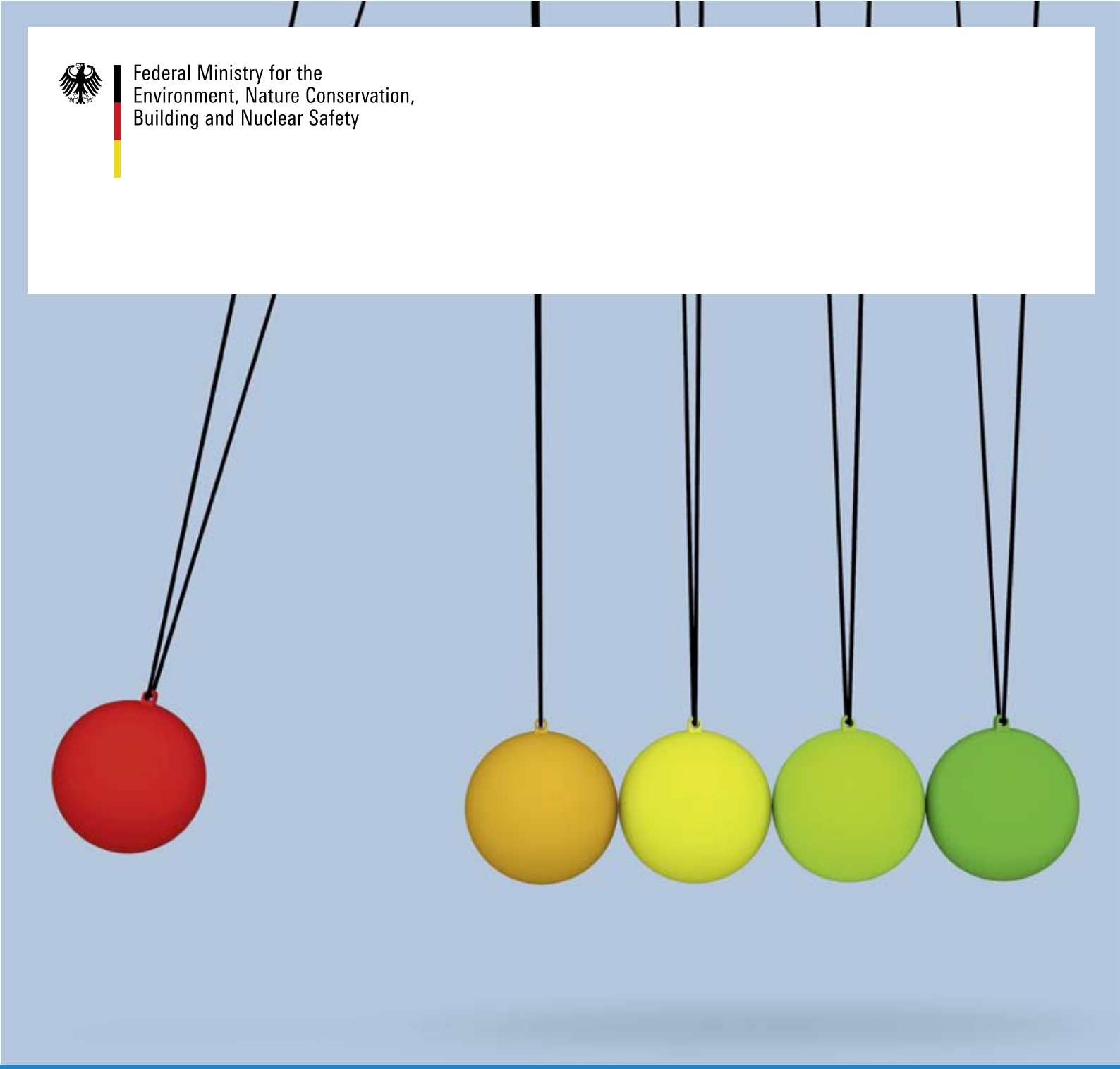

Climate Protection in Figures

Facts, Trends and Incentives for German Climate Policy

Imprint

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Foreword

Dear readers,

In a new report that came out at the start of the year, the Intergovernmental Panel on Climate Change (IPCC) once again stressed that climate change is the greatest global challenge of our time. The report is a further wake-up call for the global community to dedicate itself to advancements in climate action. Without immediate and ambitious climate action, we face a rise in global temperatures of 4°C or more, resulting in a world that we really cannot wish on ourselves. Our ability to adapt to climate change would be greatly diminished and an increase in temperatures of over 2°C would entail greater risks, as the consequences for ecosystems, human life, societies and economies would become more and more unpredictable, and adaptation ever more difficult and expensive.

The report, however, also gives cause for hope, as it states that we still have the means to limit the temperature increase to a maximum of 2°C compared to preindustrial times. The international community has agreed on this upper limit, yet brave and determined climate policies are required to see this through, at international, European and national levels. One essential requirement is the decarbonisation of energy systems across the globe. Thanks to the Energiewende - i.e. the transformation of energy systems using the two pillars of renewable energy sources and energy efficiency - we are on the right path. The Energiewende will continue to make a contribution to combating climate change, but it is not the only aspect of our climate policy. Germany and the European Union have set themselves long-term climate targets that meet the requirements of a 2°C limit: a reduction of 80–95 per cent of greenhouse gases by 2050 compared to 1990 levels. For Germany, this means a reduction percentage towards the upper end of that range. This Herculean task can only be accomplished if we get to work quickly and ambitiously – and only if everyone becomes involved: policy-makers, industry, society, national government, the federal states and the municipalities. Also, we can – and must – advance climate action in the transport sector and in agriculture. As the Minister for Federal Environment and Building, I am very aware of the great potential in the building sector, and we mean to take full advantage of this.

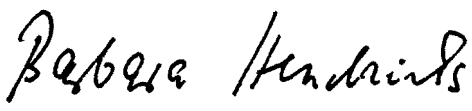
Combating climate change is no easy task: With the measures currently in place we will only be able to reduce greenhouse gas emissions by 33 per cent at good economic growth rates by 2020.

Therefore, in order to reach our next objective of at least 40 per cent reduction by 2020, we will have to step up our action considerably. We aim to bridge this gap with concrete measures and will approve an inter-departmental action programme this year. This will include the basis for a long-term climate action plan, which will assist us in considering our steps after 2020.

It is vital that we be honest with ourselves and the public about the figures. We must give an authentic account of where we stand in terms of combating climate change, and introduce measures that are capable of achieving the necessary progress. This is exactly the aim of this brochure: It displays the broad spectrum of climate policy in Germany, including clearly presented figures; it also explains Germany's climate targets in the context of European and international agreements; it shows how emissions have developed in individual sectors in recent years, and which measures are already effectively contributing to reductions; finally, it looks at the economic and social effects of climate change mitigation.

Advancement in climate action is a central concern for the German Federal Government. I strongly believe that consistent climate policy provides a major opportunity for our country and by fostering innovation, creating jobs and strengthening growth our society and the economy can only benefit. By expanding renewable energy sources and enhancing energy efficiency, we aim to reduce Germany's greenhouse gas emissions, making Germany a positive example for other countries when a new, legally binding global climate agreement is signed in Paris in 2015.

I hope you will find this brochure interesting and informative.



Dr. Barbara Hendricks, German Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety

1. Introduction

Since the early 1990s, Germany has been making significant progress in climate policy:

- **Decoupling economic growth from greenhouse gas emissions**: Since 1990, German greenhouse gas emissions fell by almost 25 per cent, despite an increase in gross domestic product.
- **Decline in per capita emissions**: Between 1990 and 2012, per capita greenhouse gas emissions fell by almost 26 per cent. However, Germany continues to have above-average levels when compared to other EU countries.
- **Achieving the Kyoto targets**: On average in the years 2008–2012, Germany not only achieved the reduction targets it committed to in the Kyoto Protocol, but even surpassed them.

Causes and consequences of climate change

While the world's population continues to grow, industrialisation marches on across the globe. As a result, the global demand for energy and fossil resources such as oil, gas and coal is also rising. If this growing demand continues to be met predominantly by fossil fuels, then emissions of climate-damaging greenhouse gases will also increase.

- **A historic burden**: Since the early days of industrialisation, the concentration of naturally-occurring greenhouse gases in the atmosphere has increased worldwide: carbon dioxide (CO_2) by approximately 40 per cent, methane (CH_4) by 150 per cent, and nitrous oxide (N_2O) by 20 per cent. Greenhouse gases have now reached atmospheric concentrations exceeding all levels from the past 800,000 years.
- **Our climate is changing**: Since the middle of the last century, various changes have been taking place throughout the entire climate system – changes unlike any in previous millennia. Not only is the temperature of the lower atmosphere increasing, but so too is that of our oceans. As glaciers thaw, permafrost soil becomes warmer, ice sheets shrink, and the sea level rises.
- **Mankind is the cause**: According to scientific findings by the Intergovernmental Panel on Climate Change (IPCC), an overall examination of extensive observations, models and physical correlations provide convincing evidence that human activity is the main reason for the current change in our climate.
- **Rise in temperature and sea levels, increase of extreme conditions**: Since the beginning of the 20th century, air temperature in Germany has increased by an average of 1°C. The mean global temperature rose by over 0.8°C during this period, while the mean sea level rose by approximately 19 cm. Across the globe, extreme weather events are becoming more and more frequent.
- **Serious consequences – happening now**: The consequences of climate change can already be seen today in ecosystems on all continents and in all oceans. Unique ecosystems , such as coral reefs, are already under threat and harmful consequences for communities and economies are already apparent, for example in the area of food production.
- **Future impacts**: If climate change continues to worsen in the coming decades, then heat stress, for example, will increase. Extreme weather events are predicted to become even more frequent, in turn meaning even more serious impacts upon communities and ecosystems . In addition, there will also be a greater risk of sudden, irreversible climate changes (tipping points). A rise in global temperatures of an additional 2°C would thus mean greater hazards. A rise in the planet's temperature of 4°C or more, when compared to preindustrial levels, would entail very high risks for humans and ecosystems, causing unavoidable damage. Furthermore, our ability to adapt to climate change would be greatly diminished.

In order to prevent the irreversible consequences of climate change, the international community has committed itself to avoiding a global temperature increase of over 2°C compared to preindustrial levels (see Chapter 2). In order to stay within this limit, the individual states must radically reduce their greenhouse gas emissions. However, if current emission trends continue, the mean global temperature is, according to calculations by the

Intergovernmental Panel on Climate Change, set to increase by 4°C or more within a century. Until now, industrialised nations have been responsible for a large proportion of emissions and so they have a particular role to play in the necessary reductions. However, greenhouse gas emissions are now also increasing in emerging economies and developing countries. Combating climate change is therefore only possible if all states ensure environmentally-friendly development in the long term.

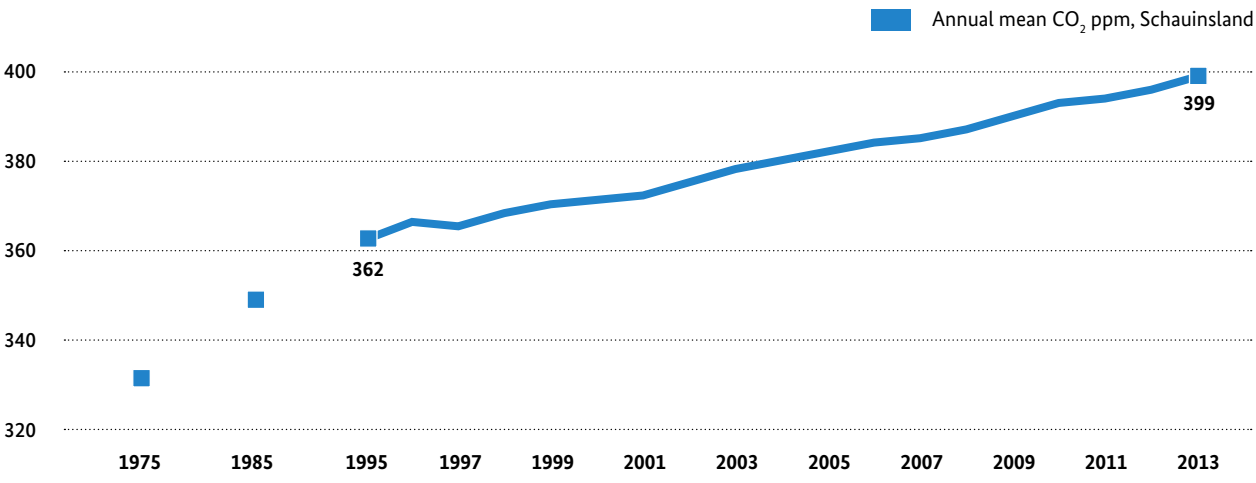
The dawn of a climate-friendly age

Germany is shouldering its responsibility and aims to make a greater contribution to international climate policy than ever before. Transformation of the energy system and the restructuring of energy supply are paving the way for a new, climate-friendly age. The use of renewable energy sources and increasing energy efficiency are already helping to lower demand for fossil fuels. In 2012, fuel costs amounting to some EUR 36 billion were saved (approximately EUR 10 billion through renewable energy sources and EUR 26 billion in energy efficiency). Germany is striving for a pioneering role in both areas.

The German government sees dedicated climate policy as a driver for progress that can strengthen both prosperity and competitiveness.

This brochure aims to report on climate policy in Germany today by providing informative facts, figures and time series. The first part describes the objectives of climate change mitigation. The second looks at developments in greenhouse gas emissions in individual areas. The brochure also highlights trends in renewable energy sources and energy efficiency. The final chapters consider the economic impacts and social aspects of climate action.

Diagram 1: **Trend in CO_2 concentration**



Source: www.umweltbundesamt.de/sites/default/files/medien/pdfs/JM_CO2.pdf

2. Climate targets

INTERNATIONAL AND EU CLIMATE TARGETS

In 1992, the United Nations adopted the Framework Convention on Climate Change (UNFCCC). Its aim is to prevent dangerous interference with the climate system caused by human activity. Five years later, the third Conference of the Parties (COP) on the Framework Convention on Climate Change agreed on the first legally binding targets for global climate change mitigation in the Kyoto Protocol. The signatory industrial nations committed to reducing emissions by at least 5.2 per cent, compared to 1990 levels, between 2008 and 2012. Due to the European Union's policy of burden-sharing, Germany was to achieve an average reduction of 21 per cent from 2008 to 2012. These reductions, however, are not sufficient to limit global warming to 2°C. The reduction targets under the Kyoto Protocol are therefore just a first step and in order to stay under the 2°C limit, the Intergovernmental Panel on Climate Change finds the following goals must be achieved:

- **Significant reduction by 2020**: Industrialised countries must reduce their overall greenhouse gas emissions by 25–40 per cent compared to 1990 levels by 2020. In addition, emerging economies and developing countries must keep their emission levels between 15 and 30 per cent below trend forecasts.

- **Widespread prevention by 2050**: Industrialised nations must, by this time, have reduced their greenhouse gas emissions by at least 80 to 95 per cent compared to 1990 levels. Global levels must have at least been halved.

STAGES OF AN INTERNATIONAL CLIMATE POLICY AGREEMENT

The contracting states are working towards adopting a comprehensive climate policy agreement, the aim of which is to extend the Kyoto Protocol following the expiration date of its commitment period at the end of 2012. Important stages so far have been:

- **15th COP in Copenhagen in 2009**: It was hoped that, here, negotiations would be conclusive, however it was not possible to reach a consensus. Nonetheless, the contracting states managed to reach a political agreement, which outlined key elements of future climate policy.

- **16th COP in Cancun in 2010**: The summit managed to get industrialised and developing countries to agree on a voluntary commitment to reductions. In addition, a work programme towards a comprehensive climate policy agreement was adopted.

- **17th COP in Durban in 2011**: The working group Durban Platform (ADP) was established. The ADP will negotiate a legally binding agreement in time for the Climate Change Conference in Paris in 2015, which should come into force by 2020 at the latest. Thanks to the ADP, it was possible to do away with the established, strict differentiation in the level of commitments required between industrialised, emerging and developing countries. Previously, the targets had only been legally binding under international law for industrialised countries. Contributions towards reductions made by emerging and developing countries had previously only been on a voluntary basis.

- **18th COP in Doha in 2012**: The nations agreed on a second eight-year Kyoto commitment period. This is an interim agreement until 2020 at the latest, by which time the future climate agreement should come into force.

- **19th COP in Warsaw in 2013**: The countries agreed on the key elements in financing climate action measures. They also decided on a basis for calculating emission reductions in forest conservation, which constituted a decisive breakthrough in the area. The UN forest protection programme can now be implemented at a national level.

THE EUROPEAN UNION'S CLIMATE TARGETS

In its climate and energy package, the European Union has set out ambitious climate action targets. Concluded in 2008 by the European Parliament, it came into force one year later. The package defines climate and energy targets under the "Europe 2020" growth strategy as well as outlining the so-called 20-20-20 targets for the year 2020:

- **Reduction in EU-wide emissions by 20 per cent, compared to 1990 levels**[1]
- **A 20 per cent increase in the proportion of renewable energy used for energy supply**
- **A 20 per cent improvement in energy efficiency**

The European Union also stated it would be prepared to increase its 20 per cent reduction target to 30 per cent if other industrialised countries are prepared to commit to similar reduction targets.

Further climate targets are provided for in:

- **The Renewable Energy Directive**[2]: This sets out legally binding targets for the individual member states for the share of renewable energy sources. For Germany, this amounts to 18 per cent.
- **The Effort Sharing Decision**: This concerns areas that are not included in the European emissions trading system: transport, households, business, trade, services and agriculture. EU-wide greenhouse gas emissions should be reduced by 10 per cent by 2020 compared to 2005 levels. The legally binding reduction targets for the individual member states are based on their GDP per capita. Targets for the member states therefore range from minus 20 per cent (reduction) to plus 20 per cent (increase in emissions). For Germany, this means a reduction of 14 per cent.
- **The European Commission's Climate and Energy Policies Proposal 2030**: Published at the start of 2014, this proposal recommends a 40 per cent reduction in greenhouse gas emissions compared to the 1990 levels by 2030. In addition, the share of renewable energy sources should be increased by at least 27 per cent. The proposal also sets out a commitment to significantly improving energy efficiency and is designed to form the basis of future European climate and energy policies.

Expansion of the emissions trading system

A key instrument in achieving the European Union's climate targets is the emissions trading system. It was adopted in 2003 by the European Parliament and Council of the European Union, and was launched on 1st January 2005. In practice, it functions as follows:

- **Market-based instrument**: An upper limit for emissions is set according to the cap and trade principle, after which point these are considered as a limited, finite resource. The emissions are allocated a price, set according to supply and demand on the market. The companies involved are required to verify they have enough allowances for the amount of emissions their facilities cause. In concrete terms, this means that if additional allowances are required, businesses must purchase extra emission permits. Equally, they can sell permits if they reduce their emissions. This therefore creates incentives to invest in future-oriented, climate-friendly technology.
- **Sectors involved**: In the industry sector, the emissions trading system mainly covers iron and steel processing, coking plants, refineries, crackers, cement and lime production, glass and ceramics works, brickworks, and paper and pulp production. In addition, energy sector companies with a rated thermal output greater than 20 megawatts are also covered. As of 2012, the scheme now also includes all emissions from EU air traffic, i.e. from all flights to or from EU airports. However, enforcement of the system on international flights has been temporarily suspended in order to enable a global solution.
- **Third trading period**: The third trading period began in 2013. A first EU-wide limit was placed on the total amount of CO_2. The individual member states no longer have their own national emissions budgets. These were used to allocate national emissions allowances to domestic plants during the first two trading periods (2005 – 2007 and 2008 – 2012).
- **Incorporation of further greenhouse gases**: At the launch of the third trading period, N_2O emissions from the chemicals industry and perfluorocarbons (PFCs) from the aluminium industry were included in the emissions trading system. These gases are even more harmful to the climate than CO_2. The allowable emissions volumes are converted into "CO_2 equivalents." These are calculated in terms of global warming potential.

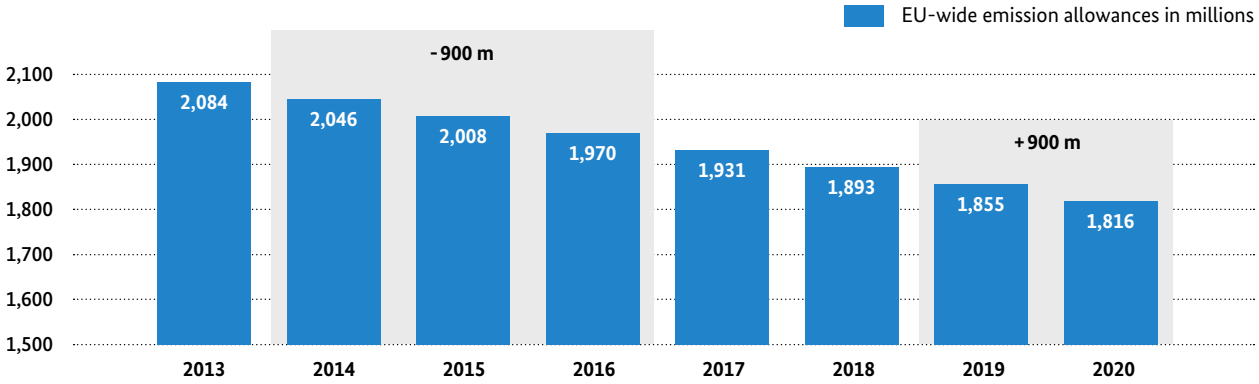
- **The emissions trading system's contribution to climate action**: In 2013, the EU-wide upper limit for greenhouse gas emissions set for sectors covered by the emissions trading system amounted to 2.08 billion tonnes (2,084,301,856 tonnes) of CO_2 equivalents. As of 2014, the approved volume of CO_2 will be lowered to 1.74 per cent per year. The benchmark for this is the average amount of permits issued annually between 2008 and 2012. This corresponds to a reduction of 38,264,246 tonnes per year. Consequently, in 2020, emissions in sectors covered by the emissions trading system will have fallen by 21 per cent EU-wide compared to 2005 levels.

- **Reaction to the decline in demand**: In the past years, the demand for emissions permits declined considerably, resulting in a price drop (see page 33). The cause of this was the oversupply of emissions certificates, which, according to estimates, amounted to approximately 2 billion permits. Because of the low price, there was little incentive for businesses to invest in climate-friendly technology. In response to this, the Council of the European Union and the European Parliament decided to withhold emissions allowances at the end of 2013. In 2014, 2015 and 2016, the total number of auctioned allowances will be 900 million below the planned number. The withheld allowances are scheduled to be returned in 2019 and 2020. In order to ensure the efficiency of the emissions trading system, a structural reform is required. Talks are currently underway at an EU-level in this regard.

