Federal Ministry for the
Environment, Nature Conservation,
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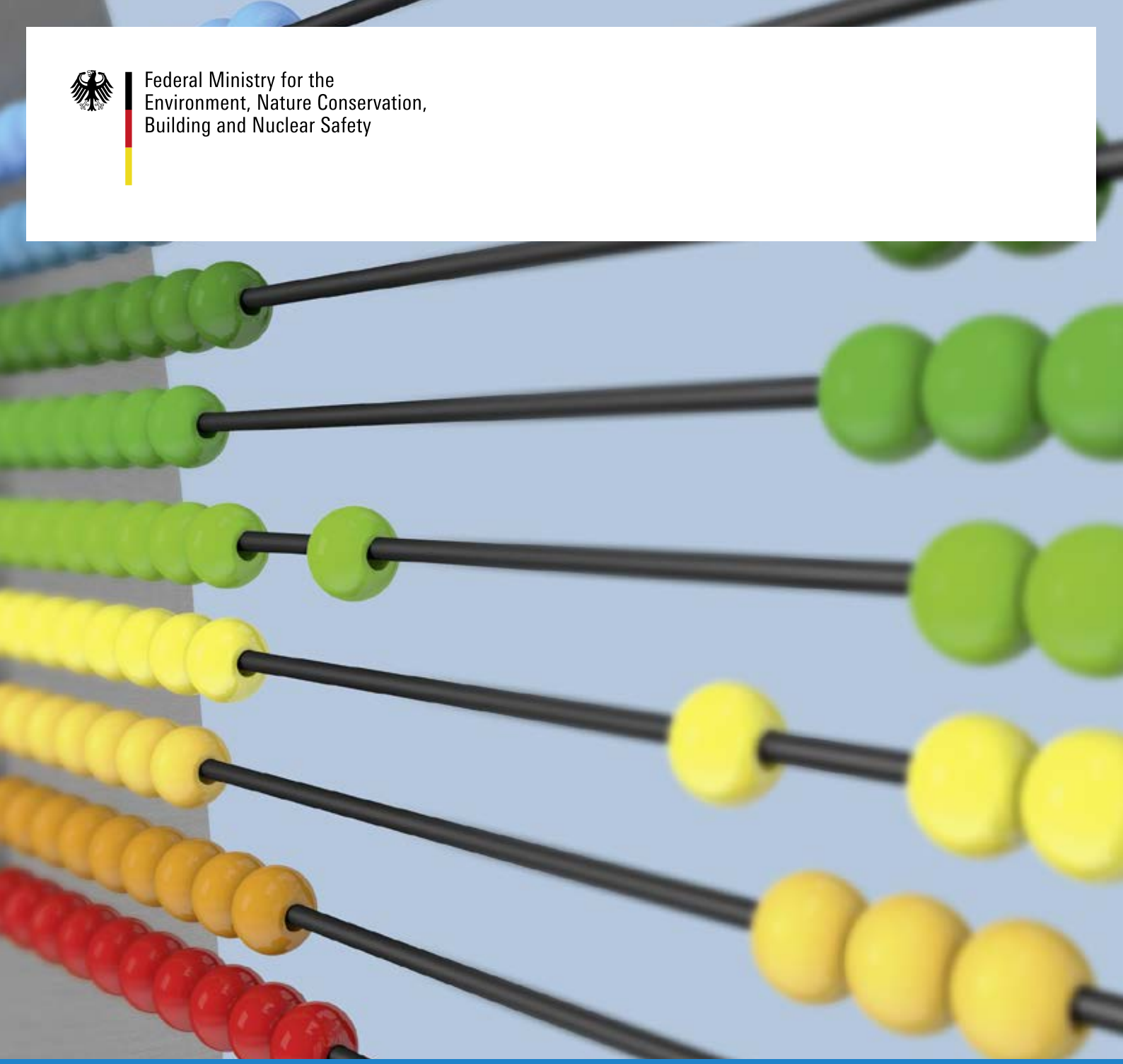

Climate Action in Figures

Facts, Trends and Incentives for German Climate Policy
2015 edition

Imprint

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Contents

Foreword

2015 is a crucial year for climate action. At the climate change conference in Paris at the end of this year we want to negotiate and adopt a new climate agreement that is binding for all parties. As its contribution to the Paris agreement, the European Union has agreed to reduce its greenhouse gas emissions by at least 40 per cent by 2030, and in doing so is taking on a leading role internationally.

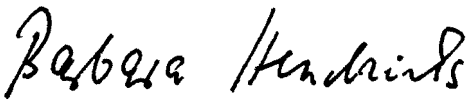
The German government is also standing by its climate goals. By the middle of this century we want to reduce greenhouse gas emissions in Germany and the European Union by 80 to 95 per cent compared with 1990 levels. A comprehensive transformation will be required to achieve this almost complete elimination of greenhouse gas emissions: in energy supply, the transport and building sectors, agriculture, the waste sector, industry and in the trade, commerce and services sector. The clock is ticking.

In Germany, this transformation will only succeed if we lay the right foundations today. This is why the German government, under my lead responsibility, drew up the Climate Action Programme 2020 and adopted it at the end of last year. With this action programme, and its broad catalogue of over 100 measures, we are ensuring that greenhouse gas emissions in Germany will be cut by at least 40 per cent by 2020 compared with 1990. To implement these measures we also launched an alliance for action at the beginning of this year, bringing together the government, Länder, municipalities, industry and major groups. This alliance will support implementation of the adopted measures and will discuss further contributions. I am convinced that with this alliance we will achieve broad participation, secure the necessary acceptance for climate action and further advance our efforts.

The 2020 climate goal is an important step along the road to 2050. The German government will draw up a Climate Action Plan 2050 setting out further reduction steps up to the middle of the century. This plan will also be supported by a broad public dialogue.

Climate action means taking on responsibility for the current and future generations - locally, regionally, nationally and globally. I strongly believe that climate action offers huge opportunities. If we actively shape the transformation process it will benefit people, the environment, industry and society. There are already many positive examples of this. Germany can lead the way and encourage other countries to follow, enabling the international community to succeed in complying with the two-degree target.

This brochure presents climate policy in all its diversity, with many facts and figures. I am certain that it can clearly illustrate the next steps that are required.
I wish you an interesting read.



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

1. Introduction

Climate action in 2015

The demand for fossil fuels is growing worldwide. As a consequence, the greenhouse gas emissions which are responsible for climate change are increasing. As this continues, the impacts will be felt by both people and ecosystems: the average global temperature is rising, extreme weather events are becoming more common, the oceans are becoming warmer, glaciers and permafrost are thawing, ice sheets are losing their mass and sea levels are rising. All of this leads to long-term consequences for societies and economies worldwide.

Climate action in Germany: progress made

As part of its contribution to international efforts to slow down climate change and mitigate its harmful impacts, the German Federal Government has adopted ambitious climate action goals. Germany, as a major industrial nation, is therefore living up to its responsibilities in Europe and internationally. Overall, Germany has made progress since the early 1990s:

- **Reduction of greenhouse gas emissions by 27 per cent (2014)**
- **A more than six-fold increase in final energy from renewable sources**
- **Reduction of per capita primary energy consumption by more than eight per cent (2014)**

Germany stands by its commitments

The German Federal Government remains committed to agreed climate action targets. By 2020, it hopes to have reduced greenhouse gas emission levels in Germany by a minimum of 40 per cent in comparison to 1990 levels. At the same time, it is targeting an 80 to 95 per cent reduction of greenhouse gas emissions by 2050 in comparison to 1990 levels.

Projections of future greenhouse gas emissions show, however, that such ambitious goals cannot be met without further efforts. Based on measures agreed upon until mid-2014, the German Federal Government assumes that greenhouse gas emissions are likely to fall by 33 to 34 per cent by 2020 (give or take one per cent). Reduction targets for 2020 would thus fall short by anywhere from five to eight per cent. Considerable additional efforts are therefore needed if targets are to be reached.

The German Federal Cabinet thus adopted the Climate Action Programme 2020 on 3 December 2014. It included additional climate protection measures across all relevant sectors. Significant potential for savings can primarily be found in the energy, building and transport sectors. Alongside this, a National Energy Efficiency Action Plan (NAPE) was also adopted that includes measures designed to increase energy efficiency, helping to bridge gaps in efforts to meet climate goals for 2020. The Climate Action Programme 2020 and the National Energy Efficiency Action Plan underline the will of the German Federal Government to achieve the goals it has set itself - it is now crucial to implement the measures adopted as quickly and as exactingly as possible.