- **Changes in allocation**: As of 2013, the EU Emissions Trading Directive considers the auctioning of permits as the primary method of allocation. However, this has so far only fully applied to electricity production. In concrete terms, this means: since 2013, the energy sector must purchase much of "its" emissions allowances on the market. In contrast, the industrial sector still benefits from permit allocations free of charge. Only 20 per cent of the sector's emissions allowances were auctioned in 2013. Unlike in previous years, allocation is no longer carried out according to previous emissions - instead, benchmarks now serve as the basis. These are calculated from an average of the best 10 per cent of plants in each industry sector.

- **Growing importance of auctioning**: The share of auctioned permits for industries is also set to increase. In 2020, this figure should be at least 70 per cent. From 2027, all emissions allowances will only be available from auctions. However, there are still special provisions for sectors where there is a particular risk of emissions being relocated outside of the EU. These provisions provide for full, free of charge allocations. The above-mentioned

Diagram 2: **Upper limit in the European emissions trading system with backloading**



Source: http://ec.europa.eu/clima/policies/ets/cap/index_en.htm

benchmarks are used as a basis for defining the number of allocations. In addition, the number of emission allowances allocated free of charge is to be reduced annually by a consistent proportion, in line with the total amount of emission permits.

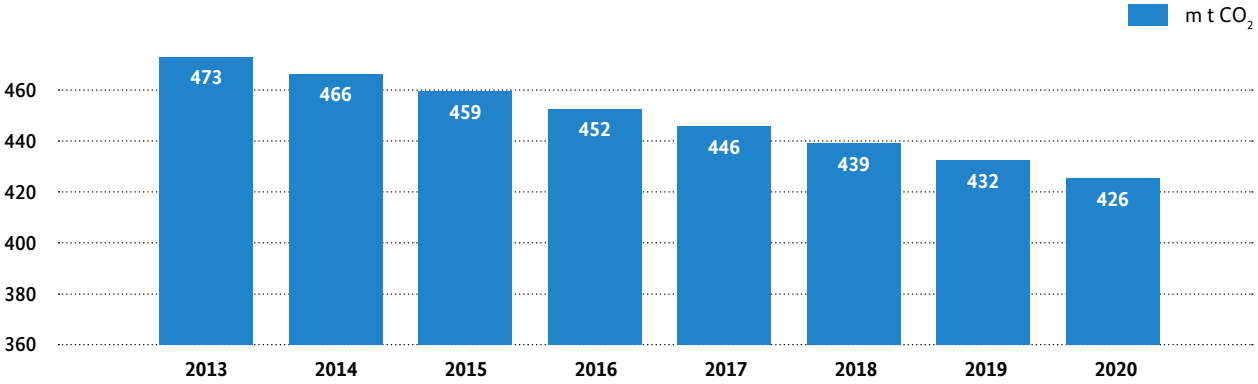
Combating climate change beyond the emissions trading system

On 17th October 2012, legally binding emissions values were set for sectors not covered by the emissions trading system[3] (see above). This was done under the Effort Sharing Decision of 2009. This also aims to reduce greenhouse gas emissions by 10 per cent, compared to levels in 2005, by 2020. The overall target of 10 per cent was distributed among the individual member states. This means that each member state's reduction target is based on its economic output. The requirements therefore vary between countries.

Unlike the emissions trading system, which so far is only concerned with CO_2, N_2O and HCF emissions, the Effort Sharing programme also includes methane (CH_4), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6). *Diagram 3* shows the individual emissions limits for Germany.

The Effort Sharing Decision stipulates that any EU state unable to meet its emissions limit can transfer up to 5 per cent of its emissions to the following year. In addition, they may purchase emissions from other EU member states. They can also balance their accounts by investing in projects that reduce emissions carried out in developing countries or 36 other states (annex B countries)[4]. If they still are unable to stick to their emissions limit, then they must settle the deficit in the following year as well as sticking to the limit set for that period, i.e. extra reductions are required. In addition, there is a penalty of a further 8 per cent of the deficit, which also has to be saved, and furthermore, they are obliged to publish an action plan. This plan must detail which measures are foreseen in order to meet reduction targets.

Diagram 3: **Effort Sharing Emissions Limits for Germany**



Source: European Commission – Implementing Decision 2013/634/EU, Annex II

THE GERMAN FEDERAL GOVERNMENT'S CLIMATE AND ENERGY POLICIES

CLIMATE POLICY

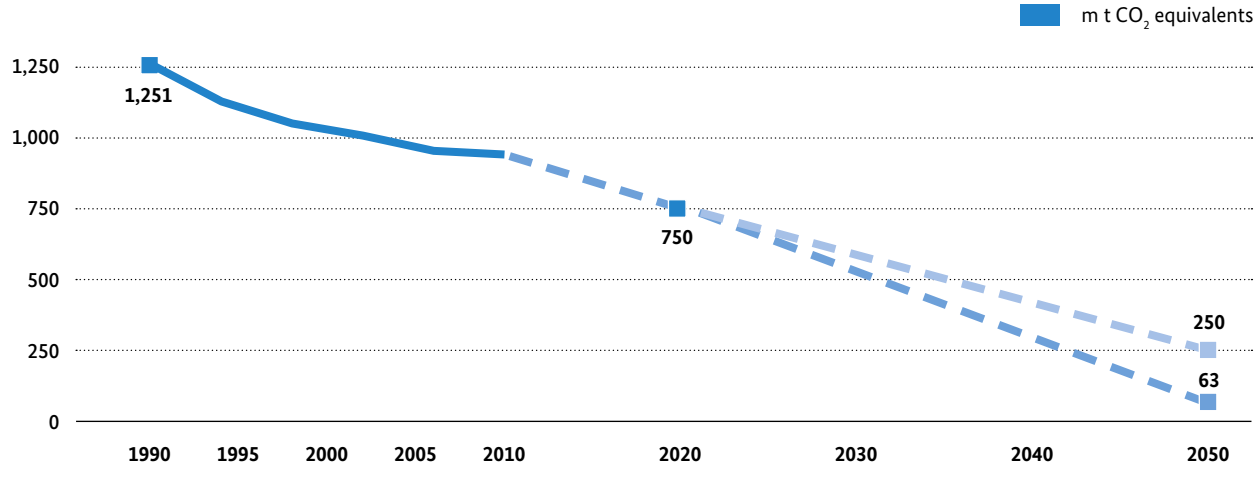
The German Federal Government's aim is to make climate policy a driver of progress that improves Germany's prosperity and competitiveness. The production and use of energy hereby plays a central role. Effectively combating climate change means giving greater priority to this area, and thus the "energy policy triangle" sets out basic objectives. Equal emphasis is given to the following objectives:

- *Climate and environmental compatibility*
- *Supply security*
- *Affordability*

Specifically, Germany's climate policy provides for:

- **A gradual reduction of greenhouse gas emissions**: By 2020, emissions should be reduced by at least 40 per cent compared to 1990 levels.
- **Widespread prevention as a long-term goal**: By 2050, greenhouse gas emissions should fall by 80 to 95 per cent compared to 1990 levels.
- **Further expansion of renewable energy sources**: By 2025, their share in electricity consumption should amount to 40 to 45 per cent, and by 2035 by as much as 55 to 60 per cent. By 2050 the share of renewable energy sources used for the supply of electricity should gradually climb to at least 80 per cent. In addition, the German government is also striving to adopt a new Renewable Energy Sources Act (EEG) by summer 2014.
- **Greater priority placed on energy efficiency**: The German government wishes to develop a national action plan for energy efficiency, the goal of which is to reduce energy requirements. To achieve this, ambitious efficiency measures will be financed by the Energy and Climate Fund. The initial phase will focus on energy-saving building improvements, consultancy on preventing bad investments, free of charge consultations for low-income households and product labelling for efficiency levels. Furthermore, the German government will push for ambitious and dynamic standards for energy-relevant products at a European level.
- **Increased climate action in transport**: Energy consumption in transport should be reduced by 10 per cent by 2020, and by 40 per cent by 2050, compared to 2005 levels. This goal will be backed by a number of different

Diagram 4: **Trajectory for greenhouse gases by 2050**



Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf as well as the Federal Ministry of Economics and Technology and the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – Energy Concept

measures that primarily aim to increase the efficiency of all forms of transport. Switching to electric power will contribute significantly towards this goal.

- **Immediate goals** also include a fundamental reform of the emissions trading system and a global climate policy agreement.

In 2010, the Energy Concept had already defined a number of further climate and energy policy targets. Each year, the German government checks the progress of these by using scientific monitoring, then publishing the results. Additionally, a comprehensive strategic progress report is compiled every three years. This identifies obstacles in implementing the Energiewende, and also suggests further measures for improving approaches, if necessary. The first progress report will be completed in 2014.

EXPANSION OF RENEWABLE ENERGY SOURCES

The German Feed-In Act ("Stromeinspeisegesetz") was the first to oblige grid operators to accept and purchase electricity from renewable energy sources. The EEG upholds the obligation for grid operators to accept renewable energy. It also stipulates that electricity from renewable energy sources should be given priority. It also provides for different rates of remuneration, tiered according to technology and plant size. Since entering into force, the EEG has been continually developed. It is the key instrument for expanding renewable energy sources in the electricity sector.

In recent years, the amount of electricity available from renewable energy sources increased significantly. This, in turn, lowered prices on the electricity exchange. Due to the merit-order effect (the operational ranking of the power plants) there has been a considerable rise in the "EEG levy" – the difference between the set feed-in price for renewable energy sources and the trading price of electricity - since 2010. In 2012 this amounted to 3.59 cents, rising to 5.28 cents in 2013, and amounting to as much as 6.24 cents per kilowatt hour in 2014.

The on-going expansion of renewable energy sources requires better coordination of the entire energy supply system, from conventional energy sources, grids, and storage systems to renewable energy sources. Today, electricity is produced relatively close to where it is consumed. In future, however, the south of Germany will receive a great deal more electricity from wind power plants in the north. This will require improvements to the grid infrastructure, and expansion is urgently needed.

Diagram 5: **Climate and energy targets according to the Energy Concept 2010**

	CLIMATE	RENEWABLE ENERGY		EFFICIENCY				TRANSPORT
	GHG (compared to 1990 levels) (Minim.)	Proportion Electricity (Minim.)	Proportion total (Minim.)	Primary energy	Electricity	Energy productivity	Building renovations	
2020	-40 %	35 %	18 %	-20 %	-10 %	Increase of 2.1 % per year	Doubling of rate 1 % → 2 % Heating -20 % by 2020 Primary energy -80 % by 2050 (compared to 2008 levels)	1 million electric vehicles by 2020; 6 million by 2030
2030	-55 %	50 %	30 %	↓	↓			
2040	-70 %	65 %	45 %					
2050	-80 to -95 %	80 %	60 %	-50 %	-25 %			

Source: Second monitoring report – Energie der Zukunft, April 2014

This should be accelerated through financial incentives and planning instruments. Modern grid systems can also regulate electricity providers, storage, and consumption, as well as the electricity grid. Intelligent electricity metres and variable load-based tariffs also contribute to greater energy efficiency and energy savings and will therefore also be introduced.

INCREASING ENERGY EFFICIENCY

Further to the reduction of greenhouse gases and the expansion of renewable energy sources, in 2010 the German government's Energy Concept outlined a number of broader energy efficiency objectives:

- **Reducing primary energy consumption**: By 2020 this should be reduced by 20 per cent compared to 2008 levels. By 2050, it should be as low as half those levels.
- **Increasing energy productivity**: In order to achieve the reduction target for energy consumption, energy productivity must be increased by an average of 2.1 per cent annually between 2008 and 2050, based on final energy consumption levels.
- **Reduction in electricity use**: By 2020, gross electricity consumption should fall by 10 per cent compared to 2008 levels. By 2050, the reduction should amount to 25 per cent.

The German government also aims to make better use of the potential in energy and electricity savings. Suitable framework conditions will be put in place to achieve this. These will enable private consumers and businesses to use energy more efficiently and thereby save energy costs and protect the environment. The German government plans to ensure:

- **Better market transparency for energy services**: Both the public sector as well as private households should benefit.
- **Better labelling of energy consumption**: This extra transparency should help consumers to take energy efficiency into account when purchasing products.
- **Expert consultation and targeted information**: These measures should inform consumers on how they can exploit untapped energy-saving potentials and save money. The government also aims to expand free of charge energy consultation services for low-income households.
- **Efficiency incentives for businesses**: Businesses will be encouraged to identify and exploit energy-saving potentials independently. In order to aid this, economic incentives in the form of tax breaks for introducing energy management systems have been granted since 2013. Support programmes and energy consultations will also enable SMEs to increase their energy efficiency.
- **Implementation of funds from the National Climate Initiative and the Energy Efficiency Fund**: Funds supporting projects that contribute to improving energy efficiency in Germany will be granted.

The building sector is another important focus, as it holds great potential for improved energy efficiency. Throughout Germany, buildings currently consume some 40 per cent of final energy and are simultaneously responsible for a third of all CO_2 emissions. The building sector is therefore a cornerstone of climate policy. The German government's plans in this regard are as follows:

- **Reduction in primary energy consumption**: By 2050, primary energy consumption in buildings should be reduced by approximately 80 per cent. Major investment will be required to achieve this, yet such investments usually offer long-term savings.
- **Reducing the need for heating**: A central objective is a long-term reduction of the need for heating in existing buildings in order to achieve an almost climate-neutral built environment by 2050. Climate-neutral means buildings have very low energy requirements that are mainly covered by renewable energy sources. By 2020 energy requirements for heating should fall by 20 per cent.
- **Greater rate of renovation**: In order to achieve an almost climate-neutral built environment by 2050, energy consumption will have to be reduced at a greater

rate through energy-efficient building renovations. The rate of energy-efficient renovations would have to be doubled in terms of quality (depth) and quantity (scope and number). This means that there must be an increase from a current rate of 1 per cent to at least 2 per cent.[5]

- **The Renewable Energies Heat Act (EEWärmeG)** entered into force on 1st January 2009. It stipulates that owners of new buildings must ensure a proportion of the heating and cooling energy needs are covered by renewable energy sources. District heating from co-generation or the use of exhaust heat are possible alternatives. The revised EEWärmeG came into force on 1st May 2011. So far the energy use requirements apply not only to new buildings but also to existing public buildings. It is Germany's aim to increase the share of renewable energy sources used in heating and cooling to 14 per cent by 2020. The coalition agreement provides for the continuation and development of the EEWärmeG on the basis of the 2012 progress report, and to implement EU law.

- In addition, it will also be aligned with the **Energy Saving Ordinance**. The use of renewable energy sources will continue to be on a voluntary basis in existing buildings. With the current revision of the Energy Saving Ordinance, efficiency requirements for new buildings will be increased by 25 per cent as of 1st January 2016. Additionally, energy certification gains importance as an information tool for consumers. The German government expects the revisions to give new impetus to energy saving in buildings. The EU Buildings Directive also stipulates that new public sector buildings constructed after 2018 must be as low-energy as possible. Other buildings have an additional two years to meet these requirements.

- **The CO_2 building renovation programme** plays a central role in this area. It aims to motivate owners to modernise their property as soon as possible and to fulfil maximum energy efficiency (renovation roadmap). Support from the KfW has assisted energy efficiency renovations on over 2.5 million homes since 2006. This enables a reduction in CO_2 emissions of around 5 million tonnes per year. The building renovation programme will also continue to receive a budget of EUR 1.5 billion per year, initially until 2014, financed by the climate and energy fund. As of 2013, an additional EUR 300 million will be guaranteed per year – initially for a period of 8 years (totalling EUR 2.4 billion) – for better subsidy conditions. In accordance with the coalition agreement, the building renovation programme is also to be upgraded and simplified.

REDUCING GREENHOUSE GAS EMISSIONS IN THE TRANSPORT SECTOR

Transportation is one of the biggest causes of CO_2 emissions, the principal reason being the predominant use of fossil fuels. Road traffic's share in transport-related emissions amounts to over 95 per cent. Transport emissions can therefore only be reduced if there is a successful reduction in road traffic.

Road traffic is exceptionally important in terms of climate action in the entire European Union – which is why the EU has set new emissions limits for cars. These amount to:

- **From 2015 onwards**: 130 grams of CO_2 per kilometre (introduced in stages from 2012, increasing annually for 65 per cent, 75 per cent and 80 per cent of new EU vehicles)

- **From 2021 onwards**: 95 grams of CO_2 per kilometre (introduced in stages from 2020 for 95 per cent of new EU vehicles)

In a similar measure, the European Union also prescribed emissions norms for light commercial vehicles in 2011. It is expected that this will allow massive energy savings in road traffic. The EU's emissions limit for light commercial vehicles are:

- **From 2017 onwards:** 175 grams of CO_2 per kilometre (introduced in stages from 2014, increasing annually for 70 per cent, 75 per cent and 80 per cent of vehicles)

- **From 2020 onwards:** 147 grams of CO_2 per kilometre

Additionally, the European Commission proposed in its White Paper on Transport that greenhouse gas emissions from transport within the Union should be reduced by

60 per cent by 2050 compared to 1990 levels. There is currently no national greenhouse gas reduction target for transport, yet there is no doubt that the transport sector must also contribute to achieving the climate targets.

With its three approaches "avoid – shift – improve," the German government aims to significantly improve climate policy in the area of transportation. In order to promote these three approaches, it has decided on the following:

- **Massive expansion of electro mobility**: In order for individual motorised mobility to make a substantial contribution towards achieving the 2020 and 2050 conservation targets, electric engines must become widespread, particularly when considering the limited potential of sustainably produced biomass. For this reason, the German government has concluded that by 2020 around one million electric vehicles should be driving on Germany's roads. By 2030, this number should rise to as much as six million, with an increasing amount of the electricity they use having to come from renewable energy sources. Two instruments which will be central in achieving this are: the national development plan, and, based on this, the government's electro-mobility programme. Rapid market penetration will be aided primarily by support in research and demonstration, as well as through tax relief. The German government also plans to create the necessary conditions for favouring electric vehicles at a municipal level. This should, in turn, create incentives for use.

- **Greater CO_2 reductions for fuel**: With the introduction of the biofuel quota, the German mineral oil industry is obliged to provide increasing volumes of biofuel (6.25 per cent in 2014). From 2015 onwards, coinciding with the implementation of the EU's Fuel Quality Directive, the aims of the quota will be geared towards greenhouse gas emissions: these will, by this time, be reduced by 3 per cent through the use of biofuels. In 2017, the reduction should amount to 4.5 per cent, and as of 2020 approximately 7 per cent. To ensure that the growing demand does not have a negative impact on climate action, the Biofuel Sustainability Regulation defines stricter conditions for fuels produced from renewable resources: Only biofuels that save at least 35 per cent of greenhouse gases, when compared to fossil fuels, may be offset according to the biofuel quota. Reductions must reach 50 per cent by 2017, and 60 per cent by 2018 and, in addition, protected land areas may not be ploughed or deforested. In order to achieve even greater CO_2 reductions in the area of fuels, objectives for this must be suitably defined. Further decisions on expanding the role of biofuels should only be made once new biofuel alternatives and sufficient biomass sources have been established and developed, and once the additional expense for transport has been forecast.

- **Measures in shipping traffic**: The German government supports efforts on an international level to limit the climate impact of shipping traffic. Alongside technical measures, such as limiting the CO_2 emissions of new vessels, market-based instruments are also under consideration, such as including shipping traffic in an emissions trading system. However, it is not expected that the International Maritime Organisation (IMO) will approve such measures in the foreseeable future. Even in the EU, shipping traffic is the only form of transport not yet obliged to reduce greenhouse gas emissions, even though the EU White Paper provides for a reduction of 40 per cent by 2050, compared to 2005 levels. In a first step, the European Commission has presented a proposed regulation on reporting CO_2 emissions from shipping traffic. This should set the groundwork for introducing further climate measures through the IMO at an EU level, or worldwide.

- **Modal shift for freight traffic**: In the long term, rail traffic and inland waterways must take on a greater share of freight transport. The German government's national sustainability strategy also provides for a reduction in the intensity of freight and passenger transportation. A sustainable approach to freight and logistics also involves a decoupling of traffic volumes and energy consumption. However, the goals of the national sustainability strategy for freight transport are so far not being achieved. The same applies to similar targets set out in the German Federal Government's Energy Concept. In order to decouple the predicted growth in freight transport from the environmental impacts and use of resources, additional increases in efficiency are necessary. Furthermore, a modal shift towards the most environmentally-friendly and

cost-efficient mode of transport is needed, as well as a greater use of alternative fuels and electric engines, all while reducing energy consumption. With climate-friendly alternatives, "Green Logistics" can contribute significantly to decoupling increased transport volumes from CO_2 emissions worldwide.

The European Union also strives towards climate conservation in air traffic:

- **Reducing greenhouse gas emissions in air traffic**: Air traffic is growing faster than any other mode of transport in Germany, the EU and worldwide and this dynamic growth is expected to continue. The German government has therefore supported the work of international bodies, such as the UNFCCC and the International Civil Aviation Organisation (ICAO), for a number of years. Current priorities are: The inclusion of air traffic in emissions trading, and the use of biofuels. The European Commission's White Paper on Transport sets out a 40 per cent increase in the share of low-emission fuels in air traffic by 2050. However, beyond this there are currently no further policy targets. The aviation industry itself will aim towards a CO_2-neutral growth as of 2020. It also wishes to halve its CO_2 emissions by 2050, compared to 2005 levels.

ENHANCING CLIMATE CHANGE MITIGATION IN AGRICULTURE AND FORESTRY

Agriculture has an equally important role to play in achieving the climate targets (see also pages 28 and 29). There are currently no legally binding targets, although emissions from agriculture are subject to the requirements of the EU's Effort Sharing Decision.

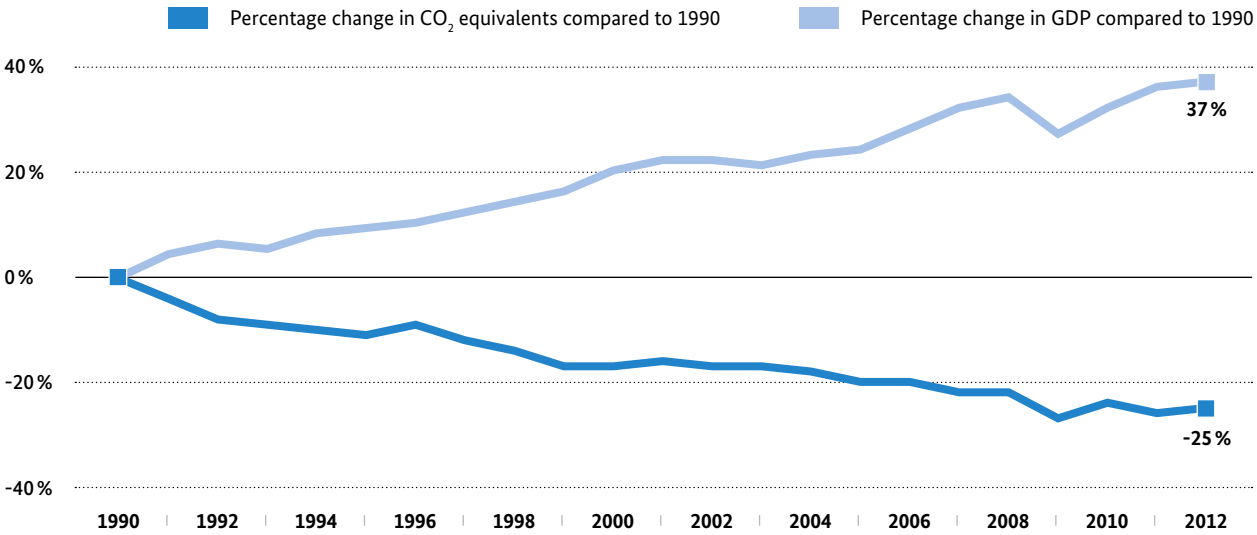
Because of forests' ability to store CO_2, they and the forestry industry have a direct influence on climate action. Throughout Germany, approximately 1.2 billion tonnes of CO_2 are stored in biomass above and below ground. As trees grow they remove CO_2 from the air and bind it in their structures. Wood is made up of as much as 50 per cent CO_2 and is therefore one of the main natural CO_2 sinks. The CO_2 balance depends largely on the age groups and species of trees: Young forests have a greater CO_2 sink effect due to their strong annual growth, while in comparison, older forests have lower growth rates in terms of above-ground biomass, despite their growth being long term, both above and below ground. In Central Europe a long-term balance is emerging between CO_2 absorption (growth) and release (rotting). In Germany today, parts of forests are reaching an age where tree growth is beginning to level out. In the mid-1990s, Germany's forests had a CO_2 sink capacity of some 80 million tonnes per year, but this figure is currently only around 20 million tonnes of CO_2 annually. In its Forest Strategy 2020, the German government calls for the preservation of forests as natural CO_2 sinks. Measures will also be taken to adapt forests to climate change, for example by selecting suitable species through forest management. CO_2 reduction potentials should also continue to be tapped. Wood from sustainable forestry will be used to replace energy-intensive materials with poor ecological and CO_2 balances.

3. Emission trends

The data in *diagram 6* shows that Germany has already achieved significant progress: Since the base year, 1990, greenhouse gas emissions fell almost continually. However, the collapse of the East German economy at the start of the 1990s did, initially, play a large role in this. As a consequence, emissions fell in the energy sector in particular. Nonetheless, the German government's committed climate policy was decisive for the positive trend in the long term. The large-scale expansion of renewable energy sources was also a major factor. *Diagram 6* also highlights the following:

- **Effects of the global economic crisis**: Greenhouse gas emissions fell drastically in 2009. The cause of this was the global economic crisis, which led to an economic downturn in Germany. One year on, in 2010, emissions began to rise again. This was partly due to economic recovery, but also to a comparatively cold winter.
- **Germany meets its international reduction targets**: Although economic activity recovered in Germany in 2010, and the economy has subsequently seen annual growth, Germany not only managed to stick to its Kyoto target in 2009, but also in 2010, 2011, and even 2012. Germany is obliged to reduce its greenhouse gas emissions by an average of 21 per cent between 2008 and 2012, compared to 1990 levels. On average, the country even achieved a reduction of as much as 24 per cent. It therefore also contributes to achieving the 8 per cent reduction the EU committed to under the Kyoto Protocol.[6]
- **Decoupling of greenhouse gas emissions from gross domestic product**: Although CO_2 equivalents fell continually after 1990, Germany's GDP rose significantly in the same period. This means that greenhouse gas emissions and GDP have been decoupled.

Diagram 6: **Decoupling economic growth from CO_2 emissions**



Source: http://www.umweltbundesamt.de/presse/presseinformationen/treibhausgasausstoss-im-jahr-2013-erneut-um-12
and Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen): Selected efficiency indicators for Germany's energy balance

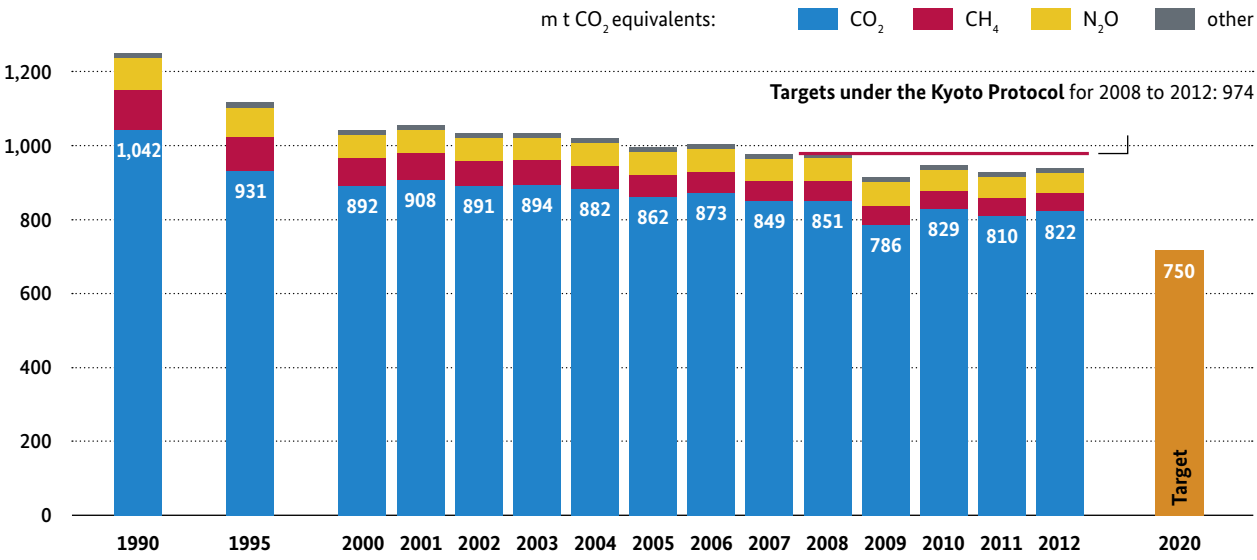
This development can be seen very clearly towards the end of the 1990s. This also demonstrates that it is possible to achieve reductions in greenhouse gas emissions even when the economy is growing. One of the main challenges in combating climate change is to strengthen and globalise this trend.

EMISSION TRENDS BY SECTOR AND REGION

TRENDS THROUGHOUT GERMANY BY GAS

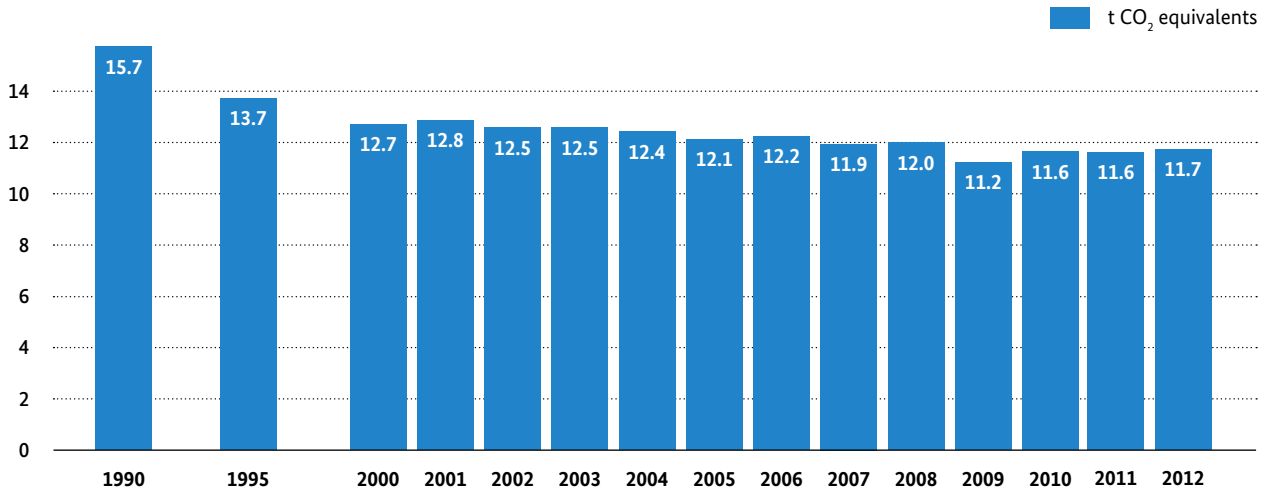
The breakdown of greenhouse gas emissions gives a clear picture and, as was the case in 1990, the majority of greenhouse gas emissions in Germany in 2012 still came in the form of CO_2. In 2012, only 11.2 per cent of greenhouse gases resulted from emissions of CH_4 or N_2O gases. CO_2, however, made up over 87 per cent of emissions, and mostly resulted from fuel combustion. This means that the main challenge is to produce and provide energy in a way that causes zero CO_2 emissions – this is the key to reducing greenhouse gases.

Diagram 7: **Emission trends by gas**



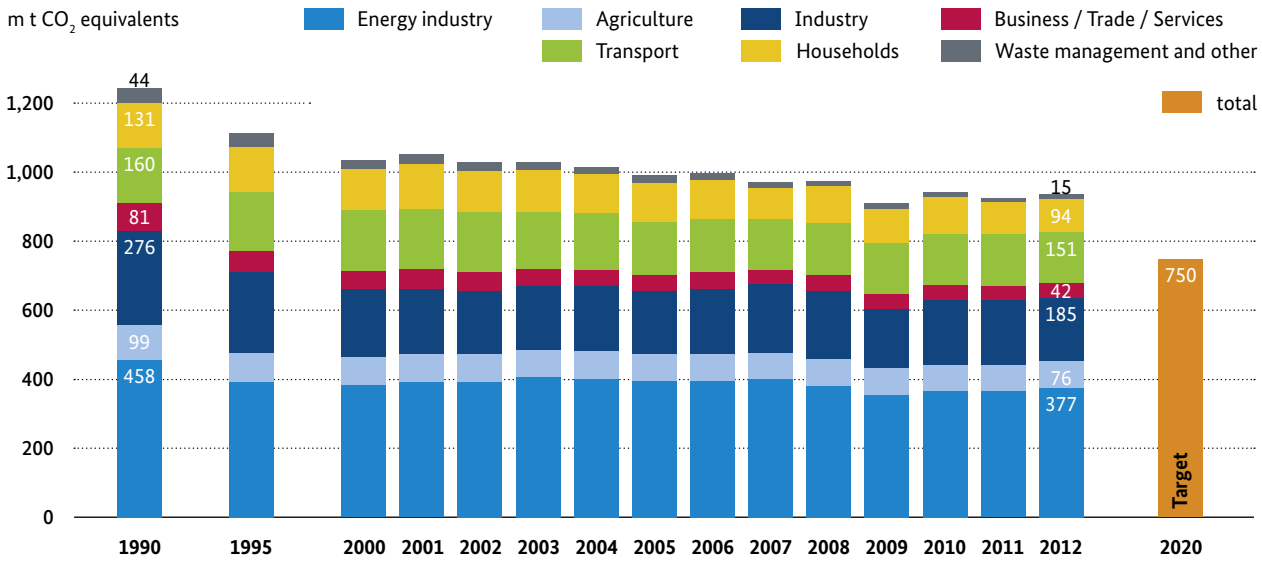
Source: Federal Environment Ministry, special evaluation 2014

Diagram 8: **Per capita emission trends**



Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf
Federal Statistics Office: Population

Diagram 9: **Emission trends by sector**



Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

TRENDS IN PER CAPITA EMISSIONS

Diagram 8 shows that greenhouse gas emissions have also fallen per capita in Germany. From 1990 to 2012, a roughly 26 per cent reduction was recorded. Per capita emissions remained largely stable between 2010 and 2012, mainly because of the population level on which the the calculations were based: As a result of a census, the population was corrected downwards by 1.5 million inhabitants at the start of 2011. The population in 2011 was measured at 80.3 million inhabitants (2010: 81.8 million).

In comparison to other EU States, per capita emissions in Germany were above the average. In 2010, this amounted to approximately 10 tonnes. Along with Germany, the main emitters in the European Union are Italy, France and Spain (EU 27). Page 34 shows further emissions with international comparisons.

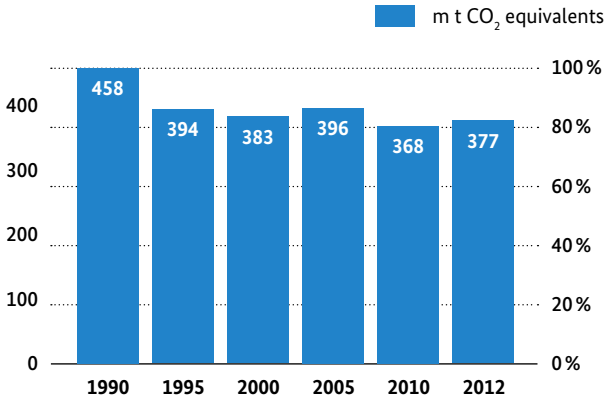
EMISSION TRENDS BY SECTOR

Diagram 9 shows that, compared to 1990, greenhouse gas emissions fell in all sectors. It also shows, however, that the individual sectors emit greenhouse gases to varying extents. The main emitter is the energy industry, which contributed 40 per cent of emissions in 2012. Despite a change in overall emissions, this remained approximately consistent with 2011 levels. Industry ranked second at almost 20 per cent. Its share was 0.5 per cent lower in 2012 than in 2011. The third largest emitter is transport, at 16 per cent. The sector's share also fell in 2012 by 1 per cent, compared to 2011. Private households rank fourth; their share was approximately 10 per cent. This represented an almost 2 per cent decrease in 2010. Agriculture was responsible for around 8 per cent of greenhouse gas emissions in 2012. The smallest shares were recorded in business, trade and services (approximately 4 per cent), as well as waste management (approximately 2 per cent).

The energy industry

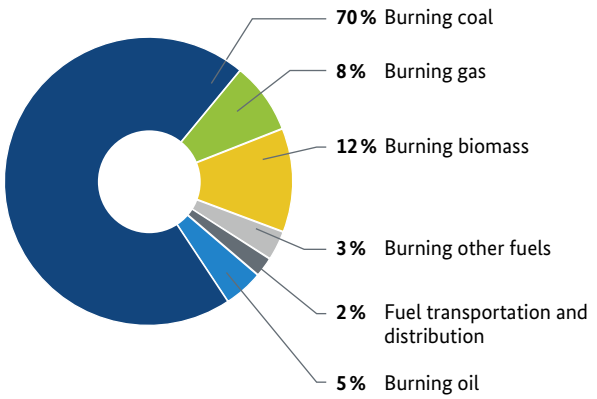
The energy industry in Germany is still the greatest emitter of greenhouse gases. Nevertheless, CO_2 equivalents have declined considerably, in fact by almost 18 per cent since 1990. The reduction was particularly pronounced between 1990 and 1995. The reason for this was the changeover to low-emission energy sources, meaning a major decline in the use of lignite. In addition, a large number of outdated plants were shut down following German reunification. 1995 saw a period of stagnation, a phase marked by occasional divergent trends and only minor reductions. A considerable reduction was only witnessed after 2007, the result of an increase in energy production efficiency, and the use of renewable energy sources on a wider scale (see page 37). Still today, coal burning is the main source of emissions. In 2012, its share was 70 per cent. The energy industry in this diagram includes the entire public supply of electricity and heat. Emissions from electricity consumption in private households, business, trade and services are therefore included.

Diagram 10: **Emission trends in the energy industry**



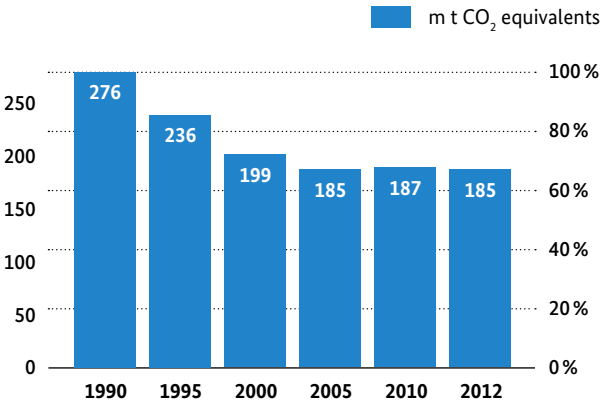
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 11: **Emissions sources in the energy industry, 2012**



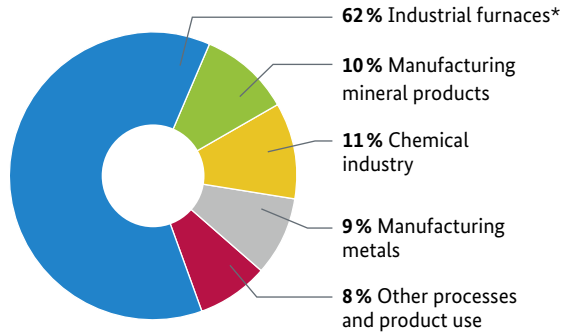
Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014

Diagram 12: **Emission trends in industry**



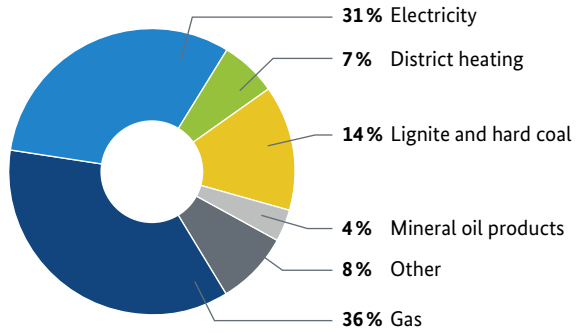
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 13: **Emission sources in the energy industry, 2012**



Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014
* Industrial furnaces: combustion processes, e.g. firing rotary kilns

Diagram 14: **Final energy consumption in industry 2012**



Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) analysis tables 1990–2012, as of: July 2013

Industry

CO_2 equivalents from the German industry sector have fallen by over 30 per cent since 1990. Nevertheless, it is still the sector responsible for causing the most CO_2 equivalents, after the energy sector.

In the first years after German reunification, the decline in emissions from industry was particularly pronounced. The reasons for this were the restructuring of the industry sector in Germany, as well as a decline in industrial production in the new federal states due to a lack of competitiveness and ageing technology.

In 2005, measures were introduced that, for example, reduced the proportion of clinker in cement, or required a greater amount of used paper in paper production. In recent years, the overall amount of emissions from industry has remained relatively stable. However, the decline in business activity as a result of the global economic crisis can be detected. Consequently, in 2009 emission levels from the German industry were at their lowest since 1990, at 174 million tonnes of CO_2 equivalents. In 2010 and 2011, levels increased slightly due to economic recovery. 2012 then saw a further, slight reduction. The diagram covers all emissions from combustion processes in industrial plants, including in-house electricity production and process-related emissions, such as CO_2 emissions in cement manufacture.

Gas and electricity make up the largest proportion of final energy consumption in industry at over 60 per cent (2012: 67.5 per cent).

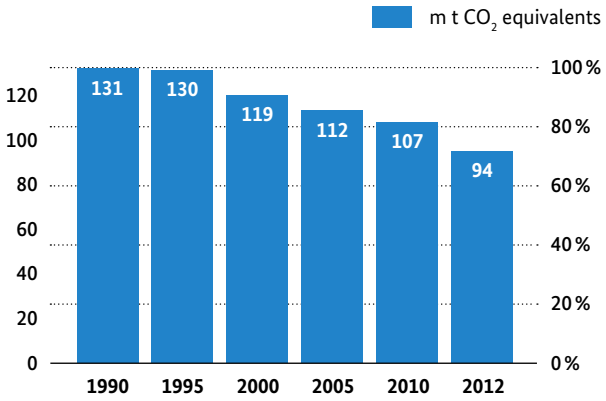
Households

A feature of private households is, for example, that CO_2 equivalents fluctuate much more than within the energy industry. Emissions reached their highest levels (since 1990) in 1996. In that year, private households were responsible for 144 million tonnes of CO_2 equivalents as a result of a colder than average winter. Over 70 per cent of final energy consumed by households is used for indoor heating. Therefore, lower emission levels can be expected during relatively mild winters. In 2012, mineral oil products and gas provided around 58 per cent of final energy consumed.

In addition to weather conditions, economic and social factors also influence the emission levels of private households. For example, the rising number of private households plays an important role, as does the growing square metreage occupied per person. Nevertheless, CO_2 equivalents from private households have fallen by 30 per cent since 1990. This can primarily be explained by the declining use of fuel oil. 2011 saw a large reduction in emissions from private households compared with 2010. This was the lowest level recorded since 1990. The main cause for this was the mild weather, resulting in reduced requirements for indoor heating. Then, in 2012, there was a slight rise in CO_2 equivalents.

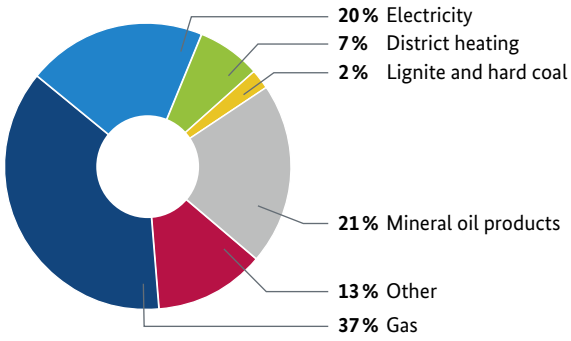
Although emissions from electricity consumption in private households are attributed to the energy industry in this diagram, it is worth looking at trends in final energy consumption in households. These declined considerably, mainly due to the gradual replacement of light bulbs with energy-saving bulbs, which was based on European Commission guidelines (Regulation 244/2008). In addition, the increased efficiency of electrical appliances played an important role.