Key stages in international climate mitigation efforts

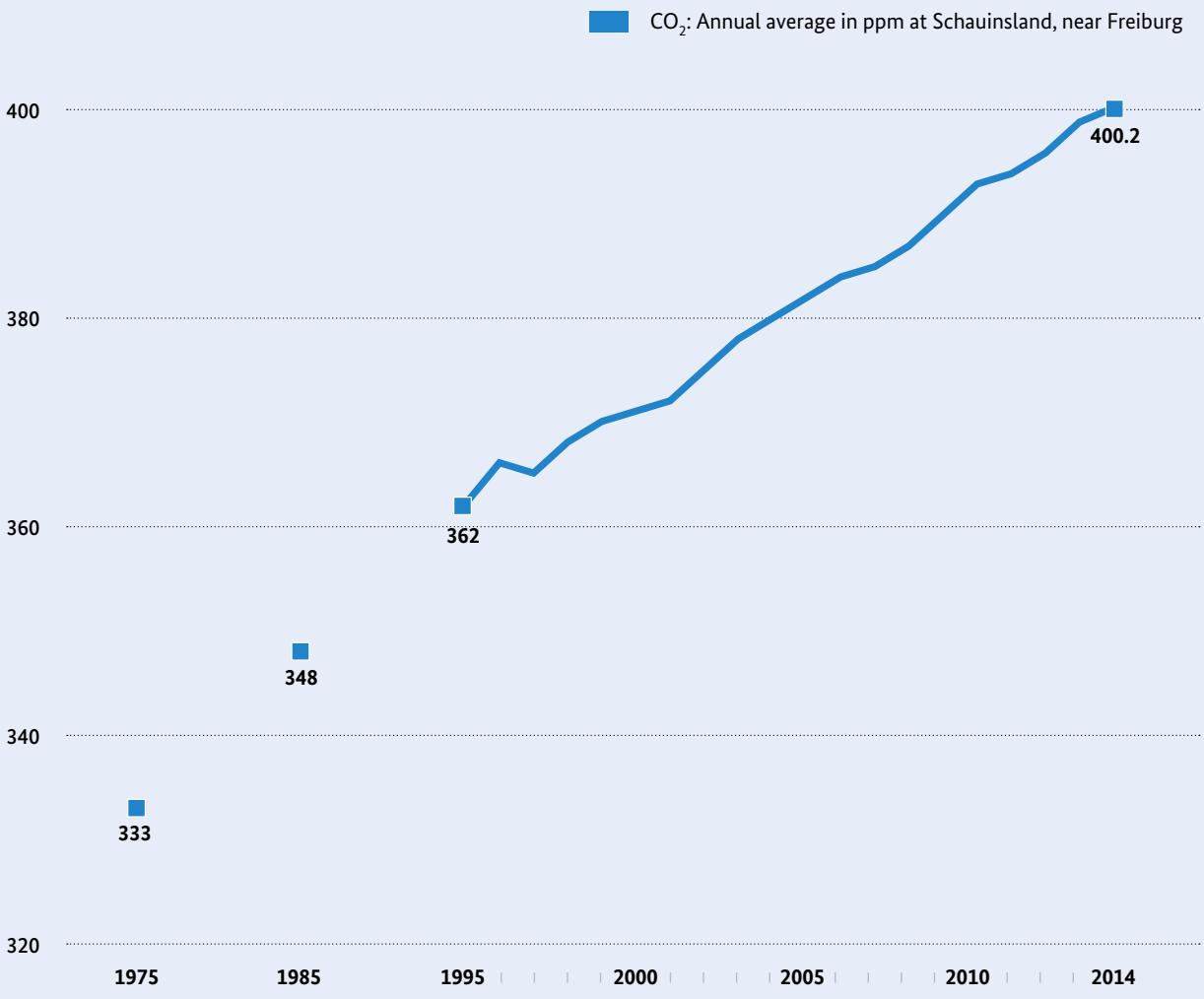
In 2015, the relevant parties will set a course for proceedings at the international level from 2020 onwards. At the UN Climate Change Conference in Paris, it is planned that all participating states will sign an agreement on climate change which will help set a long-term limit on global temperature increases to two degrees Celsius in comparison to pre-industrial levels. In this respect, all states will be requested to impart their reduction quota to the international community. These will also form part of the agreement at the Paris Conference on Climate Change.

The previous conference – which took place in Lima towards the end of 2014 – saw the initial formulation of general outlines of such an agreement. Nevertheless, negotiations still face major challenges. There has still been no decision made as to the legal form that any future agreement should take. China and the USA – the two largest emitters in the world – have been sending out positive signals. At the end of 2014, both countries agreed on climate targets; by 2030, China wants to increase its share of renewables to 20 per cent. In turn, the US has committed to a 26 to 28 per cent reduction in the emission of greenhouse gases by 2025 in comparison to 2005. By setting these targets, both countries have sent an important political signal. However, the pledges made by international community so far are still insufficient to limit global warming to two degrees Celsius.

Despite international efforts, the concentration of carbon dioxide (CO_2) in the Northern Hemisphere in spring 2014 crossed over the symbolic threshold of 400 parts per million (ppm). The period 2012-2013 had already seen the biggest increase in CO_2 concentration since 1984, at 2.9 parts per million. The measuring station at Schauinsland near Freiburg, Germany recorded an annual average of 400.2 parts per million for 2014.

This publication provides information on the current status of German climate action efforts. The first part covers international, European and national climate targets. The second part presents trends in greenhouse gases over the course of time in various contexts, alongside current developments in renewable energy and energy efficiency. The third part deals with the economic effects. The fourth and last part deals with climate action in social contexts. There were a few changes in methodology in comparison to the 2014 brochure due to changes in European reporting requirements. These pertain to small biomass cogeneration plants, gas and oil mini cogeneration, the use of wood in private households, solar thermal energy and heat pumps.

Figure 1: **Evolution of CO_2 concentration levels in the atmosphere**



Source: Federal Environment Agency

2. Climate targets and instruments

International and EU climate targets

International climate action

Ever since 1992's Earth Summit in Rio de Janeiro, the international community has been working towards halting damage that humans are causing to the climate system. In 2010, the international community agreed to limit temperature increases to a maximum of two degrees Celsius above pre-industrial levels. The operational framework necessary to implement these efforts was agreed upon using the United Nations Framework Convention on Climate Change, adopted in 1992, and the Kyoto Protocol of 1997. The latter represented a milestone in international climate policy, setting out firm and legally binding limitation and reduction targets for the first time. These applied to industrial economies and include the six most important greenhouse gases: CO_2, methane (CH_4), nitrous oxide (N_2O), partially halogenated fluorocarbons (HFCs), perfluorocarbons (PFCs) und sulphur hexafluoride (SF_6).

Reduction targets within the Kyoto Protocol

Reduction targets pertained to two different time periods:

First Commitment Period

In 1997, developed nations committed themselves to a minimum five per cent reduction in emissions by 2008-2012 in comparison to 1990 levels. In total, this target was ratified by 191 countries including all EU Member States, as well as Brazil, China and South Korea. The USA, however, has not ratified the Kyoto Protocol up until this point. In order to reach the five per cent target, signatories agreed upon individual reduction commitments. For the European Union, this meant a reduction of eight per cent. This amount was divided amongst the EU Member States: Germany's reduction obligation was set at 21 per cent.

Second Commitment Period

After tough negotiations, 2012 saw signatory states agree to a second commitment period: this involved an agreement that in the 2013-2020 period, greenhouse gas emissions should see an 18 per cent reduction in comparison to 1990 levels. The European Union is thus obliged to reductions of 20 per cent. The European Union, the EU Member States, Iceland, Norway, Lichtenstein, Monaco and Switzerland have all given their commitment to do so: their combined contribution to greenhouse gas emissions is currently around 15 per cent.

Further reductions required

Even if all signatories ratified and implemented all the targets included in the first commitment period, it would still not be sufficient to limit the increase in the temperature of the planet to two degrees Celsius. If this is to be achieved, developed countries will have to work towards a reduction of 25 to 40 per cent in their emissions by 2020 in comparison to 1990 levels. In addition, emerging and developing economies must keep their emission trends to about 15 to 30 per cent under current trend forecasts. It will even be necessary to reduce global emissions by 40 to 70 per cent compared to 2010, according to the findings of the Intergovernmental Panel on Climate Change (IPCC), as published in their Fifth Assessment Report 2013/14 and in other sources.

In addressing global climate change, signatories plan to negotiate a new and binding international agreement in Paris in 2015. This should enter into force by 2020 and incorporate all states for the first time, the way for this having been paved during the 2014 Climate Change Conference in Lima. It is planned that all states will submit a transparent, comparable and verifiable way of contributing to climate change mitigation. There was also one more notable success in Lima: the sum of funds for initial capitalisation of the Green Climate Fund was increased substantially during the conference.

International climate action instruments

In 2009, developed countries set themselves the goal of raising 100 billion US dollars annually for climate funding by 2020, a sum that will be raised from both public sources, and alternative/private sources. This money is intended to help developing countries mitigate climate impacts and adapt to climate change; Germany is making a fair contribution to these funds. Climate funding can be either bilateral or multilateral.

Clean Development Mechanism and Joint Implementation

The Clean Development Mechanism (CDM) and Joint Implementation (JI) are flexible mechanisms that were agreed upon as part of the Kyoto Protocol. They allow states and companies to implement part of their reduction commitments abroad. This means that industrialised countries can undertake and/or finance climate projects in emerging and developing economies.

States and companies thus receive carbon allowances for emissions avoided abroad. In this way, reductions achieved abroad can be counted towards their own reduction obligation, the advantage being that obligations can be achieved more economically. The United Nations assesses both the climate action projects and the reductions in emissions.

Bilateral climate funding

In 2013 the German Federal Government set aside almost two billion euros for international climate funding. Of this, payments of 1.7 billion euros were made as bilateral aid.

Climate change is a crosscutting issue which affects the entire development portfolio.[1] In turn, climate funding promotes sustainable development and is thus a key aspect of long-term development goals. For this reason, climate funding is organised primarily by the German Federal Ministry of Economic Cooperation and Development. The Ministry supports climate-related activities in almost all of its 79 partner countries. Priorities for action are discussed and agreed together with the countries in question, on the basis of regular consultations.

In regards to global climate change, international climate funding must promote international climate funding measures in developing countries and help to implement agreements made at climate conferences. The Federal Environment Ministry is supporting these efforts via the International Climate Initiative (IKI). The IKI promotes climate mitigation measures in terms of limiting and adapting to climate change, forest maintenance (REDD+) and conservation of biodiversity.

Multilateral climate funding

This concerns another key element of German climate funding. In the following, three multilateral climate funding instruments will be presented as examples:

Green Climate Fund
This was settled upon at the climate conference in Cancún in 2010. Its goal is to support developing countries – especially the poorest and most vulnerable – on their paths to low-emission and climate-friendly development. More than 30 industrial and developing countries have pledged a total of nearly 10.2 billion US dollars in order to provide the fund with initial capital. The Green Climate Fund thus counts as the largest multilateral climate fund and, at the same time, a key component of future climate funding. Germany has pledged a contribution of 750 million euros.

Climate Investment Funds
This programme promotes the dissemination of climate-friendly technologies and further programmes for climate change adaptation. It is currently funding projects in 63 developing countries.

Global Environmental Facility
This was created through a Franco-German initiative and has been fostering environmental protection programmes in developing countries since 1991. Areas in which support is offered include biodiversity, climate policy, the fight against land degradation, international water conservation, chemicals and waste, sustainable forest management and ozone protection. Projects are implemented by bodies such as the World Bank and the United Nations Environment Programme.

The European Union's climate targets

Climate and energy policy 2020

In March 2007, the European Union agreed upon reduction targets, which were subsequently adopted by the European Council in 2008 as part of a climate and energy package. They refer to a period of up until 2020 and cover three key topics:

- **Reducing emissions**
  By 2020, greenhouse gas emissions within the EU should be 20 per cent lower than in 1990. The EU furthermore pledged to the international community that it would reduce emissions by 30 per cent by 2020, provided that other countries also commit to comparable reductions.

- **Renewable energy**
  Similarly, renewable energies should account for 20 per cent of total energy use by 2020.

- **Energy efficiency**
  Energy efficiency should increase by 20 per cent by 2020.

Future developments in emissions trading will be decisive in efforts to achieve the targeted emissions reductions. The EU Emissions Trading Scheme is made up of larger emitters from the energy and industry sectors and implements EU climate targets by making certificates available to the businesses concerned *(see page 14)*. Here, the quantity of greenhouse gas emissions that are traded in the form of carbon allowances should – by 2020 – be 21 per cent lower than 2005 levels. For the sectors that are not participating in emissions trading, various binding targets, varying from Member State to Member State, are applicable; measures must be undertaken to enforce these targets. These were defined as part of the European Commission's Effort Sharing Decision and are determined by the per capita economic output of each respective EU Member State, ranging from the obligation to reduce emissions by 20 per cent to the right to give off 20 per cent more emissions. Germany is required to make a 14 per cent reduction compared to 2005 levels.

In the case of renewable energies, development obligations also vary according to EU Member State. These also apply for the period up until 2020 and set out the minimum share that renewable energies have in total energy consumption. Quantities range from ten per cent for Malta up to 49 per cent for Sweden. Germany's minimum is set at 18 per cent.

The European Union's 2020 Strategy – which is closely linked to these climate and energy policy targets – serves to make smart, sustainable and inclusive growth a reality. The core idea is that climate and energy policy should create additional jobs, promote green growth and ensure Europe's competitiveness. To this end, the expansion of renewable energies should provide for 417,000 new jobs by 2020. The targeted increases in energy efficiency should create an additional 400,000 jobs.[2]

Climate and energy policy 2030

The European Union is well on track to achieving its 2020 targets. Against this backdrop, the European Council determined the 2030 targets in October of 2014:

- **Further reduction of emissions**
  By 2030, greenhouse gas emissions should have been reduced by a minimum of 40 per cent in comparison to 1990 levels. The primary instrument to be used here is once again emissions trading: all sectors subject to emissions trading should reduce their emissions by a minimum of 43 per cent in comparison to 2005 levels. In order to achieve this, the upper limit of permissible greenhouse gas emissions will see a linear decrease of 2.2 per cent annually from 2021 on (in comparison to 1.74 per cent since 2013). Those sectors that do not participate in emissions trading will be required to reduce their emissions by 30 per cent by 2030 in comparison to 2005.

- **Further expansion of renewable energies**
  By 2030, renewable energies should account for a minimum of 27 per cent of EU-wide energy consumption. This is not only intended to make a sustainable energy system possible: it can also ensure international competitiveness and minimise dependence on imported energy. The expansion of renewable energies is thus a key pillar of EU policy.

- **Further increases in energy efficiency**
  Today, new buildings consume just half of the heating energy that was required in the 1980s. Energy requirements in industry have also been significantly reduced, dropping by around 19 per cent since 2001. On the basis of such progress, the European Commission's draft climate and energy policy for 2030 aims to improve energy efficiency by 30 per cent in relation to future energy consumption forecasts (based on current criteria). The European Council, however, only managed to agree to 27 per cent. These figures will nevertheless be re-examined in 2020 and, where appropriate, increased to 30 per cent.

The 2030 objectives pave the way towards a low carbon economy within the EU by making possible a cost-efficient reduction in greenhouse gas emissions of at least 80 per cent by 2050 (in comparison to 1990 levels). They

provide investors and Member States with a long-term regulatory framework and a key means of orientation, and at the same time provide the EU a basis for international climate negotiations.

The European Union's instruments

Emissions trading

Emissions trading system is the key instrument in EU-wide moves to minimise emissions. This was decided upon in 2003 by the European Parliament and the European Council.

How it works: On the basis of the Cap-and-Trade principle, an upper limit is set for emissions, thus turning them into a limited and scarce commodity. Their price is determined in the marketplace via supply and demand. Some of these permissions are distributed free of charge, and the rest are auctioned at market. Companies affected are required to arrange for permits corresponding to the level of emissions caused by their facilities. In real terms this means that in cases of higher demand, companies will be required to purchase emission rights. Conversely, if they are able to reduce emissions they can then sell allowances. This provides incentives to invest in future-proof, climate-friendly technologies.

Trading periods: The first trading period (2005 to 2007) only affected CO_2 emissions from incinerators and energy-intensive industries. Emissions certificates were distributed free of charge, almost without exception. At the beginning of the second trading period (2008 to 2012), non-EU states such as Iceland, Lichtenstein and Norway became involved in emissions trading. At this point, trading now also involved N_2O emissions arising from nitric acid production. Approximately 90 per cent of emissions certificates remained free of charge. Other new factors included plant operators being permitted to buy emissions certificates through the CDM and JI instruments *(see page 12)*. This made available an additional 1.4 billion tonnes of CO_2 equivalents. The third trading period began in 2013, bringing with it other new features: In addition to CO_2 and N_2O, permission was also required for PFC emissions from primary aluminium production. Moreover, it is estimated that in the current period, at least 48 per cent of carbon allowances must be bought (and thus also paid for) at auction.