Diagram 15: **Emission trends in households**



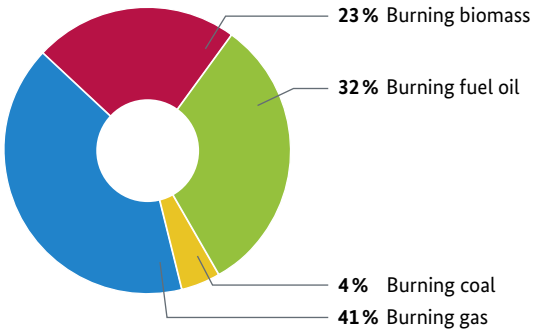
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 16: **Energy consumption in households 2012**



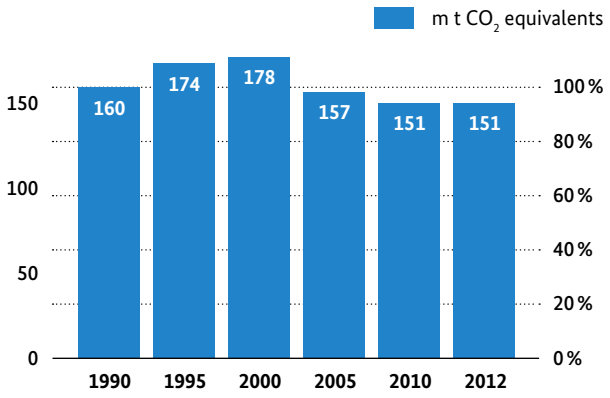
Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) analysis tables 1990–2012, as of: July 2013

Diagram 17: **Energy sources in households 2012**



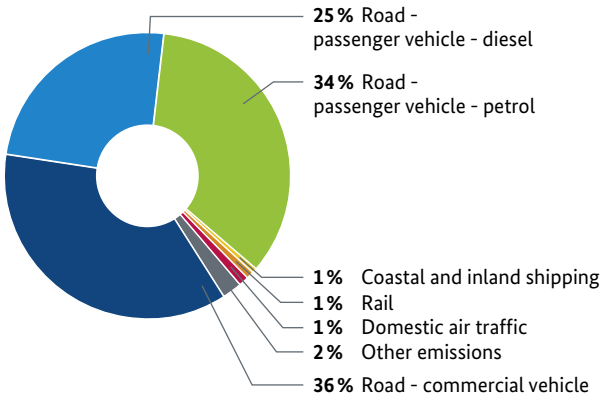
Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014

Diagram 18: **Emission trends in transport**



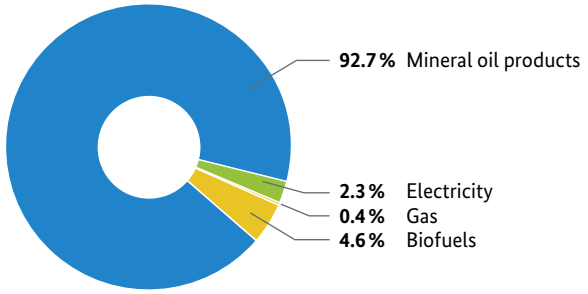
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 19: **Emission sources in transport 2012**



Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014

Diagram 20: **Final energy consumption in transport 2012**



Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) analysis tables 1990–2012, as of: July 2013

Transport

Since 1990, CO_2 equivalents in the transport sector have fallen by nearly 6 per cent. Nonetheless, transport is still one of the main emitters. Between 1990 and 2000, CO_2 equivalents from transport rose by over 11 per cent. Two main reasons for this were the increase in kilometres travelled, and the general trend towards more powerful, heavier vehicles.

In the following years the level of CO_2 equivalents from transport fell. This was principally due to efficient engines and vehicle construction, causing less CO_2 emissions per passenger kilometre. A further factor was the increased use of passenger vehicles with diesel engines. The latter was the result of fuel tax relief and lower fuel consumption in diesel engines. The ecological tax reform introduced at the end of the 1990s also played a role: From that point on, motor vehicle tax was based on emission values instead of cylinder capacity. The result is that clean-exhaust vehicles are favoured. Consequently, transport-related CO_2 equivalents declined by approximately 15 per cent between 2000 and 2012.

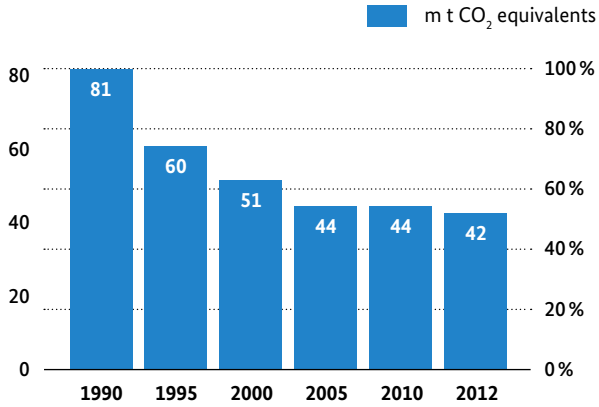
Some 95 per cent of greenhouse gases resulting from transport are caused by road traffic. Overall, mineral oil products are the main source of greenhouse gas emissions.

Business, trade and services

Diagram 21 shows that CO_2 equivalents from business, trade and services nearly halved since 1990. The chief causes of this were: Improvement in heat insulation, modernisation of plants and machinery, as well as measures towards automation and process optimisation. As with private households, the need for indoor heating was a major influential factor on CO_2 equivalents. Fluctuations in emissions can therefore also be considered as primarily having been the result of weather conditions in this sector.

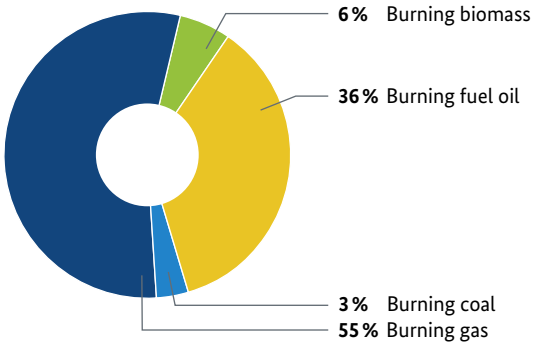
It is significant that coal is used less and less for heating: In 1990, coal burning caused as much as 36 per cent of CO_2 equivalents, while in 2012 this proportion had reduced to only 3 per cent. Electricity and gas cover 66 per cent of final energy consumption in the business, trade and services sector. Coal, however, now has a share of only one per cent in final energy consumption. Emissions resulting from electricity and heating from public supply to business, trade and services are not included in this diagram (as with private households), but are instead attributed to the energy industry. Nonetheless, it is certainly worth looking at the final energy consumption in this sector.

Diagram 21: **Emission trends in business, trade and services**



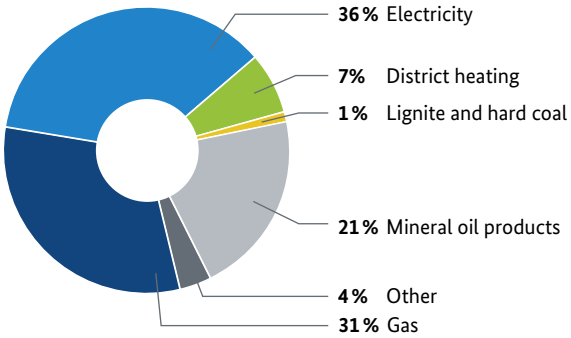
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 22: **Energy sources in business, trade and services 2012**



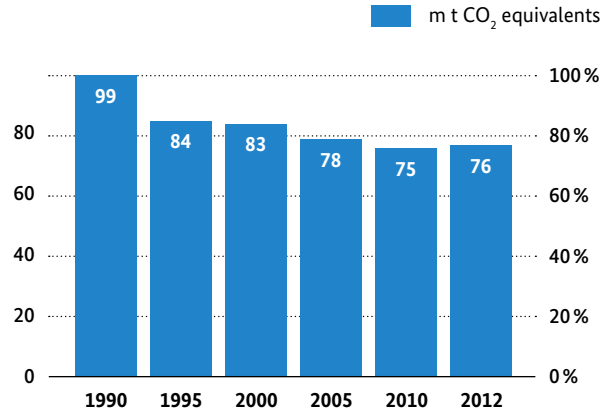
Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014

Diagram 23: **Final energy consumption in business, trade and services 2012**



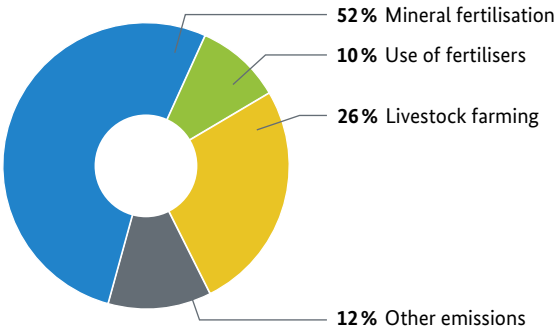
Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) analysis tables 1990–2012, as of: July 2013

Diagram 24: **Emission trends in agriculture**



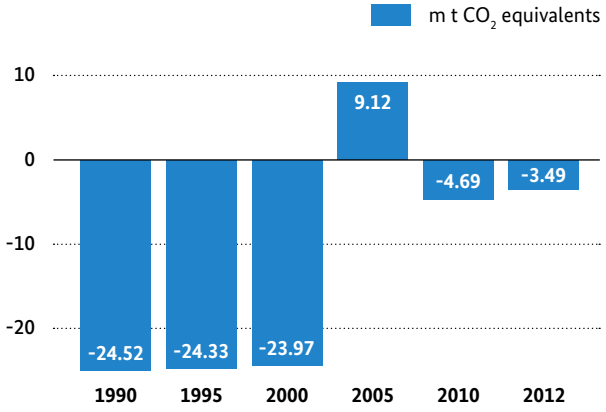
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 25: **Emission sources in agriculture 2012**



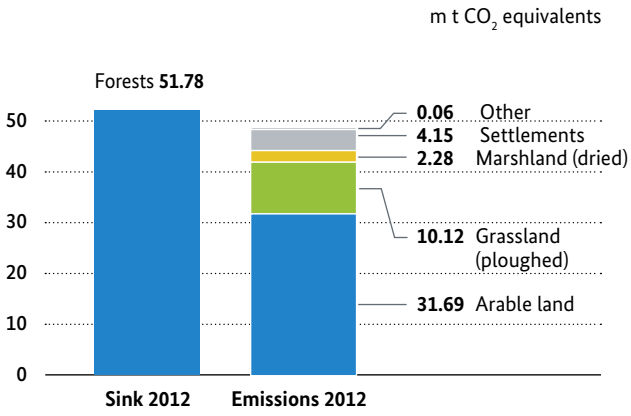
Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014

Diagram 26: **Emission trends in LULUCF**



Source: Federal Environment Agency – National UNFCCC reporting 2013, p. 61

Diagram 27: **Emissions and carbon sinks in LULUCF 2012**



Source: http://www.umweltbundesamt.de/sites/default/files/medien/384/bilder/2_tab_emi-senken-lulucf_2013-10-04_neu.png

Agriculture

Diagram 24 shows that CO_2 equivalents from agriculture have fallen by approximately 23 per cent since 1990. Unlike other sectors, agriculture primarily emits CH_4 and N_2O. These gases produced in livestock farming, are the result of fertiliser use, and are discharged from agricultural soil. From 1990 to 1992, emissions from livestock farming fell by nearly 5 kilo tonnes. The reason for this was that animal populations declined during German reunification: Instead of growing livestock numbers, the aim was to intensify livestock breeding and to specialise. In order to further minimise emissions from agriculture, mineral fertilisers (artificial fertilisers) are to be used for specific requirements, particularly in the area of nitrogen fertilisation. Another important approach is the promotion of ecological agriculture.

Land use, land use change and forestry

Humus-rich soil, moors, grasslands and forests consist of organic compounds that bind greenhouse gases in their structures and store them. However, changes in land use frequently cause the absorption capacity of soil to be diminished. If, for example, grassland is converted into arable land, then greenhouse gases will be released. The same happens with intensive use, the effect of which is that land that once provided a form of storage becomes a source of emissions. The use of moorland by agriculture as arable land and grassland caused around 4 per cent of all greenhouse gas emissions in Germany in 2010.

The type of land use or land use change[7] and forestry practices have a decisive impact on the storage capacity of soil and forests. Between 1990 and 2001, the sector was able to store approximately 25 million tonnes of CO_2 equivalents annually in Germany. However, between 2002 and 2007, this area emerged as a new source of emissions.

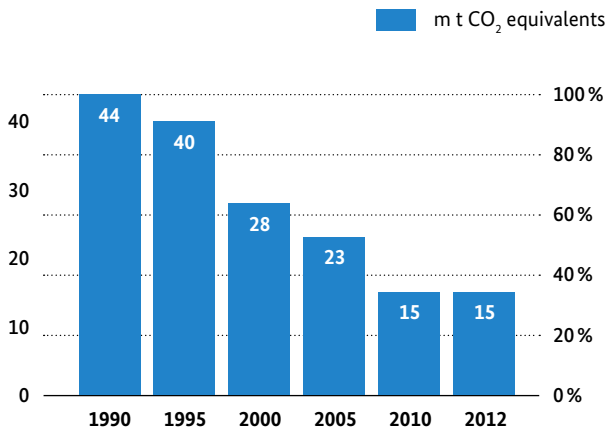
In 2012, the forests absorbed almost 52 million tonnes of CO_2 equivalents. In the same year, approximately 32 million tonnes of CO_2 equivalents were released from arable land. Overall, this figure rose to as much as 48 million tonnes of CO_2 equivalents through the development of settlement areas, and the use of marshlands and grassland, as well as the liming of forest soils, mainly categorised as "Other" in *diagram 27*. Nevertheless, in 2012 almost 3.5 million more tonnes of CO_2 equivalents were absorbed than released due to land use, land use change and the forestry sector. For information on trends in the storage capacity of Germany's forests, see also page 19.

Compared to emission calculations in the other sectors, there are considerable methodological difficulties in determining both emissions and absorption of CO_2 through land use and forestry. Firstly, in forestry storage capacity may also be lost through natural occurrences such as forest fires or insect infestations. Secondly, it is almost impossible to distinguish between natural storage processes, and climate action achieved through forestry activity. For this reason, there are special calculation rules for this sector in the international climate policy agreements. Consequently, emissions resulting from and absorbed by land use and forestry are not taken into consideration as efforts towards either the European reduction target (20 per cent by 2020) or the German emissions reduction target (40 per cent by 2020).

Waste management

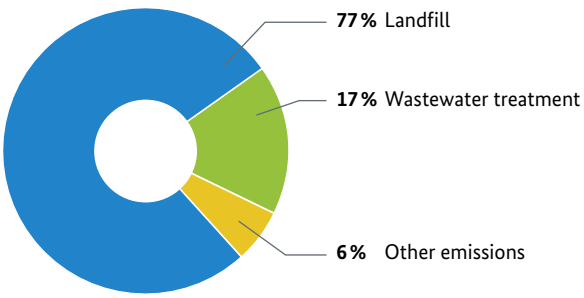
The greatest reduction in CO_2 equivalents since 1990 was recorded in the waste management sector. Levels had fallen by 66 per cent by 2012. This was primarily achieved through measures that limited the release of CH_4 from landfill sites, as well as a ban on storage of municipal waste that has not been pre-treated - these measures came into force in 2005. Altered disposal channels for municipal waste also play an important role as more and more recyclable materials are separated and recycled. The recycling of used paper, glass, packaging and bio-waste means lower energy usage and contributes to a reduction in greenhouse gases. As well as emissions from waste management, this sector also includes emissions from the waste water sector.

Diagram 28: **Emission trends in waste management**



Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 29: **Emission sources in waste management 2012**

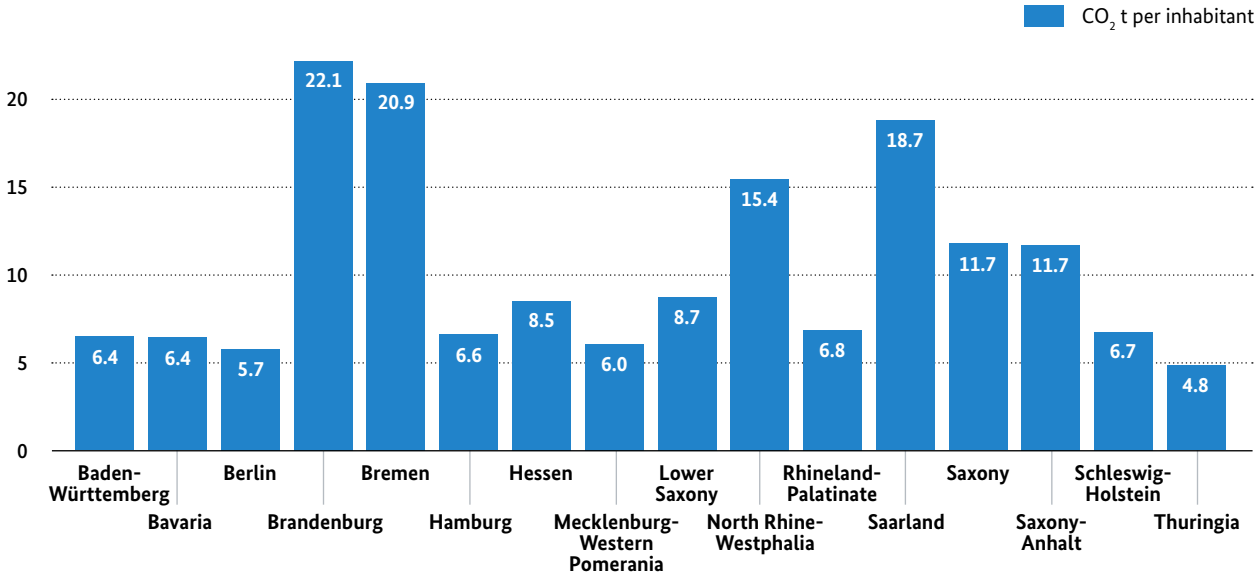


Source: Federal Environment Agency – Special evaluation from the inventories of national UNFCCC reporting 2014

CO_2 EMISSIONS BY FEDERAL STATE

Diagram 30 shows that per capita emissions vary greatly between the German federal states. For example, the average inhabitant in Brandenburg produced 22.1 tonnes of CO_2 in 2010, while the figure for Thuringia was merely 4.8 tonnes. This striking discrepancy shows how important economic structure can be. High per capita emissions levels occur in regions where electricity is predominantly produced by burning lignite and hard coal (North Rhine-Westphalia, Brandenburg), and also where steel production is an important part of the economy (Saarland, Bremen). The varying economic structures and characteristics pose different challenges for climate policy in the federal states.

Diagram 30: **Breakdown of CO_2 emission to federal states**



Source: Federal Environment Agency: National UNFCCC reporting 2014, national accounts in the Länder 2010

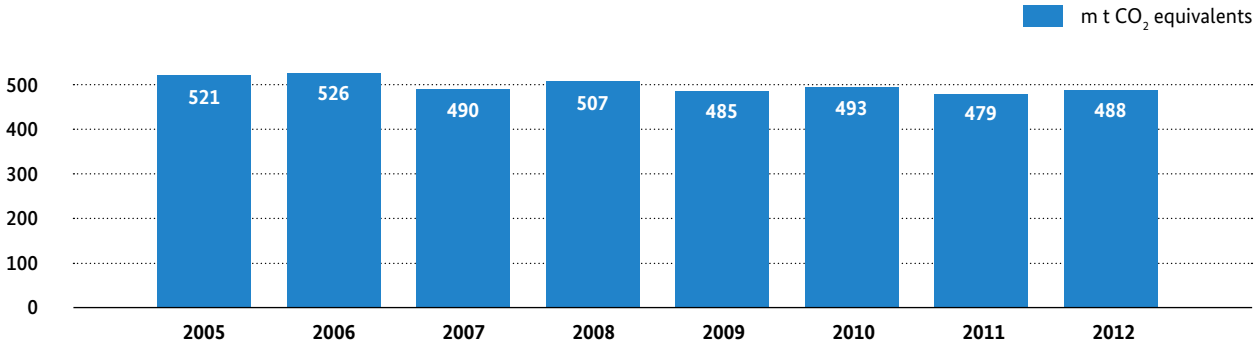
EMISSION TRENDS INSIDE AND OUTSIDE THE EMISSIONS TRADING SYSTEM

The emissions trading system has contributed to reducing emissions in Germany. During the first trading period (2005 to 2007), operators of 1,850 plants across Germany were obliged to take part in emissions trading. During this phase, a total of 499 million tonnes worth of emissions allowances were allocated per year and during the second trading period (2008 to 2012), 1,650 plants were obliged to participate. These plants received 452 million tonnes worth of allowances per year – 389 million tonnes of which were free of charge. Around 40 million tonnes were auctioned and the remaining permits were kept as a reserve for new plants. In the third trading period, beginning in 2013, further plants were included (1,820 plants) and since then, the trading rules have not only applied to CO_2 – further greenhouse gases are now included (N_2O und HFCs). For further information on the emissions trading system, see page 11 of this brochure.

Auctioning of German emissions allowances is done via the European Energy Exchange AG, headquartered in Leipzig. In a single EU-wide procedure, allowances are auctioned there each week. All permitted bids are listed in descending order according to value and to determine the hammer price, which is consistent for all successful bidders. The hammer price fell by over 60 per cent between 2010 and the end of 2013.

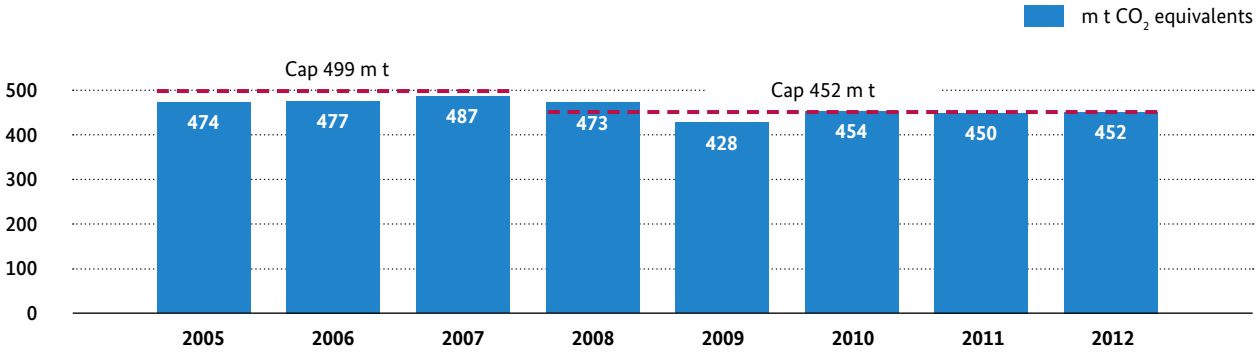
From 2005 to 2012, CO_2 equivalents fell in Germany by approximately 5 per cent in the sectors subject to the emissions trading system. In sectors not covered by the emissions trading system, emissions decreased by nearly 7 per cent by 2012. For information on sectors outside the emissions trading system, see page 13.