Upper limits: Before the third trading period began, national upper limits applied to emissions according to the country in question. 2013 saw an EU-wide limit set in place for the first time, at around 2.08 billion tonnes of CO_2 equivalents. By 2020, this should decrease in a linear fashion by 1.74 per cent annually, and by 2.2 per cent by 2021. There is a separate upper limit for the aviation sector. This was initially set at 210.4 million tonnes of CO_2 annually for the period 2013-2020. This represents 95 per cent of the average emissions occurring between 2004 and 2006 in the aviation sector. Due to temporary coverage restrictions to an intra-EU system, the upper limits have

THE FOLLOWING PARTIES ARE REQUIRED TO PARTICIPATE IN EMISSIONS TRADING

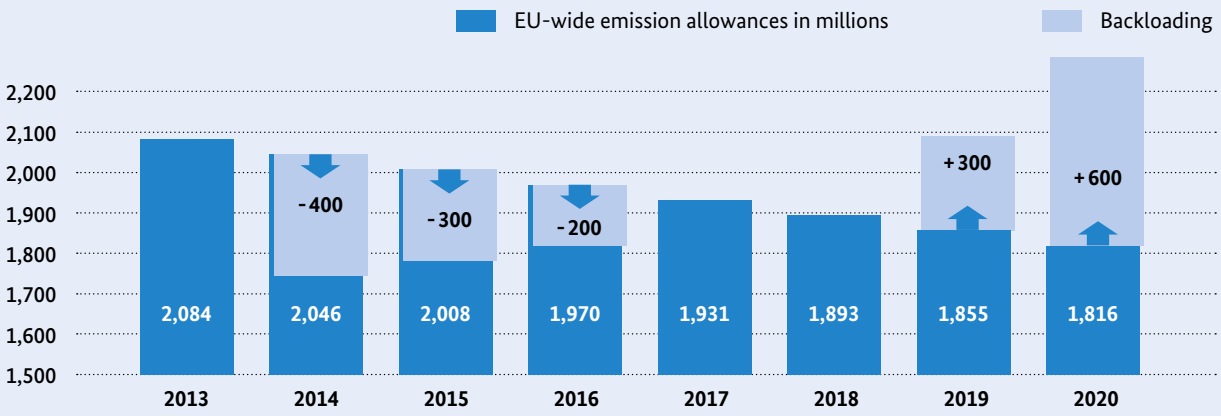
Operators of incinerators with furnace thermal capacity greater than 20 megawatts and operators of energy-intensive industrial facilities

Emissions will be measured via a plant-specific monitoring plan on the basis of the EU Monitoring Directive. Every March 31, companies will be required to submit their emissions reports to the appropriate national authority. In Germany, this is the German Emissions Trading Authority.

Initially, all aircraft operators that take-off or land in the territory of the European Economic Area (EEA)

Aviation has only been included since 2012. However, geographical scope was limited – provisionally until 2016 – to flights within the EEA. The intention was to deal with resistance from third countries opposing the inclusion of their aviation operators into the EU Emissions Trading Scheme. At the same time, this should allow the drawing up of global climate action measures within the International Civil Aviation Organization (ICAO). Aircraft with a maximum take-off weight of 5,700 kilograms are excluded, as are rescue, police, military and research flights.

Figure 2: **Upper limits in European emissions trading until 2020, using backloading (not including aviation)**



Source: European Commission: http://ec.europa.eu/clima/policies/ets/cap/index_en.htm March 2015

been reduced by around a quarter until the end of 2016. 85 per cent of emissions certificates were still being allocated free of charge in 2012, meaning that this amount will shrink to around 82 per cent in the period 2013-2020. The remainder is sold at auction (15 per cent) and used as a reserve for new entrants into the market and for fast growing airlines (three per cent). The aviation sector is furthermore able to acquire emissions certificates from the energy and industrial sectors. The reverse, however, is not permitted.

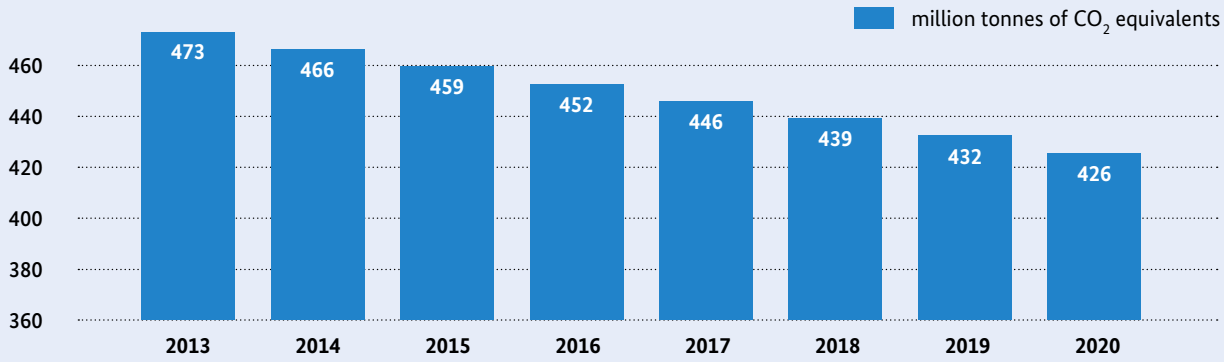
Surpluses: The European Commission has reduced the number of emissions certificates in the second trading period by 6.5 per cent in comparison to 2005 levels. This was based on the quantity of emissions reported during the first trading period, which nevertheless remained below the amount forecast, the economic and financial crisis being the most likely cause. The result was a steadily increasing surplus of emissions certificates that by the end of 2013 amounted to around 2.2 billion. By the end of 2013, as the price had dropped to 4.80 euros, the European Parliament and European Council agreed to a back-loading programme with the aim of strengthening the emissions trading scheme, stating that between 2014 and 2016, there should be a total of 900 million fewer emission allowances in circulation, subsequently to be put back on the market in 2019-2020. In January 2014, the European Commission presented recommendations for a market stability reserve meant to gradually reduce structural surpluses in emissions trading. Such structural reform is urgently needed, however, if its long-term effectiveness is to be ensured *(see page 42)*.

Effort Sharing Decision

The transport[3], household, commercial, trade, service and agricultural sectors are not subject to emissions trading. Nonetheless, they will also have to reduce emissions EU-wide by ten per cent (in comparison to 2005 levels) by 2020. Alongside CO_2 and N_2O, this will also apply to CH_4, HFC, PFCs and SF_6. The distribution of the reduction across the various EU Member States was effected within the framework of the Effort Sharing Decision *(see page 13)*. The per capita economic output of each EU Member State was used in benchmarking. This means that up until 2020, poorer EU states may even increase their emissions. However, the increases permitted will be lower than those projected in a business-as-usual scenario. Responsibility for implementing the decision will fall to the individual EU states.

In the event that Member States are unable to adhere to the agreed upper limit, they will be permitted to carry up to five per cent of their emissions over into the following year. In addition, they are allowed to purchase emissions from other EU Member States. They can also offset their balance with the help of two instruments: CDM and JI. If their upper limit is nevertheless exceeded, they will be required to compensate for their deficit in the following year, in addition to the limit set for that year. This will mean extra reduction efforts. Furthermore, a penalty of

Figure 3: **Effort-sharing upper limits for emissions in Germany**



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

eight per cent of the deficit will also have to be conserved, and they are obliged to publish an action plan. This must include a detailed plan of which measures are planned towards reaching reduction targets. In order to achieve the EU's 2030 goals, there must – outside emissions trading – be a 30 per cent reduction in emissions in comparison to 2005 levels.

Renewable Energy Directive

The Renewable Energy Directive sets out the extent to which the individual EU Member States are obliged to increase the share of renewables in final energy consumption. Figures will be determined according to per capita economic output. In addition, the directive provides a target for the transport sector: by 2020, ten per cent of this sector's energy consumption should stem from renewable sources. Biofuels will only count towards this if they emit at least 35 per cent less greenhouse gas in comparison to conventional fuels. From 2017, this amount will be raised to 50 per cent in comparison to conventional fuels (Fuel Quality Directive – *see page 23*).

The Energy Efficiency Directive

The Energy Efficiency Directive requires Member States at all levels of the energy chain to increase efficiency. To this end, they should each adopt a national energy efficiency target and develop a national action plan.

The Energy Efficiency Plan 2011

The Energy Efficiency Plan 2011 provides Member States with recommendations on the various levels at which they can apply themselves to efforts to increase energy efficiency. Amongst other things, this includes the promotion of energy efficiency in the construction sector, the replacement of outdated equipment in industry and the improvement of transport efficiency.

Further measures

- **Emission limits for passenger cars and light commercial vehicles:**
  For new-vehicle passenger car fleets, the limit has been set at 130 grams of CO_2 per kilometre from 2015, and at 95 grams of CO_2 per kilometre from 2021 (gradually introduced from 2010 onwards for 95 per cent of the EU's new-vehicle fleet).

  For new fleets of light commercial vehicles, the limit is set at 175 grams of CO_2 per kilometre from 2017 and 147 grams of CO_2 per kilometre from 2020.

- **Clean Power for Transport Package:**
  This EC Directive requires Member States to set up a recharging and refuelling infrastructure for alternative fuels. By the end of 2016, there should be national strategy plans that standardise use and technical specifications across the EU.

- **Maritime transport:**
  In mid-2013, the European Commission presented a proposal for the regulation of CO_2 emissions reporting in the maritime transport industry. These proposals will be further discussed at EU level in 2015.