Diagram 31: **Emission trends outside the emissions trading system**



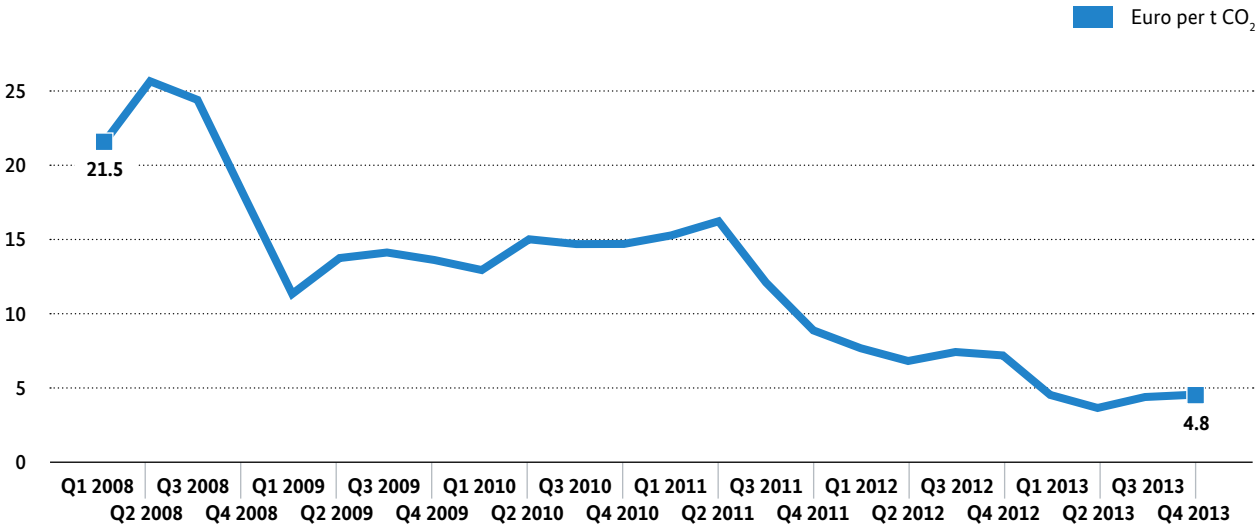
Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf
http://www.dehst.de/SharedDocs/Pressemitteilungen/DE/2013_015_VET2012.html

Diagram 32: **Emission trends in the emissions trading system within Germany**



Source: http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf
http://www.dehst.de/SharedDocs/Pressemitteilungen/DE/2013_015_VET2012.html

Diagram 33: **Trend of CO_2 prices**



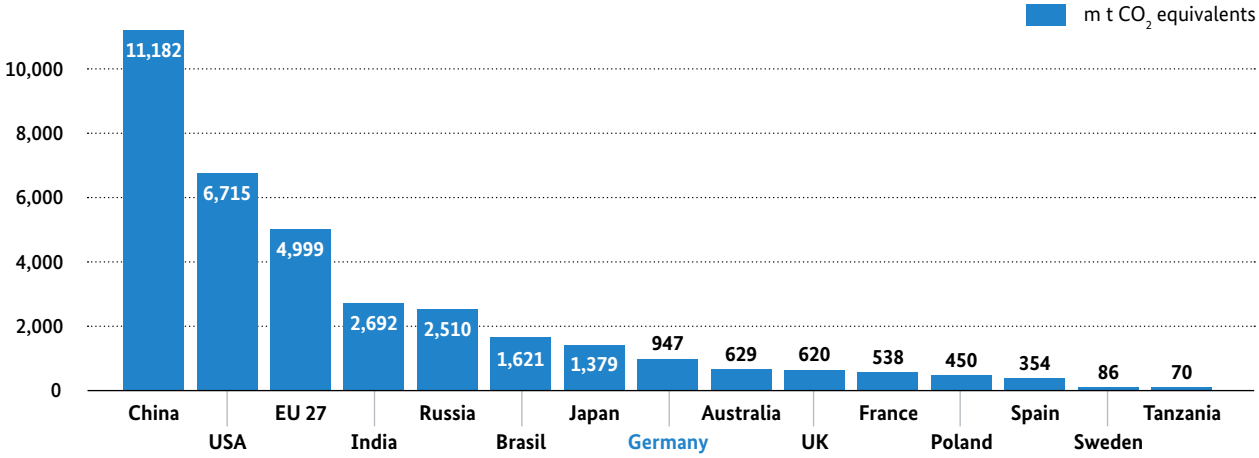
Source: ICE and Thomson Reuters, (quarterly mean values of the ICE annual futures report)

EMISSIONS IN INTERNATIONAL COMPARISON

Diagram 34 and *diagram 35* show that, despite all progress in climate change mitigation, Germany is still one of the main emitters by international comparison. Global greenhouse gas emissions were estimated at 50.1 gigatonnes in 2010. Germany was responsible for nearly 2 per cent of emissions worldwide in 2010.

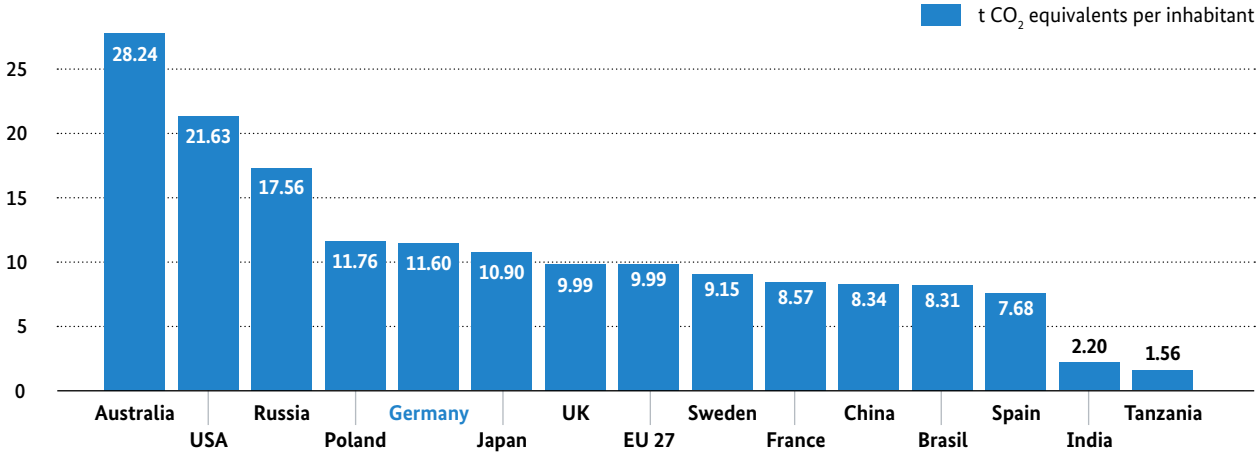
The world's largest emitters include China, the USA and India. Germany ranked seventh internationally. However, in terms of greenhouse gas emissions per capita (*diagram 35*) it's a different picture: India's share, for example, is very low in terms of per capita emissions. Germany is just above the EU average in this regard.

Diagram 34: **International emissions 2010**



Source: http://edgar.jrc.ec.europa.eu
http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Diagram 35: **International per capita emissions 2010**



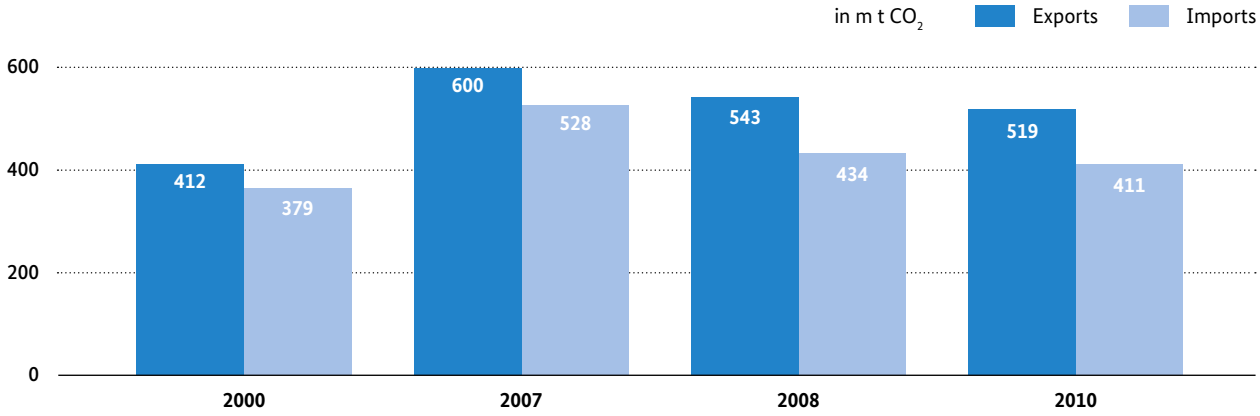
Source: http://edgar.jrc.ec.europa.eu
http://www.umweltbundesamt.de/sites/default/files/medien/479/dokumente/pi-2013-05_anlage_treibhausgasemissionen.pdf

Grey emissions

Grey emissions refer to the volume of greenhouse gases in a country that arise from the consumption of goods. So far, these greenhouse gases are measured using the territoriality principle. In other words, greenhouse gases are attributed to the country within whose territory they are generated. One exception is fossil fuels, which contribute to the greenhouse gas balance of the sales market. This means that emissions are currently calculated irrespective of the place of consumption. This makes it possible to clearly attribute emissions and avoid double counting. However, there is, in theory, still the risk that high-emission industries may be forced to move abroad – particularly to states that have no climate targets.

One of the main arguments for the continued use of the territoriality principle across the world is the advantage of national data: In their reporting duties, all states have a sovereign right to their own data. Yet this makes it difficult to calculate emissions according to the place of consumption, as this would require an obligatory sharing of data.

Diagram 36: **Grey emissions**



Source: Federal Statistics Office – National environmental accounts on CO_2 content of German export and import goods

GREY EMISSIONS IN INDUSTRIAL COUNTRIES

Situation within the OECD

In 2005, CO_2 emissions resulting from OECD country consumption were on average 16 per cent higher than figures calculated according to the territoriality principle. Less than half of the global increase in emissions between 1995 and 2000 were attributed to OECD member states, yet approximately two thirds of the goods that were responsible for this increase were consumed in OECD countries.

Situation in Germany

As a strong export nation, the situation looks somewhat different for Germany. In 2010, Germany exported goods that were reflected in the national greenhouse gas balance to the amount of some 519 million tonnes CO_2. 326 million tonnes of this originated from domestic production. Approximately 192 million tonnes resulted from the production of imported intermediate goods that were used to manufacture export goods. In 2010 as well, Germany imported goods that caused 411 million tonnes of CO_2 emissions elsewhere in the world. Thus in 2010, more emissions were exported than imported. This was also the case in the years 2000, 2007 and 2008. The difference between the territoriality principle and the consumption principle lay between 108 million tonnes CO_2 in 2010 and 109 million tonnes in 2008.

SCENARIOS IN EMISSION TRENDS

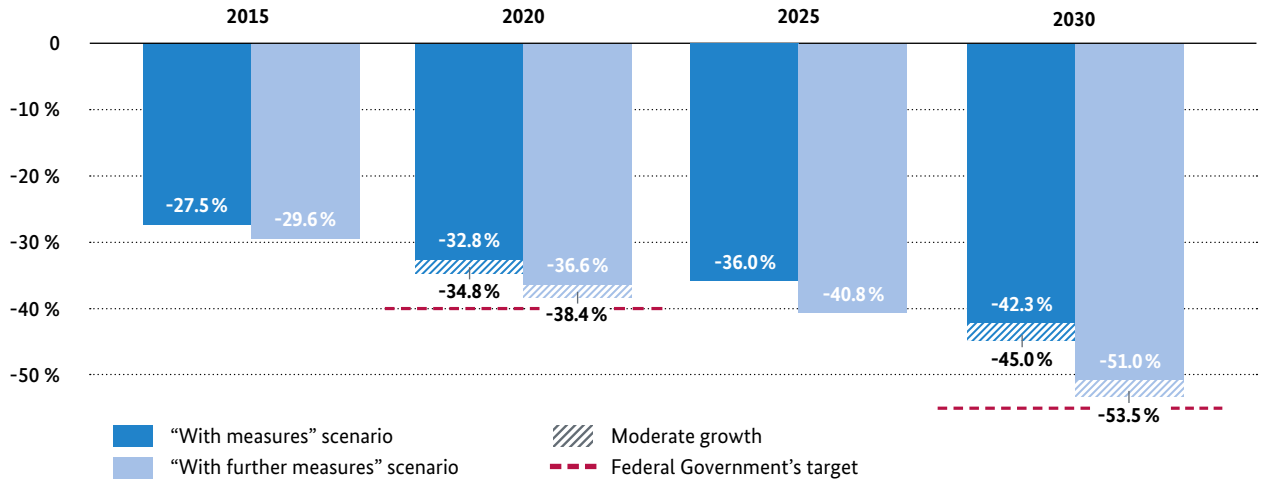
In order to gain an understanding of how existing measures, and possible further measures, towards climate change mitigation affect greenhouse gas emissions, the Federal Environment Ministry had an assessment carried out for two scenarios covering the period 2015 to 2030:

- **"With measures" scenario**: This includes all measures introduced by the German government up until October 2012.
- **"With further measures" scenario**: This not only takes into consideration measures introduced by October 2012, but also further possible energy and climate policy approaches. These, in particular, include greater efforts to save electricity and higher taxes on fuel. Otherwise the framework conditions are identical to those of the "With measures" scenario.

The results of the two scenarios

In the "With measures" scenario, greenhouse gas emissions fall by 32.8 per cent by 2020 compared to 1990 levels. By 2030, the figures decline by 42.3 per cent. In the "With further measures" scenario, emissions are reduced by 36.6 per cent by 2020, and by 51 per cent by 2030. Thus, in both scenarios, the targets set out in 2010 in the German government's Climate and Energy Concept are not fully met (see page 15). Therefore, further climate change mitigation measures must be implemented. Nevertheless, with the measures in place so far, Germany can be expected to achieve its share of the European Union's targets to reduce greenhouse gas emissions by 20 per cent, and possibly 30 per cent (see page 11) compared to 1990 levels. However, the calculated results depend heavily on the assumed framework conditions. For example, should the annual growth rate fall by 0.3 per cent, this would lead to an emissions reduction of as much as 2 per cent.

Diagram 37: **Scenarios in Emission trends in Germany 2015–2030**



Source: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety: Summary of results from the Projection Report on Greenhouse Gas Emission Trends

4. Energy trends

RENEWABLE ENERGY SOURCES

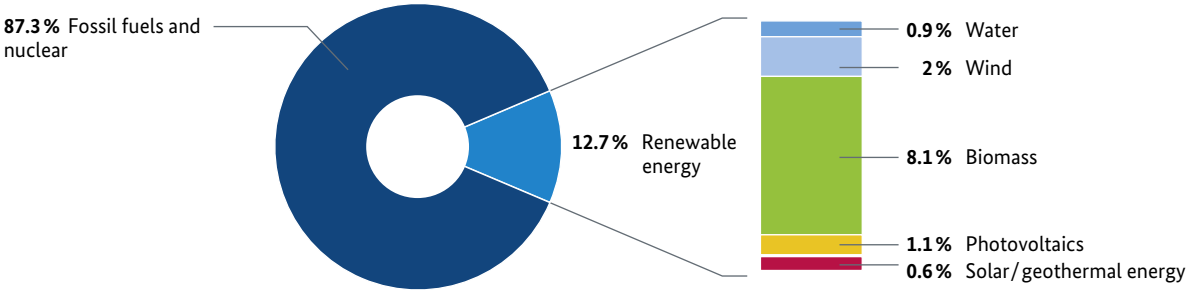
Generating and supplying renewable energy sources

In 2012, renewable energy sources covered some 12.7 per cent of final energy consumption (*diagram 38*). They provided around 318 billion kilowatt hours of energy. Compared to 2011, their proportion used in energy supply rose by one per cent.

Worldwide in 2011, renewable energy sources supplied some 16.7 per cent of final energy consumption.

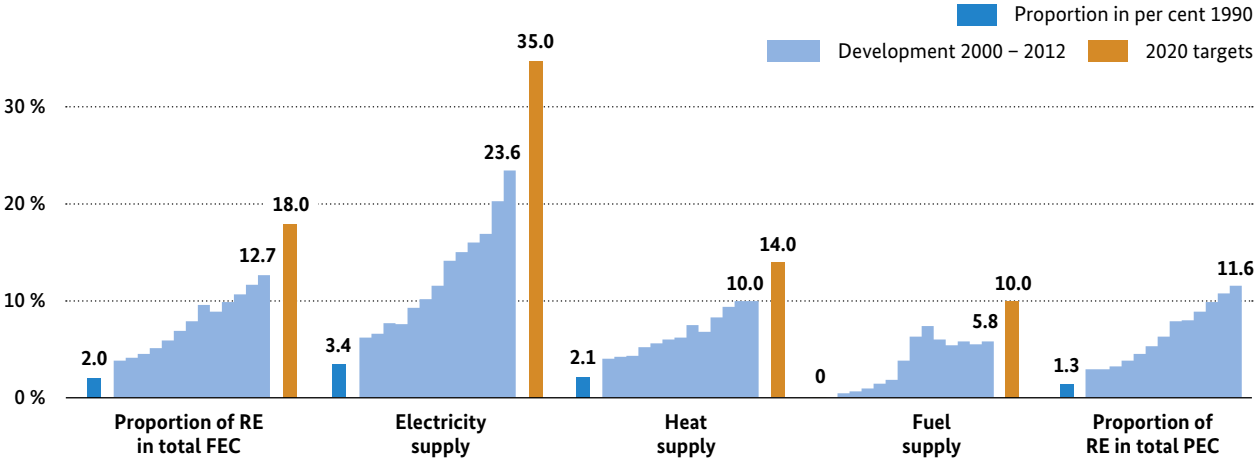
Diagram 39 illustrates that as of 1990, the proportion of renewable energy sources used in final energy consumption in Germany rose steadily. The same is true of electricity and heat supply, as well as primary energy consumption. In fuel consumption, the proportion of biofuel used increased until 2007. This evened out, with slight fluctuations, at around 5.5 per cent by 2012.

Diagram 38: **Final energy supply 2012**



Source: Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

Diagram 39: **Proportion of renewable energy sources in energy supply in Germany**



Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – Renewable energy sources 2012, p. 9; Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

Trends in final energy supply

Since the beginning of the 1990s, the proportion of renewable energy sources in the final energy mix increased significantly. The following trends in particular can be noted (*diagram 40*):

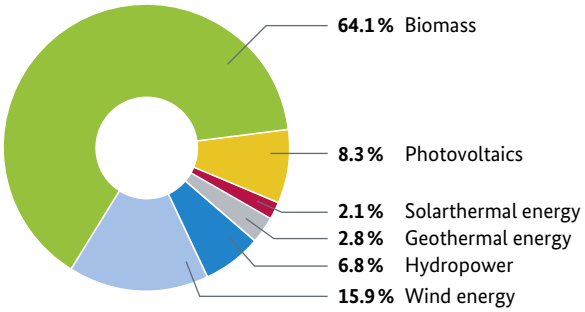
- **Electricity supply**: Since 1998, the proportion of renewable energy sources used for electricity supply almost quadrupled. The main reason for this was the growing use of wind energy. Output from this source has multiplied almost ten times since 1998. In 2012, renewable energy facilities produced a combined total of some 143.5 billion kilowatt hours of electricity.

- **Heat supply**: Since 1998, the proportion of renewable energy sources used for heat supply tripled. An important precondition for this was the German government's market incentive programme. This scheme promotes the use of renewable energy technologies for heat supply in existing buildings. Further factors were policy measures and other support programmes at national and regional levels to foster investments in heat supply coming from renewable energy sources. An example of such measures is the Combined Heat and Power Act (KWKG). The demand for renewable energy technologies used in heat supply also grew as result of the rise in prices for fossil fuels. In total, 138.3 billion kilowatt hours of heat were supplied from renewable energy sources in 2012.

- **Fuels**: Significant growth in the range of biomass fuels has only been seen since 2004. In 2012, their proportion amounted to 5.8 per cent, as 36.1 billion kilowatt hours of fuel were provided by biomass.

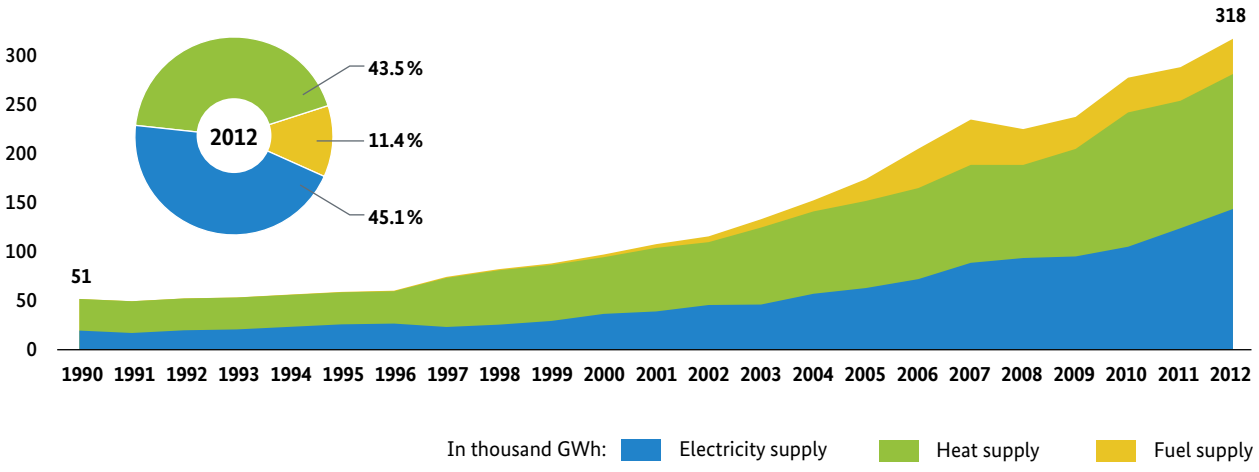
Overall, a growing trend can be seen in the use of renewable energy sources for electricity, heat and fuel supply. The greatest increase was recorded in electricity generation, with its proportion rising by 15 per cent between 2011 and 2012. A 5 per cent increase was achieved in fuel supply. For 2012, final energy supply from renewable energy sources can be broken down as follows: 11.4 per cent in fuel supply, 45.1 per cent in electricity, and 43.5 per cent in heat supply.

Diagram 41: **Structure of final energy supply from renewable energy sources 2012**



Source: Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

Diagram 40: **Final energy supply from renewable energy sources**



Source: Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

Contributions from individual renewable energy sources

- **Final energy supply** (*diagram 41*): In 2012, and as was the case in 2011, biomass once again made up the largest proportion of renewable energy sources used for final energy supply at 64.1 per cent. Wind energy ranked second at 15.9 per cent. The proportion of hydropower was 6.8 per cent, while photovoltaic plants provided almost 8.3 per cent. Geothermal and solar thermal energy, however, have so far contributed relatively little to final energy.

- **Electricity supply** (*diagram 42*): In terms of electricity supply from renewable energy sources, wind energy plants were the main contributor. As early as 2003, wind energy overtook hydropower as the main source of renewable energy for electricity. Major expansion in the photovoltaic sector saw its share increase to 18.4 per cent, making it the second largest renewable energy source in electricity supply. Biogas plants also recorded a large increase in electricity supply.

- **Heat supply** (*diagram 43*): At 73 per cent, biogenic solid fuels provided the majority of heat produced from renewable sources in 2012. In private households, firewood was the dominant source with a share of 53.8 per cent. The use of wood as a fuel also increased in heat and power plants and in industry. In 2012, this amounted to 5.2 per cent and 14 per cent respectively. At the start of the 1990s, biogenic liquid fuels and gaseous fuels such as biogas and vegetable oil were hardly used for producing heat. Yet by 2012 they had earned a share of 9.4 per cent. An increase was also recorded in heat supply from biogenous waste, which reached 6.5 per cent in 2012. Geothermal and solar thermal energy combined accounted for a share of 11.1 per cent, with heat pumps (shallow geothermal energy) being the main form of use.

- **Fuel supply** (*diagram 44*): Fuels from renewable energy sources include biodiesel, bioethanol, biomethane and plant oil. Biodiesel provides the greatest share in this at 72.8 per cent. Around 25.5 per cent is supplied by bioethanol, while biomethane contributes only one per cent, and vegetable oil only 0.7 per cent. The share of biodiesel and vegetable oil has been on the decline since 2007. Meanwhile, the supply of bioethanol doubled, largely due to the launch of E10 fuel at the start of 2011.

Diagram 42: **Structure of electricity supply 2012**

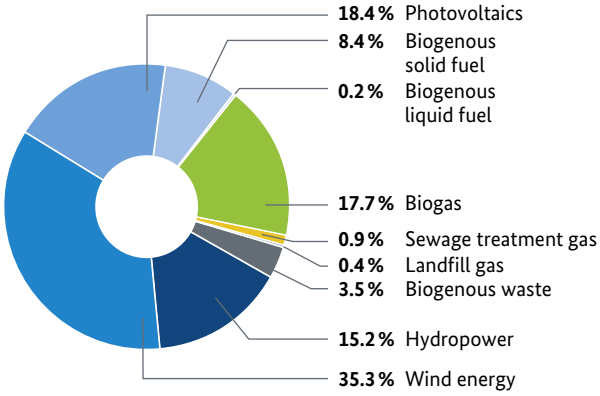


Diagram 43: **Structure of heat supply 2012**

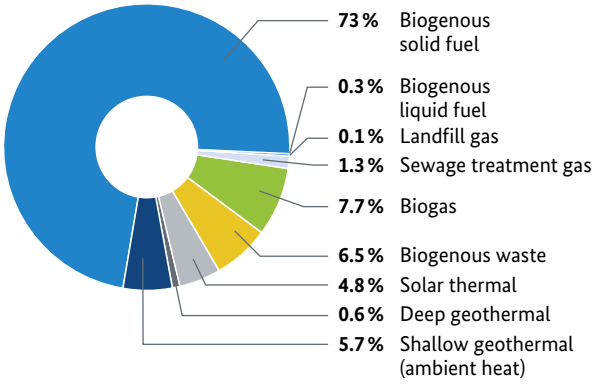
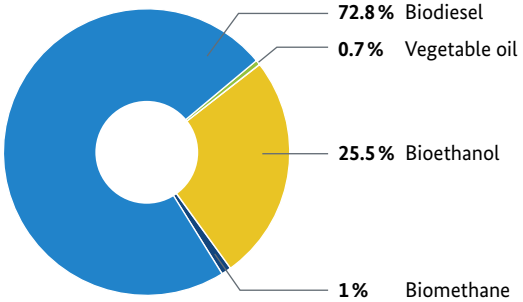


Diagram 44: **Structure of fuel supply 2012**



Source: Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

Prevention of greenhouse gas emissions through renewable energy sources

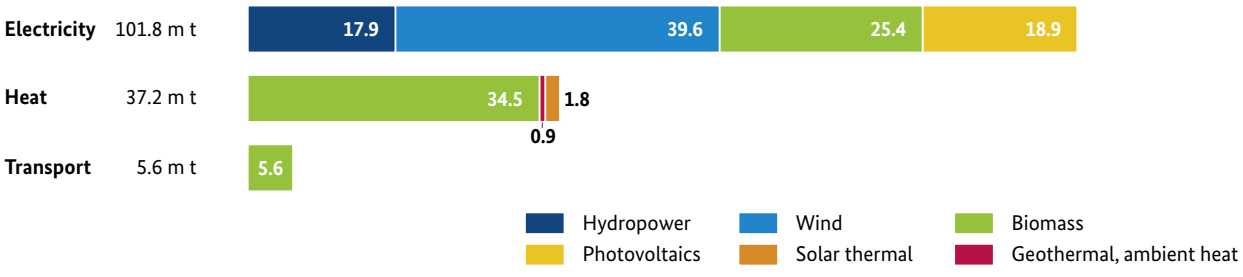
In 2012, it was possible to prevent some 144.6 million tonnes of CO_2 equivalents through the use of renewable energy sources. To calculate this, the emissions produced in providing renewable energy were deducted from the emissions that it was possible to prevent by not using fossil fuels. Compared to 2011, this means a reduction of about 16 per cent in CO_2 equivalents.

- **Electricity**: At 101.8 million tonnes, this sector saw the largest amount of greenhouse gases prevention.
- **Heat**: Here it was possible to prevent 37.2 million tonnes of CO_2 equivalents.
- **Fuels**: The smallest reduction was seen in fuel consumption, at 5.6 million tonnes.

The individual renewable energy sources contributed to this reduction as follows:

- **Biomass**: Through the use of biomass, some 65.5 million tonnes of CO_2 equivalents were prevented in 2012. Biomass had the highest share in the overall emissions reduction at 45 per cent.
- **Wind energy**: The use of wind energy prevented 39.6 million tonnes of CO_2 equivalents. Its share in prevented emissions amounted to 27 per cent.
- **Hydropower**: Approximately 17.9 million tonnes of CO_2 equivalents were prevented through the use of hydropower-generated electricity.
- **Photovoltaic**: The use of electricity generated from solar energy prevented 18.9 million tonnes of CO_2 equivalents.
- **Solar thermal and geothermal energy**: Thanks to heat gained from solar thermal and geothermal facilities, some 2.7 million tonnes of CO_2 equivalents were prevented.

Diagram 45: **Emissions avoided through renewables 2012**



Source: Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

ENERGY EFFICIENCY

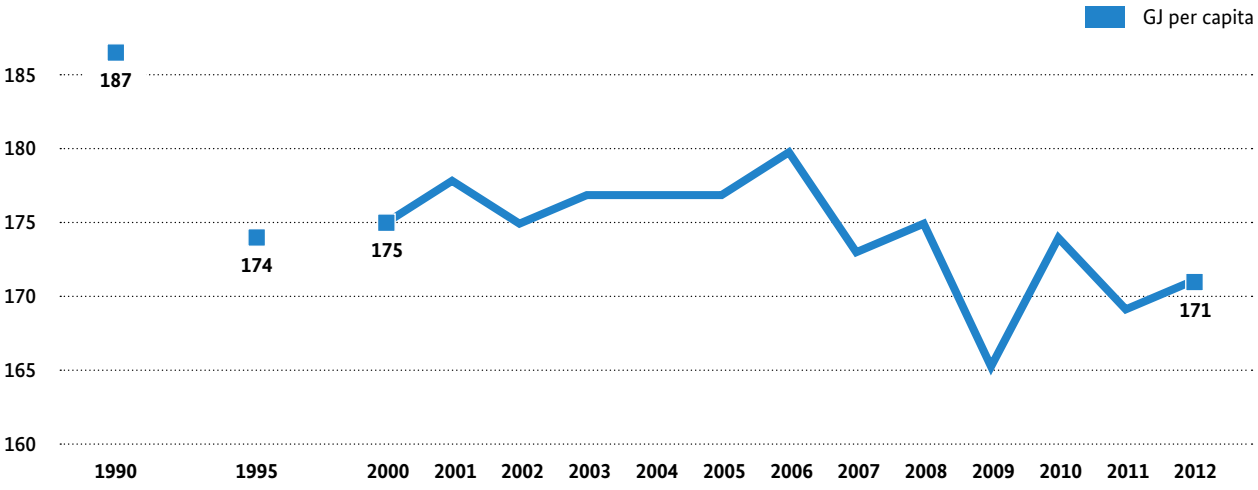
Primary energy consumption

Primary energy consumption refers to both a country's overall final energy consumption and internal consumption. Losses incurred in the production of final energy through energy conversion operations are also taken into account. Primary energy consumption is considered an important indicator of resource usage and resulting greenhouse gas emissions.

In Germany, primary energy consumption has been declining since the start of the 1990s (*diagram 46*). The reason for this is the use of renewable energy sources, which to an extent substitute for fossil fuels, as well as an increase in energy efficiency. However, if primary energy consumption per capita is compared with CO_2 emissions, it can be seen that emissions declined at a much higher rate between 1990 and 2012. Here, primary energy consumption per capita fell by 8.5 per cent, while per capita emissions were reduced by 26 per cent. During 2000–2012, primary energy consumption per capita remained almost stable.

Increases in efficiency do not automatically lead to lower energy consumption. This is due to what is known as "rebound effects." These occur, for example, when lower electricity consumption levels in household appliances lead to cost savings that encourage more frequent use of those appliances. Another example is when cost savings are used to finance other environmentally harmful activities. Empirical estimates of how rebound effects impact on potential savings vary widely, depending on the various definitions and parameters used. In the short term, losses of between 20 to 35 per cent are probable, and possibly even more in the long term.

Diagram 46: **Trends in primary energy consumption**



Source: Federal Ministry for Economic Affairs and Energy – Facts and Figures – Energy Data, Table 4, as of: 7 August 2013; Federal Statistics Office - Population

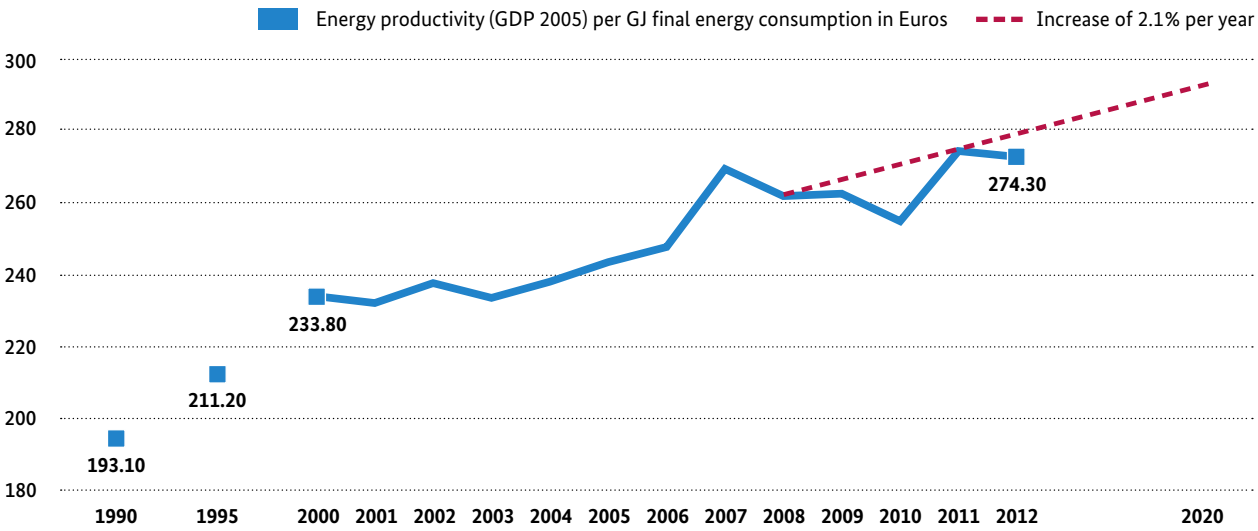
Energy productivity

Energy productivity gauges economic output generated per unit of energy consumed. It can be stated in terms of the ratio between gross domestic product and either primary energy consumption or final energy consumption. In order to assess increases in energy efficiency, it makes more sense to base calculations on final energy consumption. This is firstly because it is an indicator that is uninfluenced by changes in the power plant fleet in the energy conversion sector, and secondly, because greater efficiency in energy use and therefore the increase in energy efficiency must be achieved where the energy requirement arises - namely the sectors where the demand for final energy exists. The inverse of energy productivity is referred to as energy intensity. This measures how much energy is required to produce a unit of gross domestic product.

Since the early 1990s, energy productivity in Germany rose by over 42 per cent, while in 1990, only EUR 193.10 was generated per unit of energy. By 2012 this had risen to EUR 274.30 (*diagram 47*). This was the result of more efficient power plants and the use of energy saving potentials in business activities and private households. However, in the period from 2000 to 2012 an increase of only 17 per cent was recorded. The Energy Concept of 2010 states that primary energy consumption should have decreased by 20 per cent by 2020, and by 50 per cent by 2050, compared to 2008 levels. To achieve this, energy productivity would have to increase by an average of 2.1 per cent per year.

In order to ensure an annual increase of 2.1 per cent since 2008, it would have been necessary to generate EUR 285.69 per unit of energy in 2012. Overall, energy productivity rose by only 4 per cent after 2008.

Diagram 47: **Trends in energy productivity**



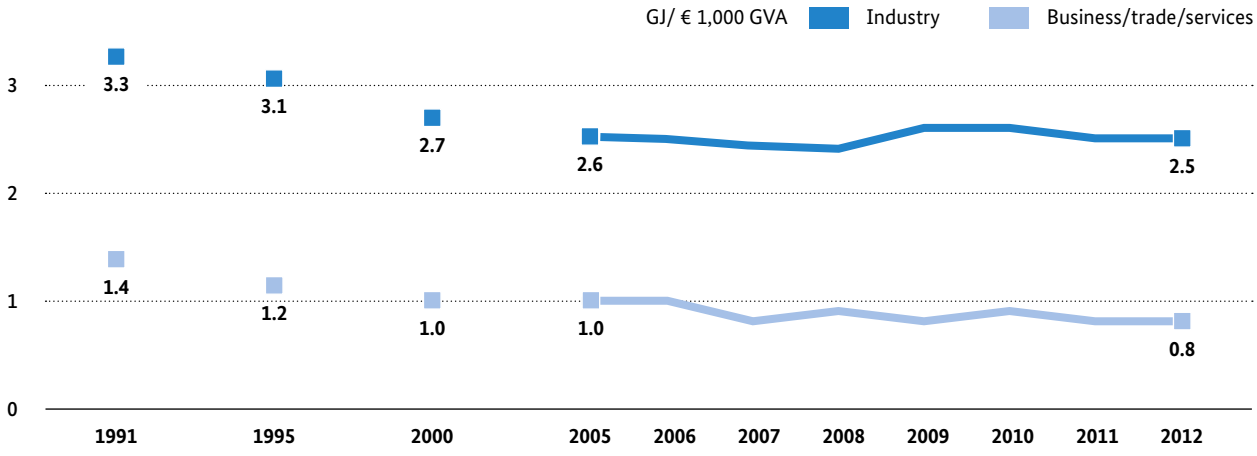
Source: Federal Ministry for Economic Affairs and Energy – Facts and Figures – Energy Data, Table 8, as of: 7 August 2013

The energy productivity levels shown here provide only limited information on technological advancements achieved in energy efficiency so far. This is primarily due to structural effects, which can, for example, result in a change in production within a sector or industry towards less energy-intensive products and processes. There may also be an increase in product-related services, or a shift in economic output within a sector, for example between an energy-intensive industry (e.g. cement manufacture) and a less energy-intensive industry (e.g. manufacture of electronic components).

ENERGY EFFICIENCY IN THE SECTORS: INDUSTRY AND BUSINESS/TRADE/SERVICES

Energy intensity here refers to the gross value added in the observed sectors. Once again, a general reduction can be seen in the industry, as well as in business, trade and services, with a pronounced reduction in business, trade and services. Since 1991, energy efficiency increased by over 40 per cent. In 2012, business, trade and services required only 0.8 gigajoules per EUR 1,000 in gross value added. By contrast, 1.4 gigajoules were required in 1991. In the industry, energy use fell by some 25 per cent. Thus it is clear that a decoupling of growth from energy has been achieved. Since 2005, energy intensity remained almost constant in both sectors.

Diagram 48: **Energy use in industry and business, trade and services**



Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) selected efficiency indicators for Germany's energy balance 1990–2012

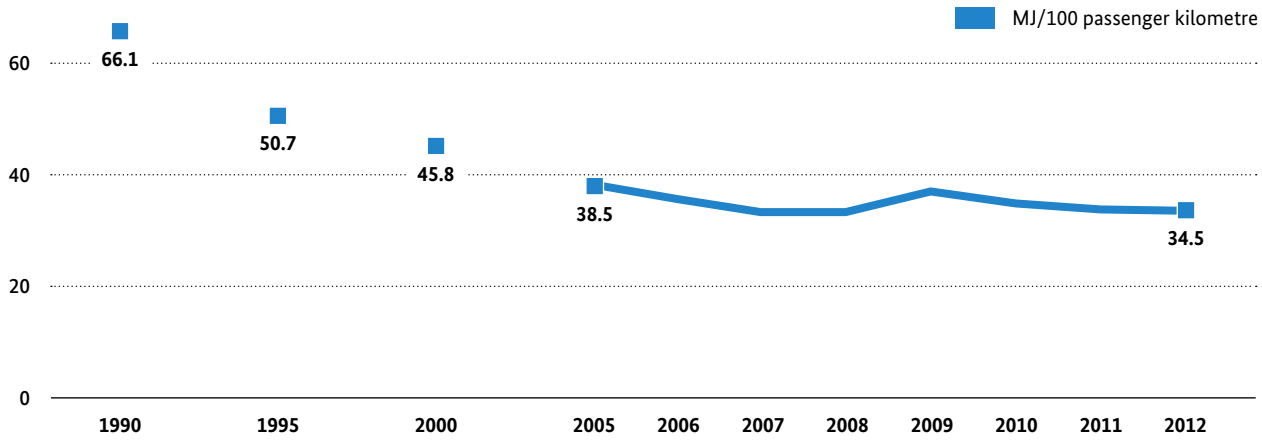
ENERGY EFFICIENCY IN THE TRANSPORT SECTOR

In the passenger and freight transport sector, energy consumption per passenger kilometre[8] almost halved during 1990–2012. In total, a reduction of 48 per cent was recorded. The greatest decrease occurred between 1990 and 2005, when energy consumption fell by a total of 42 per cent per passenger kilometre. However, since 2006 only a slight increase in energy efficiency has been achieved, and 2009 even saw a renewed increase in energy consumption per passenger kilometre (see *diagram 49*). On average, energy consumption per passenger kilometre has fallen by 2.91 per cent annually since 1990.

ENERGY EFFICIENCY IN THE PRIVATE HOUSEHOLD SECTOR

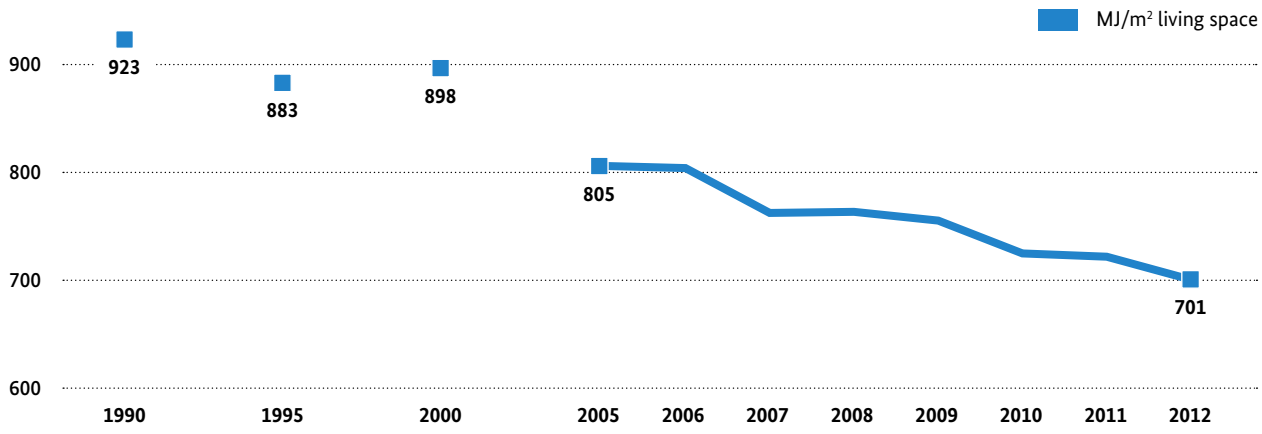
Total energy consumption (fuels, district heating and electricity) per square metre of living space has fallen by 25 per cent since 2012, compared to 1990 levels.

Diagram 49: **Energy efficiency in passenger and freight transport**



Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) selected efficiency indicators for Germany's energy balance 1990–2012

Diagram 50: **Energy efficiency in private households**

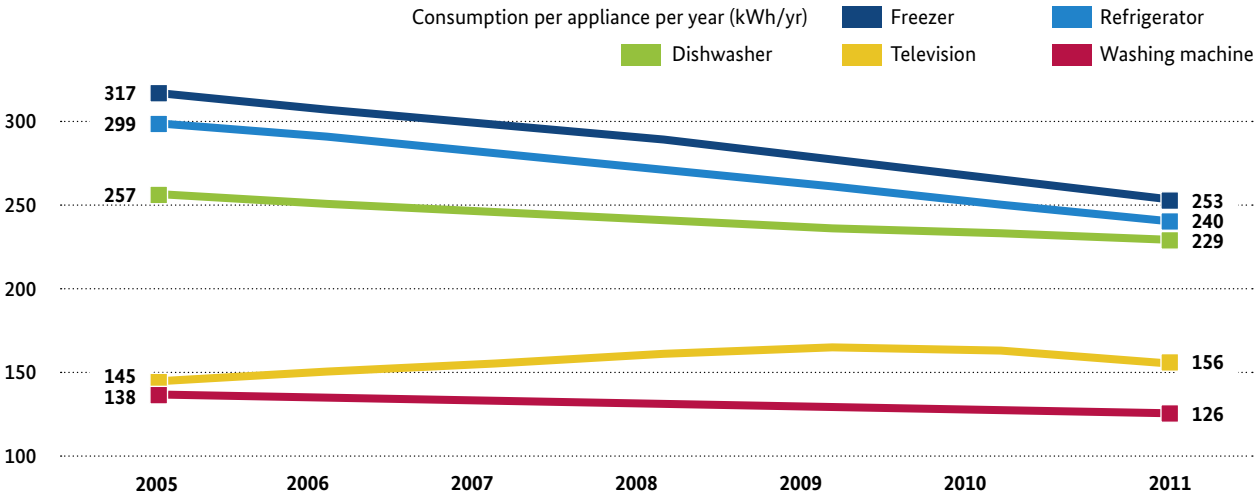


Source: Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen) selected efficiency indicators for Germany's energy balance 1990–2012

On average, an annual increase in efficiency of 1.25 per cent was recorded for private households (see *diagram 50*).