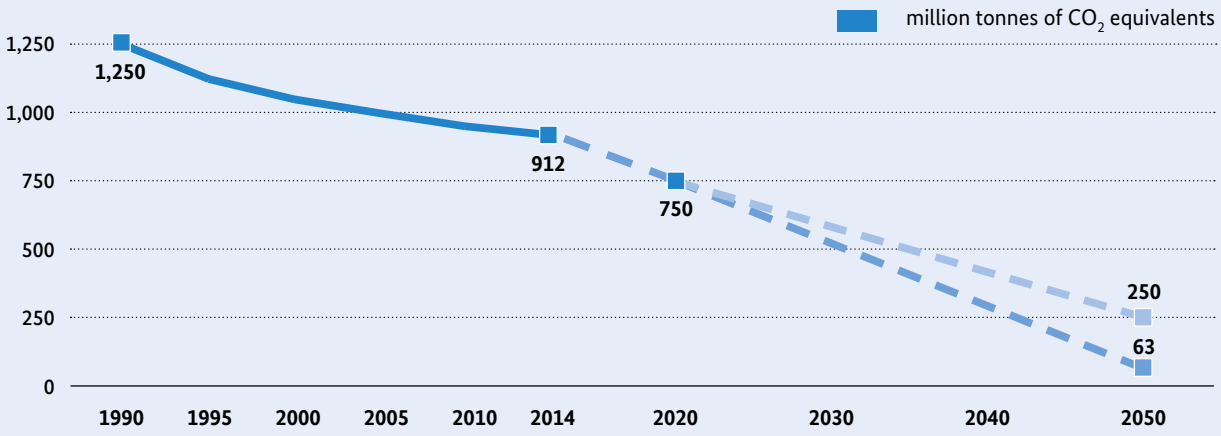
- **Ecodesign Directive:**
  This EC Directive includes requirements for the environmentally compatible design of energy-related products *(see page 57)*.

- **Restrictions on the use and emission of F-gases (EU Regulation 517/2014):**
  The F-gas regulation amended the regulation from 2006, adapting to the availability of new technologies. These new requirements have been in force since 1 January 2015.

- **EMAS Regulation (EU Regulation 1221/2009):**
  This requires participating companies to continually improve their environmental performance. Key indicators are used, for example in the areas of energy efficiency, material efficiency and greenhouse gas emissions.

The German Federal Government's climate and energy policy

Figure 4: **Trajectory for greenhouse gas emissions**



Source: Federal Environment Agency (January 2015)

Figure 5: **Current climate action and energy targets**

CATEGORY	2013	2014*	2020	2030	2040	2050
Greenhouse gas emissions						
Greenhouse gas emissions in comparison to 1990	-23.8 %	-27 %	min. -40 %	min. -55 %	min. -70 %	min. -80 to -95 %
Growth of proportion of renewable energies within energy consumption						
Proportion within gross final energy consumption	12.4 %[5]	-	18 %	30 %	45 %	60 %
Proportion within gross electricity consumption	25.4 %	27.8 %	min. 35 %	min. 50 % (2025: 40 to 45 %)	min. 65 % (2035: 55 to 60 %)	min. 80 %
Proportion within heat consumption	9.9 %	9.9 %	14 %			
Proportion within transport sector	5.5 %	5.4 %				
Reductions in energy consumption and increases in energy efficiency						
Primary energy consumption in comparison to 2008	-3.8 %		-20 %	····▸		-50 %
Final energy productivity		0.2 % annually (2008-2013)	2.1 % annually (2008-2050)			
Gross energy consumption in comparison to 2008	-3.2 %		-10 %	····▸		-25 %
Primary energy demand in comparison to 2008	-5.5 %					around -80 %
Heating demand in comparison to 2008	+0.8 %		-20 %			
Final energy needs in transport sector in comparison to 2005	+1 %		-10 %			-40 %

* Estimate

Sources: Federal Ministry for Economic Affairs and Energy, Die Energie der Zukunft – Erster Fortschrittsbericht zur Energiewende. Deviations due to data updates: Federal Ministry for Economic Affairs and Energy, Energy Data October 2014; Working Group for Renewable Energy Statistics February 2015, and Federal Environment Agency (March 2015)

Climate targets

Energy Concept 2010

The Energy Concept envisages a 40 per cent reduction of greenhouse gas emissions by 2020 compared with 1990 levels, thus implementing the coalition agreements for the 17th legislative period. In the long term, the Energy Concept will be orientated around recommendations set out by the IPCC: namely that if the two-degree upper limit is to be maintained, greenhouse gas emissions should be reduced by a minimum of 80 to 95 per cent by 2050. Intermediate targets have been formulated for the years 2030 and 2040.

Renewable energy:

- **Gross final energy consumption**
  By 2020, renewables should form 18 per cent of gross final energy consumption, rising to 60 per cent by 2050.

- **Gross electricity consumption**
  Here gradual growth in renewable energy proportions should be 35 per cent by 2020, 50 per cent by 2030, 65 per cent by 2040 and 80 per cent by 2050.

Energy efficiency:

- **Primary energy consumption**
  By 2020, this should be reduced by 20 per cent compared to 2008 levels, followed by a 50 per cent reduction by 2050. If this is to be achieved, final energy productivity (in relation to final energy consumption) must grow by around 2.1 per cent a year.

- **Electricity consumption**
  In comparison to 2008 levels, electricity consumption should be reduced by ten per cent by 2020 and 25 per cent by 2050.

- **Buildings**
  The rate of energy-efficient renovations[4] is expected to double from one per cent to two per cent. The aim is for building stock to be almost totally carbon neutral by 2050.

- **Transport**
  By 2020, final energy consumption in the transport sector should have reduced by ten per cent compared to 2005 levels, extending to a 40 per cent reduction by 2050. In addition, by 2020, there should be at least one million electric vehicles on the road in Germany. By 2030, this number is expected to increase by six million. In the field of logistics and freight transport, efforts are being made to decouple traffic density and energy consumption.

Progress will be reported using scientific monitoring measures and published annually. Every three years, the German Federal Government will present a comprehensive, strategic progress report, which will identify obstacles to implementation. It will also suggest other possible measures which could be taken to guarantee achievement of the stated objectives.

Coalition agreement 2013

The governing parties of the 18th legislative period used the coalition agreement to underline the importance of climate action as an engine of progress, able to ensure Germany's prosperity and competitiveness. A triad of energy policy targets will form the basis, setting out the following goals:

- **Climate compatibility and environmental compatibility**
- **Supply security**
- **Affordability/Economic feasibility**

In addition, the coalition agreement emphasises the will to achieve a 40 per cent reduction in greenhouse gas emissions by 2020 compared to 1990 levels, and an 80 to 95 per cent reduction by 2050. Further rollout of renewable energies will take place within a legally set out time frame: 40 to 45 per cent by the year 2025, and 55 to 60 per cent by 2035. With the aim of increasing energy efficiency, the German Federal Government undertook a national action plan *(see page 22)*.

This was adopted in December 2014. Alongside the National Energy Efficiency Action Plan, the coalition agreement sets out the development of a climate action plan for 2050. This is intended to back up the reductions to be made up until 2050 with concrete measures.

CLIMATE ACTION PROGRAMME 2020

Current forecasts[6] *(see page 45)* show that additional measures will be required if goals to reduce greenhouse gas emissions by a minimum of 40 per cent (in comparison to 1990 levels) are to be met. Without additional measures being taken it will only be possible to reduce emissions by 33 to 34 per cent (with a one per cent margin of error).

This would leave a five to eight percent gap between the 40 per cent goal and the reality. In order to close this gap, annual emissions must drop to a maximum of 750 million tonnes of CO_2 equivalents by 2020. As a comparison, in 1990 around 1,250 million tonnes were emitted, around 940 million tonnes being emitted in 2012 *(see page 26)*. Against this backdrop, December 2014 saw the German Federal Government adopt the Climate Action Programme 2020. It contains a number of additional activities to avoid the aforementioned extra 62 to 78 million tonnes of CO_2 equivalents.

Key policy measures

Climate action in the electricity sector:
Taking the electricity sector and European certificate trading into particular consideration, 22 million tonnes of CO_2 equivalents will be generated.

National Action Plan on Energy Efficiency (NAPE):
The action plan involves a variety of immediate measures, which will serve to avoid a further 25 to 30 million tonnes of CO_2 equivalents.

The Climate Friendly Building and Living strategy:
Energy-focused urban renewal and climate action in local authorities should prevent a total of 5.7 to ten million tonnes of CO_2 equivalents, of which 1.5 to 4.7 million is in addition to NAPE.

Climate action in transport:
Various measures should see a reduction of seven to ten million tonnes of CO_2 equivalents. Key instruments will include the strengthening of rail freight transportation, promotion of energy-efficient heavy-duty vehicles and revenue-neutral scaling of tolls on trucks. Tiers will be set according to vehicle energy consumption.

Reduction of non-energy related emissions across various sectors:
This will principally concern improvements in preventing waste, improving recycling and resource efficiency and minimising environmentally harmful F-gases. The industrial, trade, commerce and service sectors should thus emit 2.5 million tonnes fewer of CO_2 equivalents. Via the aeration of landfills *(see page 38)*, emissions can be reduced by an additional 0.5 to 2.5 million tonnes of CO_2 equivalents. In order to reduce agricultural emissions, the German Federal Government plans to amend the Fertiliser Ordinance *(see page 37)* and to increase the percentage of land area used for organic farming.

Emissions trading reform:
At the European level, the German Federal Government is committed to establishing a market stability reserve in 2017 *(see page 42)*. Retaining the previous quantity of allowances (as related to backloadings) should also flow directly into this reserve. How much of this can be prevented depends on the actual configuration.

Setting the example at the federal level:
The German Federal Government plans to strengthen both the Competence Centre for Sustainable Procurement and the Alliance for Sustainable Procurement. This resulted in the Sustainability programme, consisting of measures developed in early 2015. In addition to sustainable procurement, the Sustainability programme now includes measures affecting the areas of building, energy supply, environmental management, events and mobility. The public sector should also receive additional energy refurbishment timetables. This could save a further 0.3 to two million tonnes of CO_2 equivalents.

Accompanying measures in Research and Development, consultancy, education and individual initiatives should further support this process. As was set out in the coalition agreement, the German Federal Government also hopes to adopt the Climate Action Plan 2050 by 2016. The plan aims to ensure that all post-2020 milestones will be achieved. For this purpose, it is updated at regular intervals in tandem with a supervisory dialogue process.

National instruments and measures

German Renewable Energy Sources Act (EEG)

The Renewable Energy Sources Act (EEG) will be the main instrument used to direct the rollout of renewable energies. Using fixed feed, guaranteed purchase and priority dispatch of electricity from renewable energy sources, EEG has established a place in the market for technologies such as wind and solar power. The success rate is clear as in recent years the supply of electricity from renewable energy sources grew rapidly. In 2014, renewables were, for the first time, Germany's most important energy source – even more important than coal. Since its introduction, the EEG continued to be developed further.

The EEG Reform of 2014 will serve as a means of directing the further rollout of renewable energies as part of a legally consolidated process. It will also focus on low-cost technologies, bringing more renewable energies onto the market, and better apportioning responsibility for their financial support. This also provided the legal basis for determining the level of funding for ground-mounted photovoltaic systems via tenders.[7] The main amendments are to be seen in the following areas:

- **A focus on wind and photovoltaics as affordable technologies**
- **Reducing use of the Special Equalisation Scheme**
- **Involving producers of self-generated electricity**
- **Setting out a time-frame for expansion:**
  Solar power: 2.5 gigawatts (annually)
  Onshore wind energy: 2.5 gigawatts (annually)
  Biomass: around 100 megawatts (annually)
  Offshore wind energy: 6.5 gigawatts by 2020 and 15 gigawatts by 2030
- **Improved integration via direct marketing**

Development and modernisation of the network infrastructure

If energy supplies are to consist mainly of renewable energy, and if the energy market is to be liberalised, a modern infrastructure is required. The network is currently organised so that power is generated close to consumption centres. However, wind power – which is primarily generated in the north of Germany – would need transmission lines to carry it to Germany's south. To ensure the timely success of network expansion, the German Federal Government has introduced common grid expansion planning for network operators. Concurrently, it has also used the Grid Expansion Acceleration Act (NABEG) to ensure that this is a transparent and uniform procedure. Extensive public participation is anticipated, with the aim of fostering acceptance of these expansions. At the level of local networks, supplies from recentralised renewable energy systems are growing – nonetheless, this creates new challenges for the distribution network. Intelligent technologies allow the network to be more easily controlled, also reducing the need for expansion. Modern, intelligent networks, generators, storage and consumers should, in the future, be coordinated in the most effective way possible.

Renewable Energies Heat Act (EEWärmeG)

EEWärmeG came into force in 2009. It promotes the use of renewable energy for heating and cooling systems. For new buildings (with a floor space of over 50 square metres) this means that part of their heat requirements must be met using energy from renewable sources. Just how much that will be depends on the type of renewable energy chosen. The owner of the building will be free to make this choice independently. If owners do not wish to utilise renewable energies, they will be able to use replacement measures, including, for example, the use of district heating.

The public sector is obliged to use renewable energy for heating; this will also apply to existing buildings as soon as basic renovations have been done. In doing so, the government will also be performing one of the main roles of public administration: setting a good example.

Market Incentive Programme (MAP)

Accompanying the EEWärmeG, MAP provides incentives to use renewable energies in existing buildings' heating and cooling systems.

CO_2 Renovation Programme for Buildings

Financial incentives are intended to motivate owners to modernise their buildings' energy systems as early as possible. Since 2006, the federal-owned development bank *Kreditanstalt für Wiederaufbau*

(KfW) has granted 1.6 million loans and grants, with the federation having made around eleven billion euros available over the same period. In turn, this has triggered investments worth nearly 118 billion euros. A total of nearly three million homes and 1,400 municipal facilities were either renovated or newly built according to energy efficient principles. This saves around six million tonnes of CO_2 per year.

Energy Saving Ordinance (EnEV)

EnEV sets out energy requirements for buildings. It was amended in 2014 in order to underline the importance of Energy Performance Certificates for consumers. In addition, efficiency requirements for new buildings will be subject to a one-time increase of 25 per cent from 2016 onwards. .

Energy efficiency labelling for cars

This involves an obligation to present information to consumers, to help them choose particularly CO_2-efficient vehicles.

Combined Heat and Power Act

During combined heat and power (CHP) generation, mechanical energy (which can be converted into electricity) is produced and exploited at the same time as heat (which can be used for heating purposes). The Act, which supports the maintenance, modernisation and expansion of CHP, entered into force in 2002 and was most recently amended in 2012. Firstly, the amendments were meant to promote both heat storage and cold storage, which in turn help integrate variable renewable energies into the system. Secondly, the 2012 amendments substantially improved support for cogeneration plants. In 2014, Germany's Economic Ministry published a comprehensive analysis of the potential for cogeneration alongside a cost-benefit analysis. Findings from these publications will serve as a basis for future amendments.

National Energy Efficiency Action Plan (NAPE)

The German Federal Government decided upon the National Energy Efficiency Action Plan in December 2014. The measures it contains are based on a triad; "to inform, foster and demand." The goal is to increase energy efficiency in order to avoid 25 to 30 million tonnes of CO_2 equivalents. The main areas of activity will be:

- **Promoting forward energy efficiency in buildings**
  In order to take advantage of the enormous potential for savings (both technical and economic), the German Federal Government plans to continue developing and optimising existing energy consultancy services, ramp up the CO_2 Building Renovation Programme and develop and implement heating checks. Further processes are also set out in addition to immediate measures - in particular, measures in the areas of energy consultancy, municipalities and tenancy law are planned over the long term.

- **Energy efficiency as an investment and business model**
  If small and medium-sized enterprises invest in improvements to their energy efficiency, they may see a profit rate of 20 to 25 per cent. If they are to actually exploit this potential, corresponding tendering models (amongst other things) will be needed in the future. In addition, the KfW's support programmes for energy efficiency will be further developed. The German Federal Government is also planning to improve the frameworks for energy efficiency services, to develop new funding concepts, and to strengthen energy efficiency research.

- **Taking responsibility for energy efficiency**
  Consumers should get faster access to the information they need to get to grips with new, energy-efficient technologies and the advantages thereof. In addition, the German Federal Government plans to make improvements to metrology. Amongst other things, there are plans to introduce energy efficiency networks, to further develop the energy transformation and climate action initiative for small and medium-sized enterprises, and to create a national efficiency label for older heating facilities. Furthermore, the German Federal Government aims at bundling various forms of consultancy, to develop indicators and benchmarks, and to promote energy efficiency in the IT and communications sector.

The implementation of the Energy Efficiency Action Plan will be subject to annual monitoring carried out by the German Federal Government within the framework of Germany's energy transition.

National Electromobility Development Plan

The German Federal Government is striving to establish electromobility as an energy efficient, affordable, everyday, climate-friendly and environmentally-compatible alternative. The goal is that one

million electric vehicles will be on Germany's roads by 2020. In order to achieve this, the German Federal Government has adopted the Federal Programme for Electromobility. The programme sets out priorities in the promotion of electronic mobility and serves to support technological innovation in an application-orientated and technology-neutral way. This should be set in motion primarily through support in terms of research, development and demonstration. Another key component is the Climate Action Programme 2020, which sets the goal of delivering the administrative framework for a rapid introduction to the market.