At 70 per cent, indoor heating made up the greatest share in final energy consumption in private households (see page 25). The average specific final energy consumption for indoor heating in residential buildings between 2005 and 2012 (according to provisional data) fell by 9 per cent to 130 kilowatt hours per square metre, per year (temperature adjusted, not including domestic firewood). However, in the same period, average living space rose by 4 per cent. In terms of electricity, large electrical appliances, such as refrigerators, freezers, washing machines, dishwashers and televisions, are the main energy consumers in private households. Over the years, the average consumption rates of many household appliances have fallen, while older appliances often consume a disproportionate amount of electricity. According to provisional data, in 2005 a refrigerator used 307 kilowatt hours annually, for example. By 2012, this had fallen to just 250 kilowatt hours per year. However, this does not allow for the conclusion that all newer appliances necessarily save more on energy. Energy consumption through televisions, for example, increased until 2009, only returning to 2005 levels in 2012. The "stand-by" feature in electrical devices remains a problem. This feature is responsible for at least EUR 4 billion in electricity costs in Germany every year, and therefore also a high volume of greenhouse gas emissions. In total, electrical appliances, as well as information and communications devices are responsible for approximately 60 per cent of electricity consumption in private households. Yet, at around 11 per cent, they represent only a small proportion of final energy consumption in private households.

Diagram 51: **Trends in the electricity consumption of large electrical appliances**



Source: Prognos et al. 2013, Öko Institute's (Institute for Applied Ecology) interpolation of missing years

5. Economic effects

FUNDING

The Federal Government helps protect the climate with a mix of measures comprising funding programmes, economic incentives (e.g. emissions trading) and legislation (laws and regulations). The funding programmes to aid climate action had a financial volume of more than EUR 3 billion in 2012.

The government also supports climate action on an international level: In 2011, it made around EUR 162 million of its 2012 federal budget available to international climate action initiatives. Around EUR 1.17 billion of the 2012 budget was earmarked for climate action projects carried out in the context of development cooperation. Another EUR 18.5 million was set aside for "renewable energy and energy efficiency export initiatives."

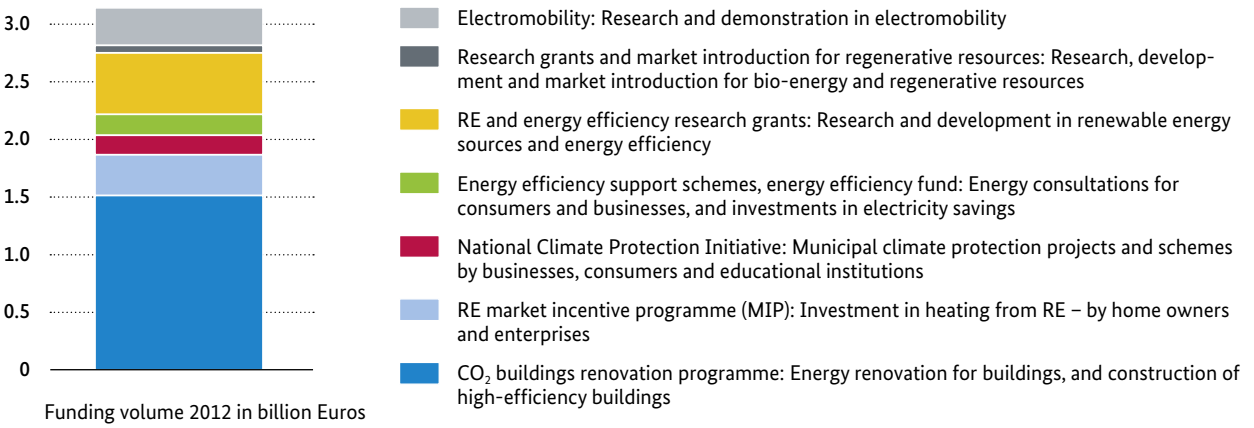
INVESTMENTS

The following trends can be observed with regard to investments:

- **Massive investment boost**: Since 2004 investments in renewable energies from energy providers, industry, manufacturers, trade, service providers and private households have risen by around 220 per cent. The highest total to date was EUR 27.9 billion in 2010 (see *diagram 53*). In 2011 and 2012 investments declined, the main reason being the sharp drop in prices for photovoltaic systems, as this meant that acquisition costs also fell. However, since the installation of photovoltaic systems made up the largest proportion of investment, this had a considerable effect on the overall sum. The investments are primarily financing new systems – so far, only a small proportion has served to upgrade or expand existing systems.

- **Decline in global investments in renewable energies**: Following a record total of USD 257 billion in 2011, global investments in renewable energies fell to

Diagram 52: **Funding progamme revenues 2012**



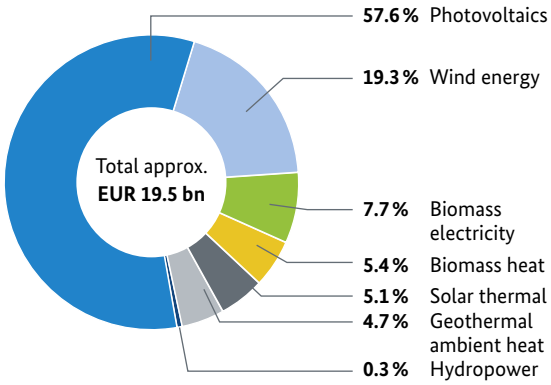
Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – "Klimaschutz und Wachstum", p.44 et seqq.

USD 244 billion in 2012. This decrease was primarily due to uncertain funding conditions in many regions. In the EU and the USA, this led to a decline of over 30 per cent. Another factor here was a sharp fall in prices within the solar industry.

- **Counter-trend**: While investments in renewable energies fell in some industrialised nations, they rose steadily in the less developed countries. The greatest investments in new systems in 2012 were made in China (USD 67 billion), the USA (USD 36 billion), Germany (USD 20 billion) and Japan (USD 16 billion).

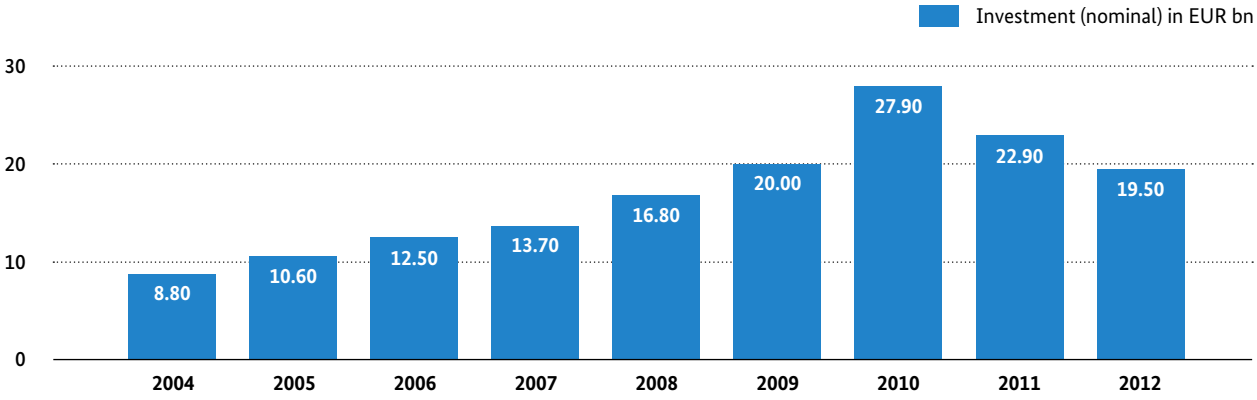
Compared to the costs of climate change, the investments in renewable energies are relatively small. In 2012 alone the costs of the damages caused by greenhouse gases amounted to roughly EUR 77 billion. The Federal Environment Agency estimates that each tonne of CO_2 currently brings about costs of EUR 82[9]. Due to differences in the methods, assumptions and measures used, some of the corresponding figures in international literature are considerably higher. They cover a total range of EUR 14 to EUR 300 per tonne of CO_2.

Diagram 54: **Distribution of investments 2012**



Source: Working Group on Renewable Energy – Statistics (AGEE-Stat), as of: December 2013

Diagram 53: **Investment trends in renewable energy**



Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – "Erneuerbare Energien in Zahlen 2012," p.39; Working Group on Renewable Energy – Statistics (AGEE-Stat)

Investments from the manufacturing industry

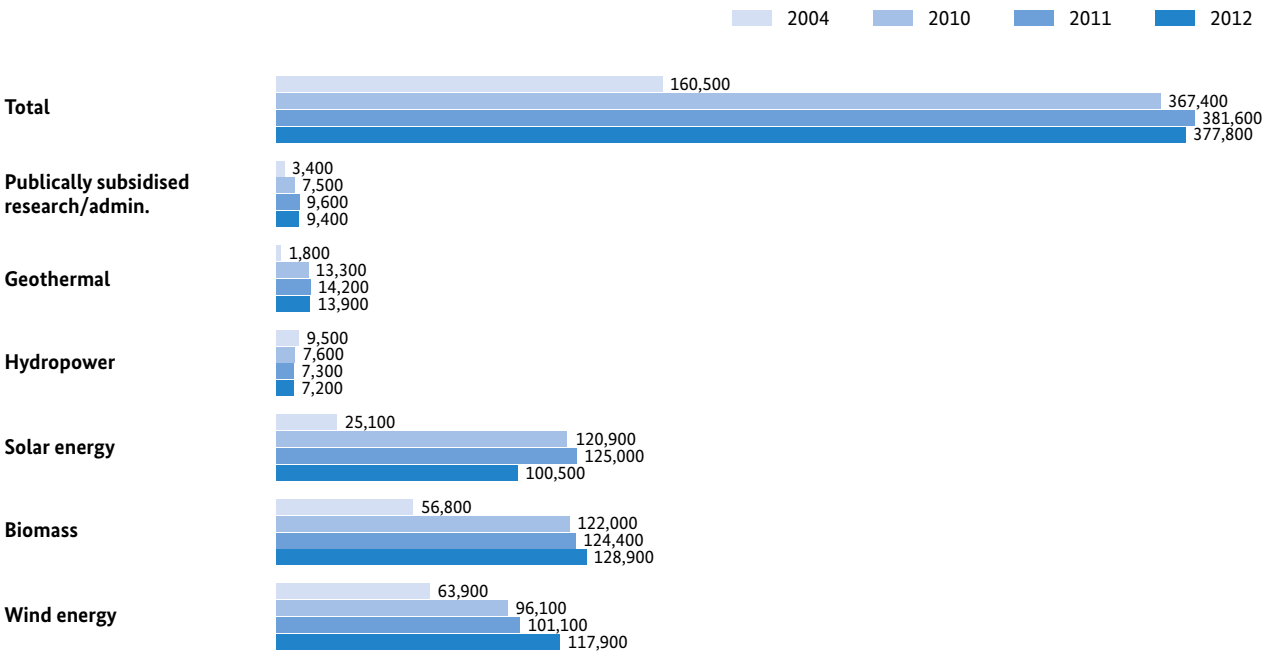
German companies from the manufacturing industry increased their investments in tangible assets for environmental protection[10] by almost 18 per cent in 2011 compared to the previous year. At EUR 7.1 billion, these made up almost 10 per cent of the companies' total investment. Around EUR 2.4 billion, over a third of the investments in protecting the environment, went into climate action and almost half of this sum (49.7 per cent) was aimed at increasing the use of renewable energies. Around 27.1 per cent of the climate investments served to improve energy efficiency and save energy. The remaining 23.2 per cent was invested in reducing greenhouse gas emissions. Between 2008 and 2011 these companies increased their proportion of climate investments in their total spending on environmental protection by over 2 per cent per year.

Diagram 55: **Investment by the industrial production sector**

	2008	2009	2010	2011
Total investment by businesses (in EUR bn)	76.13	63.73	65.07	73.47
Investment in environmental protection (in EUR bn)	5.99	5.58	6.03	7.10
Of same in climate action (in EUR bn)	1.62	1.63	1.88	2.38
Proportion of climate protection investments in overall environmental investments (in %)	27.1	29.2	31.2	33.6

Source: Federal Statistics Office, (Fachserie 19 Reihe 3.1: "Investitionen für den Umweltschutz im Produzierenden Gewerbe")

Diagram 56: **Impact by renewable energies on the employment market**



Source: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – "Erneuerbare Energien 2012," p. 40; Federal Ministry for the Environment, Nature Conservation and Nuclear Safety – "Bruttobeschäftigung durch erneuerbare Energien in Deutschland im Jahr 2012," p. 7

EMPLOYMENT MARKET

In 2012, roughly 377,800 new jobs were created in the renewable energy sector in Germany. These include all jobs where people are directly involved in manufacturing, operating or servicing systems for utilising renewable energy sources. They also take into account jobs involving the production of fuels or intermediate products. Over two thirds of this total (around 268,000 jobs) were created only after the introduction of the EEG or can be attributed to the effects of the EEG. In 2012 there were roughly 5.7 million people working worldwide in the renewable energies sector.

Model calculations also weighed up the cumulative positive and negative effects on employment. The latter comes about through factors such as losses on investments in conventional power plants. The resulting net employment shows that the bottom-line impact of the transition to renewables has a positive effect, as it brings about higher employment than in scenarios where the energy mix largely opts out of renewable energy sources. The model calculations also led to the conclusion that the increase in energy efficiency has a positive impact on the employment situation.

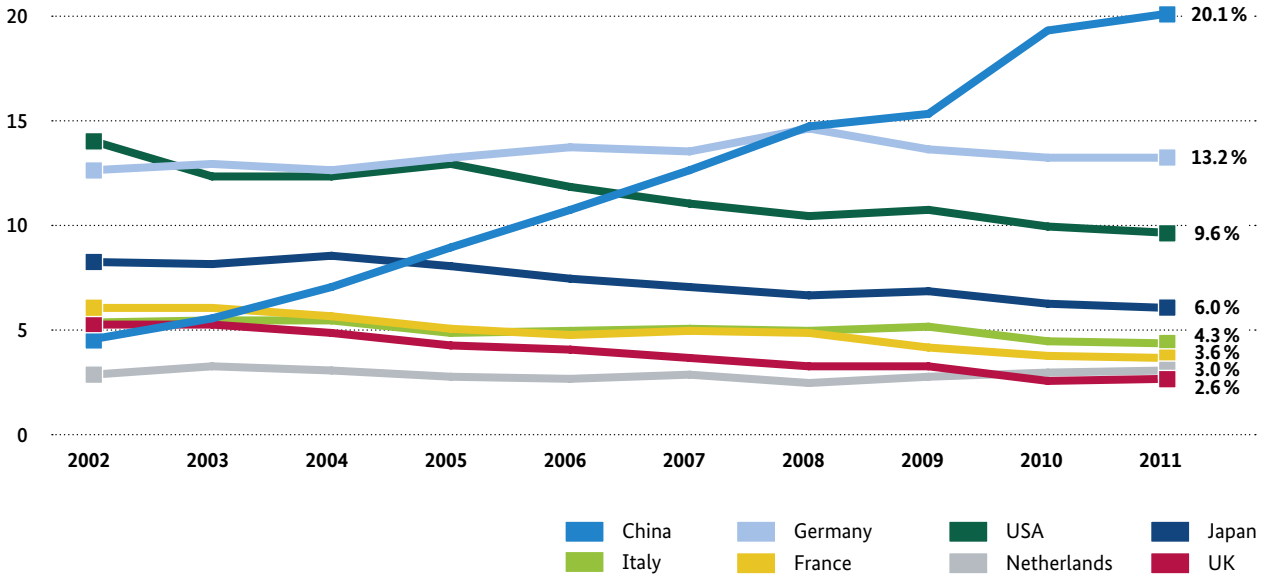
- **Impact of climate action to date**: A study commissioned by the Federal Environment Ministry calculated how climate action measures, implemented since 1995 in the areas of energy efficiency and combined heat and power, have affected the employment market. The study shows that the job count rose by 234,000 in 2012 as a result of these measures.[11]

- **Impacts of other possible efficiency measures**: If ambitious efficiency measures requiring around EUR 300 billion up to 2030 were to be implemented, the positive effects on consumption could lead to the creation of approximately 130,000 additional jobs per year. They would also enable a saving on energy costs of around EUR 21 billion by 2030.[12]

GLOBAL MARKET FOR CLIMATE PRODUCTS

Global trade in potential climate products[13] has grown steadily over recent years. From 2002 to 2011 it rose by an average of 13.2 per cent per year. As illustrated in *diagram 57* Germany was the second largest exporter of potential climate products with 13.2 per cent in 2011. China was the clear leader in 2011 with 20 per cent and has recorded the sharpest growth since 2002. China's growth primarily eroded the global market shares of the USA, Japan, the UK and France. In light of major changes on the global market, Germany's comparatively stable market share can be regarded as a sign of relative strength. Its development in the renewable energy sector has been particularly dynamic: the EEG gave domestic demand a major boost, which also, over time, led to a strengthening of exports.

Diagram 57: **Share in global trade of providers of potential climate protection products**



Source: Lower Saxony Economic Research Institute (Niedersächsisches Institut für Wirtschaftsforschung – "Studie zum deutschen Innovationssystem Nr. 9-2013")

6. Climate and society

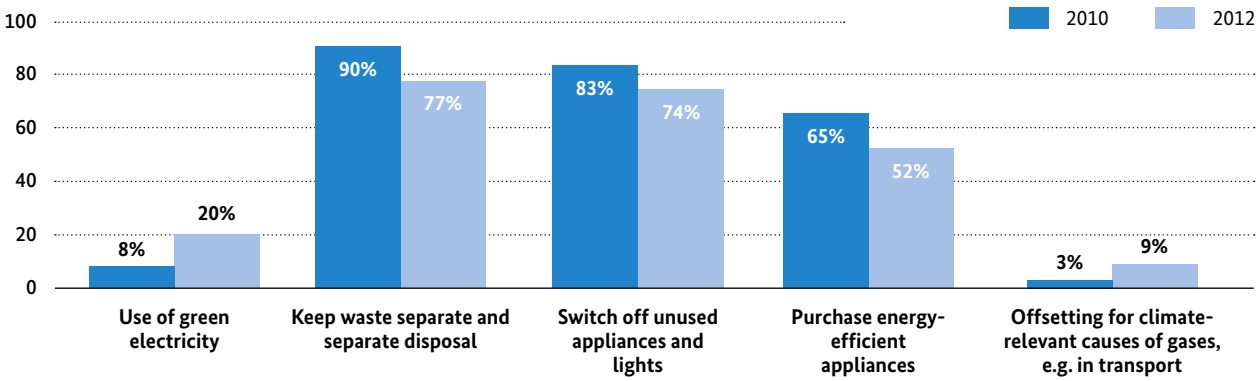
CLIMATE CONSCIOUSNESS

Every two years, German citizens are asked about their environmental consciousness and environmental behaviour on behalf of the Federal Environment Ministry and the Federal Environment Agency. In 2012, the results showed both positive and negative trends:

- **Growing importance of environment and climate action**: Surveyed shortly after the Rio+20 Conference, some 35 per cent of respondents stated that protecting the environment and the climate are some of the greatest challenges faced today. Compared to the survey in 2010, this represents an increase of 15 per cent. Protecting the environment and the climate therefore moved from third place to second place on the political agenda, after economic and financial policy.
- **Increase in use of green electricity**: 20 per cent of respondents claimed to use green electricity. In 2010, this figure was only 8 per cent. Approximately one fifth also believed green electricity would play a greater role in the near future.
- **Growing readiness to pay for offsetting**: Compared to 2010, three times as many respondents said they pay for the offsetting of climate-relevant gases.
- **Less readiness to act**: On the other hand, it appeared there is a decline in readiness to take action in everyday life towards combating climate change.[14]
- **Contradicting results on energy efficiency**: Almost one third believed that energy efficiency is an important issue to consider during future purchases of electrical appliances. Yet, compared to 2010, the readiness to purchase energy-efficient appliances fell by 13 per cent. This is particularly surprising as economising is an important factor for domestic decisions.
- **Decline in readiness to separate waste**: While in 2010, 90 per cent of respondents claimed to separate their waste, the figure in 2012 was only 77 per cent. Nonetheless, around one fifth of respondents believed that separating waste will be even more important in the future.
- **Decline in readiness to switch off unused appliances and lighting**: Compared to 2010, readiness fell by 9 per cent. However, roughly one quarter of respondents think saving electricity is important for the future.

The following pages detail active examples of efforts towards climate consciousness in municipalities, businesses and schools.

Diagram 58: **Climate protection in the population**



Source: Federal Environment Agency – Environmental consciousness study 2012, p. 43

CLIMATE PROJECTS IN MUNICIPALITIES

At a municipal level, climate policy is playing an ever greater role. There is huge reduction potential at this level, particularly in energy, transport, wastewater, water and the management of municipal property. Municipalities are therefore increasingly setting their own climate targets and introducing climate measures, which they are not only motivated to do because of ecological targets, but also due to economic incentives. It means that, in the long term, they are able to save costs, consolidate budgets and also contribute to the creation of extra jobs.