Biofuel Quota Act

The Biofuel Quota Act obliges the German oil industry to provide increasing amounts of biofuels. It also legally implements the EC Fuel Quality Directive and EC Renewable Energy Directive. The quotas, in place from 2015, use greenhouse gas emissions as a basis for measurement. Through the use of biofuels, these should see a reduction of 3.5 per cent by 2015, of four per cent by 2017 and of six per cent by 2020. At the same time, the Biofuel Sustainability Ordinance formulates stricter rules for fuels produced from renewable sources. Only biofuels that demonstrably prevent at least 35 per cent of the greenhouse gases caused by fossil fuels can be counted as part of the biofuel quotas. By 2017, the comparative reduction must increase to 50 per cent, expanding to 60 per cent by 2018. In addition, the ploughing or deforestation of conservation areas will not be allowed. This is intended to prevent the rising demand for biofuels which have a negative impact on climate mitigation efforts.

Further measures in the transport sector.

Around 95 per cent of intercontinental trade takes place by means of maritime transport. For this reason, the German Federal Government is supporting international efforts to limit the impact which shipping has on the environment. It is planned this will be achieved by implementing technical measures such as the introduction of efficiency standards for new ships and standards for the fuel use. Market-based instruments could also play a role, and may include the introduction of an emissions trading system for maritime traffic. As part of efforts to increase the efficiency of freight transport and logistics, the German Federal Government is supporting research, development and the introduction of modern technology in addition to the instruments set out in the Climate Action Programme 2020. The Action Plan for Freight Transport and Logistics will also ensure that the transport of goods is efficient, environmentally sound and multimodal. It will deploy various measures to achieve this: examples include the expansion of intelligent traffic management systems, improvements to administrative frameworks for combined transport and increasing intermodal transport capacities.

Forestry Strategy

Forestry, and forests themselves, are vital to climate policy: trees are a key carbon sink. In Germany, around 1.2 billion tonnes of CO_2 are stored as aboveground or underground biomass. As they grow, trees remove CO_2 from the air and draw it into their biomass. Approximately 50 per cent of wood is comprised of carbon, thus making it one of the greatest natural sinks. A forest's carbon balance strongly depends on the age structure and the species of trees. In addition, conditions in Central Europe mean that a balance between CO_2 update (growth) and delivery (putrefaction) is still quite far off. With the Forest Strategy 2020, the German Federal Government urges the conservation of forests as CO_2 sinks. It also sets out the measures for adaptation to climate change, such as the selection of appropriate species in silvicultural activities. Furthermore, the strategy also involves tapping CO_2 minimisation potentials. Wood from sustainable sources should be used to replace energy-intensive materials that have an adverse impact on ecological and CO_2 balances.

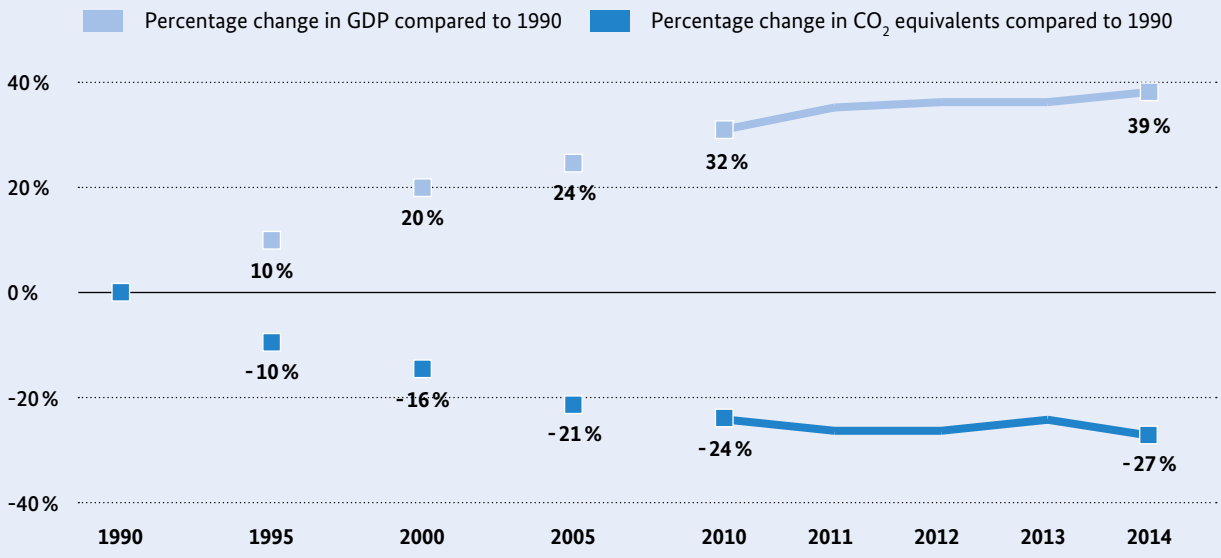
3. Emission trends

Climate action and growth

Germany has been able to significantly reduce emissions of greenhouse gases since 1990. Total emissions, (CO_2, CH_4, N_2O, HFCs, PFC and SF_6), which are converted into CO_2 equivalents, saw a 27 per cent reduction by 2014.[8] In the same time period, there was near unbroken growth in GDP. In comparison to 2013, 2014 saw significantly less greenhouse gas emitted: figures fell from 953 to 912 million tonnes of CO_2 equivalents. Weather conditions were responsible for just over half of this reduction; due to the mild winter, heat demand in 2014 decreased substantially in comparison to 2013, which was rather colder. The higher greenhouse gas emissions in 2013 can also be attributed to the fact that power generation from coal increased. In addition, the amount of electricity exported also increased by more than seven per cent.

Figure 6 further illustrates the increasing gap between GDP growth and the reduction of greenhouse gas emissions. This once again proves that, in Germany, both developments are increasingly decoupling from one another, the success of which can be attributed to a committed energy and climate policy. Nevertheless, policy, the economy and society in general are subject to further challenges as regards the transformation of the energy system. On the way towards an energy efficient, environmentally-compatible economy, the German Federal Government is pursuing its goals to harmoniously balance environmental sustainability, supply security and affordability, and to ensure that the country remains competitive.

Figure 6: **Decoupling economic growth from greenhouse gas emissions**



Source: Federal Environment Agency (January 2015), Working Group on Energy Balances (AGEB): Energieverbrauch in Deutschland im Jahr 2014 und Zeitnahschätzung 2014.

Note: There is no official statistical entry about Germany's GDP for 1990. The value for 1990 was estimated according to other data retrieved from the Federal Statistical Office.

Emission trends by region and sector

Germany-wide trends by greenhouse gas

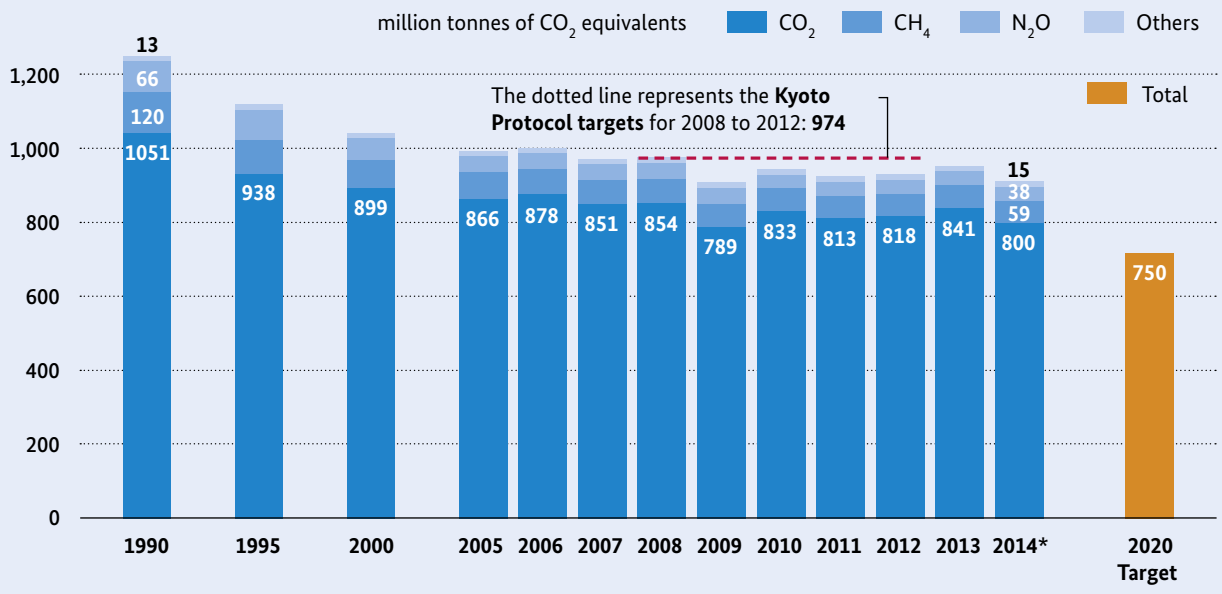
In 2013, the majority of greenhouse gas emissions (more than 88 per cent) were made up of CO_2. More than six per cent was CH_4, four per cent was N_2O and about 1.5 per cent of F-gases HFC, PFC and SF_6.[9] Initial estimates see the percentage distribution of gases stay largely stable.