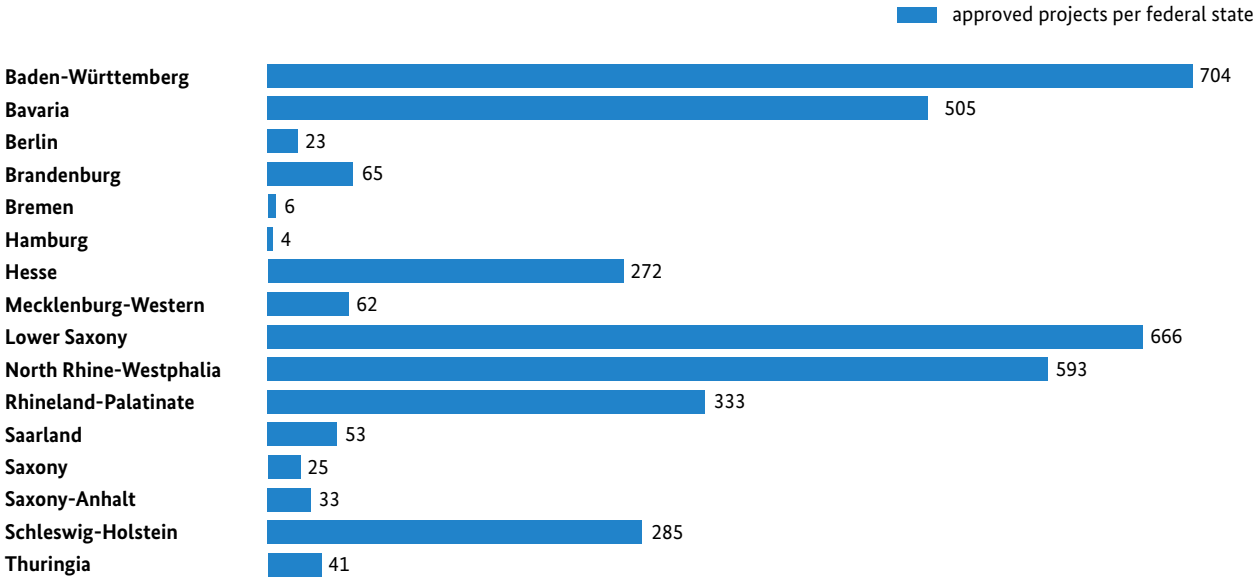
Municipalities receive support for climate measures through the following initiatives:

- **The Federal Environment Ministry's National Climate Initiative**: This assists municipalities in their climate schemes through an array of projects. As a result, between 2008 and the end of 2013, 2,500 municipalities carried out some 5,000 projects as part of the National Climate Initiative.

- **Guideline on supporting climate action projects in social, cultural and public institutions (municipal guideline)**: Under this programme, municipalities are supported in compiling climate action concepts, for example, or appointing climate managers. Investment measures, such as changing lighting, are subsidised. In addition, since 2011, 19 "Master Plan Municipalities" have received expert assistance to set an example. The "Master Plan Municipalities" have set themselves the target of reducing their greenhouse gases by 95 per cent by 2050, and their final energy consumption by 50 per cent. To do this, they devise master plans that concretely illustrate how climate targets will be achieved.

- **Promoting urban development measures (urban development support scheme)**: The national and regional urban development support scheme assists cities and communities in renovation work on existing buildings in set assisted areas. Extensive reconstruction work on buildings frequently brings considerable energy savings. Conditions for support include integrated urban development concepts that contain plans for energy improvements. Both public and private renovation projects can receive assistance from the urban development support scheme. The specific conditions are set out in each of the federal state's funding guidelines. Currently, the urban development support scheme is assisting around 4,500 active urban development projects using federal funds.

Diagram 59: **Climate initiatives – subsidised climate projects in the individual federal states**



Source: http://kommunen.klimaschutz.de/foerderung/kommunalrichtlinie/zahlen-und-fakten.html

CLIMATE ACTION IN BUSINESSES

Industrial facilities are responsible for approximately one third of all CO_2 emissions in Germany. Many businesses have meanwhile realised that combating climate change not only benefits the environment, but also offers considerable opportunities for growth. Today's global market for environmental and efficiency technologies amounts to as much as EUR 2 billion, and this is set to more than double in the next 10 years.[15] At the same time, rising energy prices, ever scarcer resources and a more environmentally conscious clientele are becoming increasingly important competitive factors in terms of business. Companies that develop climate-friendly products and invest in energy-efficient processes strengthen their market position and are more future-oriented, meaning climate action pays off for companies in the long term.

The Federal Environment Ministry supports companies that take on a pioneering role in combating climate change. As part of the National Climate Initiative, projects in the areas of energy efficiency, energy savings, cost reductions and networking receive support. Here are some examples:

- **Partnership for climate action, energy efficiency and innovation**: The Federal Environment Ministry, together with the Federal Ministry for Economic Affairs and Energy, and the German Chamber of Commerce and Industry, supported this project until September 2013. After the project was completed, the businesses involved collaborated to form an association of climate protection businesses – Verein Klimaschutz-Unternehmen e.V. The members are businesses that take an especially active approach to combating climate change, and regard themselves as pioneers. They support the German government's proposed climate targets, and have set themselves ambitious goals for climate change mitigation and energy efficiency. The association currently has 28 members from various industries and the members are selected by an advisory council, where the Federal Environment Ministry, and Federal Ministry for Economic Affairs and Energy are represented. As of early 2014, the association welcomed five new businesses as members. The Federal Environment Ministry also supports the climate protection businesses as part of the Energiewende SME initiative.

- **Energiewende SME Initiative**: The initiative was founded as a joint venture by the Federal Environment Ministry, the Federal Ministry for Economic Affairs and Energy, the German Chamber of Commerce and Industry, and the German Confederation of Skilled Crafts, and was launched on 1st January 2013. Its goal is to tap into energy saving potentials in businesses and thereby improve energy efficiency. To achieve this, the initiative offers businesses direct assistance via dialogues, information and training. It also arranges local contact partners.

Diagram 60: **The climate protection businesses**

Source: http://www.klimaschutz-unternehmen.de/unsere-mitglieder/

CLIMATE PROJECTS IN SCHOOLS

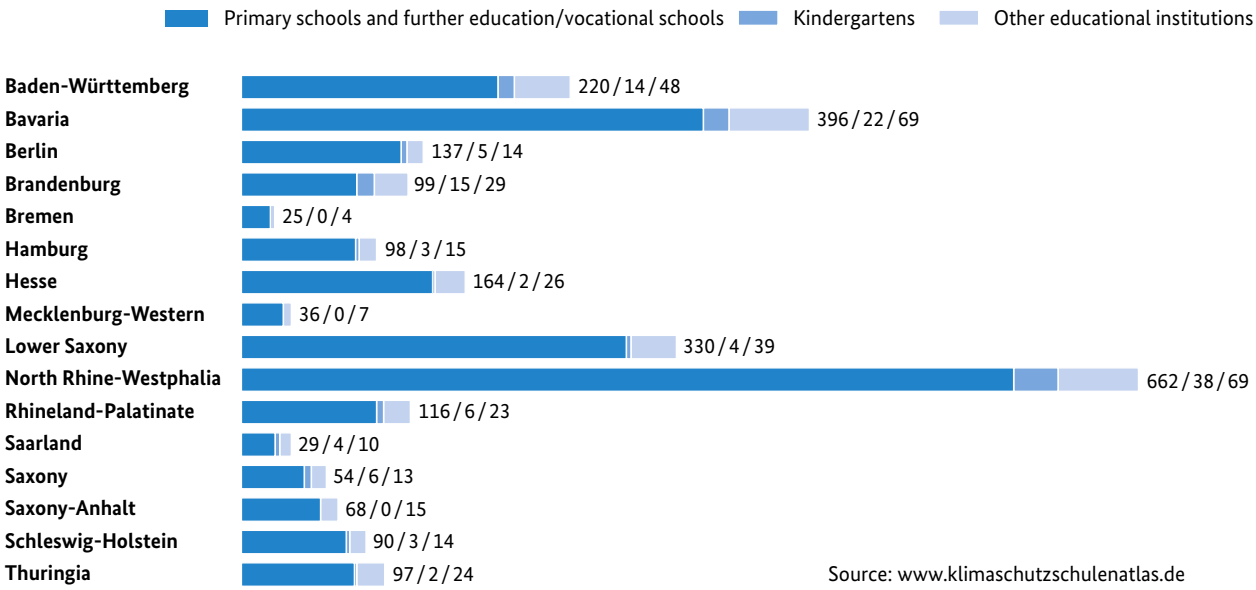
The Federal Environment Ministry has been supporting climate action projects in educational institutions as part of the National Climate Initiative since 2008. The goal is to heighten awareness of climate action amongst young citizens. Young participants are encouraged to combat climate change through educational programmes and activities.

The following projects form part of the programme "Climate Action in Schools and Educational Institutions":

- **Solar support – Making renewable energy sources visible!**: As part of this project, almost 800 schools and educational institutions with solar power units receive a display board, a data logger and educational support material. The aim is to put the spotlight on solar energy.
- **The "Klima! mobil" project**: 500 schools initiate climate action projects through a network of stakeholders from the school's local community.
- **KLIMA°Trax**: This project highlights climate issues in German cities with the help of educational GPS routing.
- **"Soko Klima" – Designing cities**: The project encourages children and young people to get involved in the climate aspects of municipal planning.
- **Studygreenenergy**: This website gives an overview of available courses on renewable energy sources and energy efficiency. The site provides information on over 300 courses.
- **Climate action in youth workshops and vocational schools**: This project makes energy and combating climate change an integral feature of vocational training, with an emphasis on training for instructors and developing suitable material.
- **Energy efficiency on site – Tackling climate change**: This project comprises 50 individual events. The aim is to provide information and encourage discussion about German and European energy and climate policy.
- **"KlimaKunstSchule"**: The project supports schools in addressing how to combat climate change in an artistic way. Around 50 to 60 artists are supporting the 200 schools involved in designing and carrying out projects.
- **"Klimaschutzschulenatlas"**: This website offers schools carrying out climate action projects the chance to present and exchange their ideas. Over 3,000 schools are involved.

Beyond this programme of activities, numerous other climate action projects are being carried out in schools.

Diagram 61: **Climate protection in schools and educational institutions**



Source: www.klimaschutzschulenatlas.de

7. Appendix

GLOSSARY

Biofuel
Liquid or gaseous motor fuels made from biomass (biodiesel, bioethanol, biogas).

Biogenic proportion of waste
Proportion of waste that can be composted under anaerobic or aerobic conditions and which arises in agriculture, fisheries and forestry, industry and households. This can include: waste wood and residual wood, straw, garden waste, slurry, biowaste, fatty waste. In particular, municipal waste includes waste types such as household waste, household-type commercial waste, bulky waste, road sweepings, market waste, compostable waste from "bio bins," garden and park waste, as well as waste from the separated collection of paper, cardboard, glass, plastics, wood and electrical and electronic equipment. By convention, the biogenic proportion of municipal waste is 50 per cent.

Carbon dioxide
Carbon dioxide (CO_2) is a colourless and odourless gas that is a natural component of the atmosphere. Consumers (humans and animals) release it by breathing, and producers (plants, green algae) transform it into energy-rich organic compounds by means of photosynthesis. As a waste product of energy production, it is above all formed during the complete combustion of carbonaceous fuels. CO_2 is the most important of the climate-relevant atmospheric trace gases with the property of being "opaque" to long-wave heat radiation. It thus prevents the equivalent re-radiation of the short-wave solar radiation reaching the earth and increases the risk of a rise in temperature at the earth's surface. It serves as a "reference gas" for determining the CO_2 equivalent of other greenhouse gases and is therefore assigned a global warming potential of 1.

Combined heat and power (CHP)
Co-generation of electricity and heat. This principle brings a marked improvement in fuel utilisation in power stations.

CO_2 equivalent
Unit for the global warming potential of a gas. It states the quantity of CO_2 that would have the same greenhouse effect as the gas in question over a period of 100 years. It is used to compare the greenhouse effect of different gases and express their contribution to global warming. The equivalence factors used follow the values specified in the IPCC 4th Assessment Report for national emission reporting. Methane (CH_4), for example, has a CO_2 equivalent of 25, meaning it is approximately 25 times more harmful to the climate than CO_2.

EEG: Renewable Energy Sources Act
The Renewable Energy Sources Act (EEG) from 2000 grants priority to renewable energy sources by regulating the grid operators' priority obligation to purchase electricity from renewable energy sources, (declining) feed-in tariffs for the individual generation methods, and allocation procedures for resulting additional costs amongst all electricity customers. Amendments to the act entered into force in 2004, 2009, on 1st January 2012 and, most recently, with retroactive effect to 1st April 2012.

EEWärmeG: Renewable Energies in the Heat Sector
The Renewable Energies Heat Act (EEWärmeG) dating from 2009 promotes renewable energy use in the heat sector by setting out obligations for owners of new buildings to meet some of their heating (and cooling) requirements from renewable energy sources.
The first amendment to the act came into force on 1st May 2011.

Effort Sharing
For the sectors not covered by the European emissions trading system, the EU set legally binding targets in 2009 for the individual member states under the Effort Sharing Decision. EU-wide, greenhouse gas emissions should fall by 10 per cent by 2020, compared to 2005 levels. The proportion is determined by the country's economic output. By 2020, Germany must have reduced its emissions in the sectors transport, households, business, trade and services by 14 per cent, compared to 2005 levels.

Emission allowances
The vested right to emit a certain quantity of a pollutant over a certain period. This is an important instrument of the Kyoto Protocol for limiting emissions of greenhouse gases. Emission allowances can be traded and are also granted in the EU's Emission Trading System (EUAs).

Energy efficiency
The ratio between a certain output or result, and the required amount of energy input.

Energy intensity
The ratio between a country's primary energy consumption and gross domestic product.

Energy productivity
The ratio between a country's total productivity (e.g. gross national product) and energy consumed (inverse of energy intensity).

European emissions trading system
The Kyoto Protocol provides for a flexible mechanism of emissions trading between states. In line with its obligations, the EU has introduced emissions trading in certain sectors (energy and industry) at business level. The EU Directive (ETD) has regulated the implementation of emissions trading for businesses in Europe since 1st January 2005. The volume of emissions allowances are awarded free of charge or auctioned, and reduce in number from period to period. Businesses that have already made large efforts towards climate change mitigation or have been particularly innovative may sell off excess permits they received free of charge. This offers them an additional source of income. If a business's allocated permits are not sufficient to meet obligations, additional efforts must be made, or extra allowances purchased, otherwise a fine will be charged. This means emissions reductions are achieved where abatement costs are lowest.

EU White Paper
In its "White Papers," the European Commission publishes strategic proposals and suggested courses of action.

Feed-in compensation
Operators of renewable energy plants are legally entitled to remuneration per kWh fed into the grid. These tariffs are above the market price and therefore reduce risks from price fluctuations, allowing profitable operations. The feed-in tariffs in Germany are regulated by the Renewable Energy Sources Act (EEG).

Final energy
The part of primary energy, after deduction of transmission and distribution losses, which reaches the consumer and is, for example, available for heating, hot water and ventilation. Final energy types include district heating, electricity, liquid hydrocarbons such as petrol, kerosene or fuel oil, and various gases such as natural gas, biogas and hydrogen.

Fossil fuels
Energy resources with carbon compounds of varying chain lengths that have been formed from biomass under high pressure and temperature over millions of years: oil, coal, gas.

Geothermal energy
Use of renewable terrestrial heat at various depths: in the case of near-surface geothermal energy, the heat of the earth is supplied by the sun. It gradually heats up the soil from the top down. In the winter the soil stores a large proportion of this heat. In the case of deep geothermal energy, the heat is released by the decay of natural radioactive isotopes. The influence of this energy source increases according to depth.

Global warming potential (GWP)
Potential contribution of a substance to the warming of near-surface layers of the atmosphere, relative to the global warming potential of CO_2, expressed as global warming potential (GWP, CO_2 = 1). The GWP of a substance depends on the length of the period (usually 100 years) on which this parameter is based.

	GWP 2nd IPCC REPORT	GWP 4th IPCC REPORT
CO_2	1	1
CH_4	21	25
N_2O	310	298
SF_6	23,900	22,800

Source: author's own diagram based on www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

Greenhouse effect
The greenhouse effect refers to the warming of the planet as a result of greenhouse gases in the atmosphere: Greenhouse gases accumulated in the atmosphere prevent heat from radiating from the earth's surface into space. A distinction is made between the natural greenhouse effect, and the so-called anthropogenic greenhouse effect, which describes mankind's increased release of climate-effective greenhouse gases. The higher concentration of greenhouse gases in the atmosphere causes a global warming, known as climate change.

Greenhouse gases
Atmospheric trace gases that contribute to the greenhouse effect and can be of both natural and anthropogenic origin. Examples are: Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexafluoride (SF_6), hydro-fluorocarbons (HFCs), perfluorocarbons (PFCs).

Gross electricity consumption
Gross electricity consumption corresponds to the sum of total electricity generated in Germany (wind, water, sun, coal, oil, gas, etc.), plus electricity imports and minus electricity exports.

Gross final energy consumption
Includes the quantities of energy needed for the internal consumption of energy conversion operations, plus transmission and distribution losses, and is therefore always higher than final energy consumption.

IPCC: Intergovernmental Panel on Climate Change
An intergovernmental board of experts on climate issues under the auspices of the United Nations, founded in 1988. According to the IPCC's assessment report of 2007, a rise in mean global temperature of 0.6 to 0.8 degrees Celsius, compared to preindustrial levels, can be confirmed. The report provides undeniable evidence of global warming and shows human intervention to be the main cause for climate changes. The 5th assessment report 2013/2014 is currently being published.

Merit-order effect
Shift of market prices along the merit-order curve or the supply curve due to market entry of power stations with lower variable costs (marginal costs). This displaces the power stations with the highest production costs from the market (assuming unchanged demand), bringing lower-priced electricity to the market.

Methane
Methane (CH_4) is a non-toxic, colourless and odourless gas. After carbon dioxide (CO_2) it ranks as the most significant greenhouse gas released by humans. According to the 4th IPCC report, its climate impact is some 25 times greater than that of CO_2, but it occurs in the atmosphere in much smaller quantities.

Nitrous oxide
N_2O (nitrous oxide / laughing gas) is a colourless gas belonging to the group of oxides of nitrogen. Like (CO_2) and methane (CH_4), it is relevant as a gas having a direct impact on the climate. According to the 4th IPCC report, its climate impact is 298 times greater than that of carbon dioxide, but it occurs in the atmosphere in much smaller quantities. The principal anthropogenic source of nitrous oxide emissions is the use of nitrogen fertilisers in the agricultural sector.

Photovoltaic systems (PV)
Direct conversion of solar radiation into electrical energy by means of semiconductors, often known as "solar cells."

Primary energy
Primary energy is the theoretically available energy content of a naturally occurring energy source before it undergoes conversion. Primary energy sources include finite energy sources such as lignite and hard coal, oil, natural gas and fissile material such as uranium ore, and renewable energy sources (solar energy, wind energy, hydropower, geothermal energy and tidal energy). Primary energy is converted into a secondary stage in the energy series in power plants or refineries. Conversion losses occur in this process. Parts of some primary energy sources are used for non-energy purposes (e.g. oil for the plastics industry).

Primary energy consumption
Primary energy consumption is the total consumption of the primary energy sources occurring in nature. It is the sum of inventory changes and the balance of amounts received and supplied. It includes the energy needed for conversion and final consumption.

Rebound effect

This effect describes the phenomenon where savings, achieved as a result of increased efficiency, do not bring about a corresponding reduction in resource usage, because, adversely, the saving causes an increase in use. There are both direct (greater use of same appliance) and indirect (greater use of other appliances) rebound effects. In extreme examples (higher resource use through energy efficiency), this effect is known as the Jevons Paradox.

Renewable energy sources

Energy sources which, on a human time scale, are available for an infinite period of time. Nearly all renewable energy sources are ultimately fuelled by the sun. The sun will eventually burn out, so, strictly speaking, it is not a "renewable energy source." However, present knowledge indicates that the sun is likely to continue in existence for more than a billion years, which is virtually unlimited from our human perspective. The three original sources are: solar radiation, geothermal energy and tidal energy. These can be harnessed either directly, or indirectly in the form of biomass, wind, hydropower, ambient heat and wave energy.

Sink

Sinks reduce the netto emissions through the absorption and storage of CO_2, for example, by plants and soil.

Smart grid

An intelligent power grid system that encompasses communicative networking and control of electricity generation units, storage facilities and other consumers in electricity grids.

Transport intensity

Transport intensity is the ratio of passenger and freight transport compared to gross domestic product.

United Nations Framework Convention on Climate Change (UNFCCC)

The Framework Convention on Climate Change was adopted at the world summit on Climate and Development in Rio de Janeiro in 1992, and has since been ratified by 194 states. It came into force in 1994. The convention is the first international agreement to define climate change as a serious concern, and commit the global community to taking action. It provides the framework for climate policy negotiations held in the Conferences of the Parties.

FOOTNOTES

1. This reduction target constitutes a decrease in the EU's greenhouse gas emissions by 14 compared to 2005. In the same period, emissions covered by the emissions trading system should decrease by 21 per cent; emissions outside of the emissions trading system by 10 per cent.

2. (2009/28/EU)

3. This does not apply to shipping traffic, nor to the sector land use, land use change and forestry (LULUCF).

4. Australia, Austria, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, USA.

5. cf. BMWi and BMUB (2014)

6. Compared to Kyoto base year

7. Land use changes due to the plantation of regenerative raw materials and energy plants are not covered.

8. One tonne kilometre corresponds to 10 passenger kilometres.

9. cf. Federal Environment Agency 2012

10. Investments in environmental protection serving the areas of waste management, water protection, noise prevention, air pollution control, nature and landscape conservation, soil remediation and climate change mitigation

11. cf. Lehr, Lutz and Ulrich (2013), p. 18

12. cf. GWS and ifeu (2012), p. 8 ff.

13. The principle of potential climate products was derived from the concept of potential environmental protection products. This was developed by research institutes and the Federal Statistics Office in the 1990s and has been used in studies ever since. A list was compiled to define environmental protection products that serve to protect the environment, but also perform other functions. In 2006, at the request of the Federal Environment Agency, this concept was expanded to potential climate products and the list was updated in 2013, more information at: *http://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/uib_1_2013_eckermann_umweltschutzgueter_methodenpapier_webfassung.pdf*

14. BMU and UBA (2012)

15. cf. Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2012c)

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LIST OF ABBREVIATIONS

ADP	Working Group Durban Platform
bn	billion
CH_4	methane
COP	Conference of the Parties
CO_2	carbon dioxide
EEG	German Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz)
EEWärmeG	Renewable Energies Heat Act (Erneuerbare-Energien-Wärmegesetz)
FEC	final energy consumption
GDP	gross domestic product
GJ	gigajoule
GVA	gross value added
GWh	gigawatt hour
HFC	hydrofluorocarbons
ICAO	International Civil Aviation Organisation
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
kWh	kilowatt hour
LULUCF	land use, land use change and forestry
m	million
N_2O	nitrous oxide
OECD	Organisation for Economic Cooperation and Development
PFC	perfluorocarbons
ppm	parts per million
PEC	primary energy consumption
RE	renewable energy
SF_6	sulphur hexafluoride
SMEs	small and medium enterprises
t	tonnes
UNFCCC	United Nations Framework Convention on Climate Change
yr	year

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