Emissions sank by 41 million tonnes of CO_2 equivalents in 2014, with a particular reduction in CH_4 and N_2O emissions.

Significant reductions in CO_2 were mainly seen in the 1990s and the early 2000s. In comparison to 2012, 2013 actually saw growth of almost three per cent in this regard. Both CO_2 and total emissions were at their lowest in 2009. This was caused by the economic crisis; since then, total emissions have risen slightly. The reasons for this growth are complex. More oil and gas was used in domestic heating as a result of a relatively long and cold winter; in addition, electricity exports rose.

In addition, new, long-planned coal power plants went on stream while older, out-of-date coal plants remained in operation due to low fuel costs. This resulted in increased consumption of lignite and hard coal. This in turn can be largely attributed to the low price of CO_2 certificates in European emissions trading *(see page 41)*. However, increased economic activity also led to an increase in emissions.

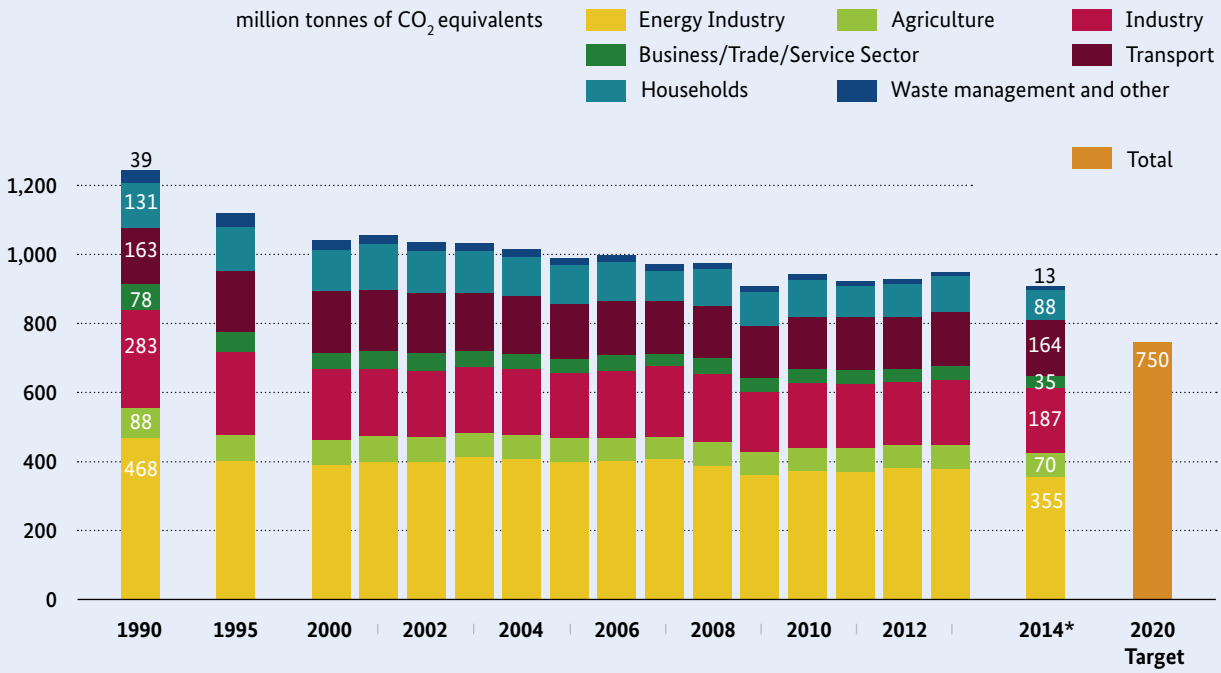
Figure 7: **Emission trends for various gases**



Source: Federal Environment Agency (January 2015)

* Estimate

Figure 8: **Emission trends by sector**
(excluding land use, land-use changes and forestry)



Source: Federal Environment Agency (March 2015)

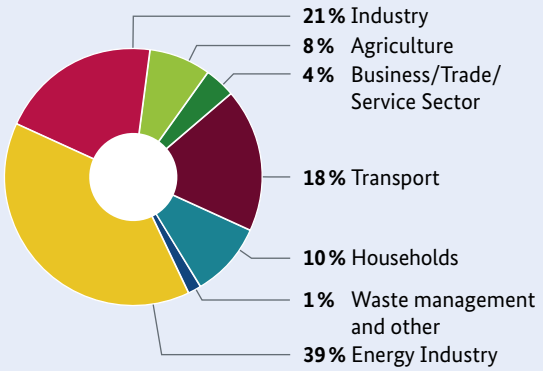
* Estimate

Emission trends by sector

A breakdown according to sector shows that the energy industry caused the most emissions in 2013, with almost 40 per cent. In comparison to previous years, this proportion has remained largely stable. After the energy industry came the industrial sector (20 per cent), transport (almost 17 per cent) and private households (around eleven per cent). Agriculture (seven per cent), the trade, commerce and service sector (four per cent) and waste management (one per cent) all showed a significantly lower proportion of emissions.

Individual shares showed few changes in comparison to the previous year. Whilst the proportion in agriculture and waste management sank by one per cent, it grew in transport and private households. Early prognoses for 2014 seemed to show a similar trend: the proportion for the energy sector and households fell by around one per cent, with slight increases in transport, industry and agriculture.

Figure 9: **Emissions according to sector 2014*** (estimated)[10]



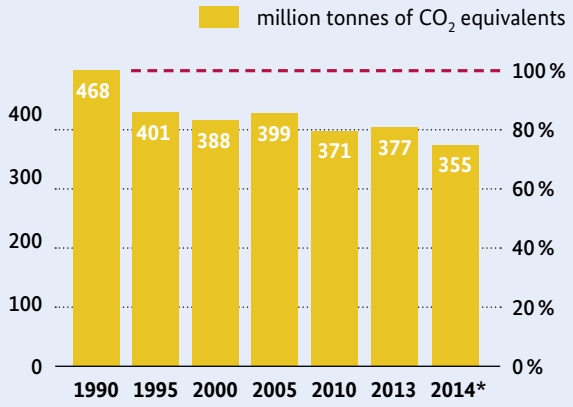
* not including land use, land use change and forestry

Source: Federal Environment Agency (March 2015)

Energy sector

The energy sector encompasses all emissions caused by public electricity and heat supplies, by refineries, or by the manufacture of solid fuels. This also includes greenhouse gases caused by private households, trade, commercial and service sector electricity consumption. In 2013, the energy sector was the largest emitter (around 40 per cent), as was the case over previous years, although emissions did decrease by two million tonnes in comparison to 2012. The main reason for this was the decline in CH_4 emissions due to the increased use of colliery gas in energy production. In contrast, CO_2 emissions, which account for around 98 per cent of total greenhouse gas emissions, stagnated. This shows that the reduction of CO_2 remains the key challenge. The greatest potential for this lies in electricity and heat provision: these two combined caused almost 80 per cent of energy-related CO_2 emissions. Initial estimates suggest that 2014 emissions were almost six per cent lower than 2013 figures.

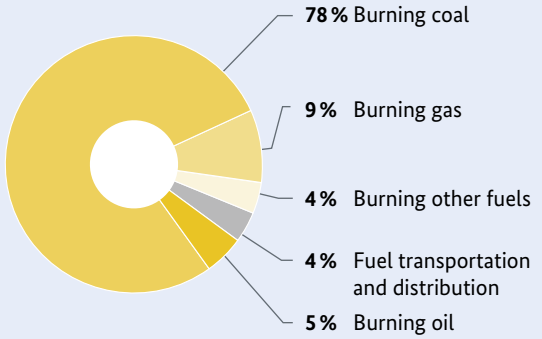
Figure 10: **Emission trends in the energy industry**



Source: Federal Environment Agency (March 2015)

* Estimate

Figure 11: **Origin of emissions for the energy industry 2013***



*excluding CO_2 from biomass

Source: Federal Environment Agency (March 2015)

RESOURCE EFFICIENCY

By preventing and recycling waste, waste and recycling management in Germany makes a significant contribution to the conservation of natural resources. This is also bringing the efficient use of raw materials increasingly to the forefront. In 2009, approximately 68 billion tonnes of abiotic raw materials were used worldwide. In Germany, around 800 million tonnes of abiotic raw material was used. With the 2002 Sustainability Strategy, the German Federal Government made it their aim to set a target of doubling raw material productivity by 2020 compared to 1994 levels. By the end of 2013, there had already been an increase of 48 per cent. In early 2012 the cabinet introduced the German Resource Efficiency Programme (ProgRess). The programme sets out a plan for the sustainable use and conservation of natural resources. This will involve reducing environmental impacts as much as possible, alongside the decoupling of economic growth and the use of natural resources. The programme demonstrates the opportunities and the potential inherent to a more efficient use of resources. In the long-term, a more sustainable and environmentally compatible use of natural resources must be ensured. This will be of benefit to the climate in several ways: energy will be used more efficiently, and via the reduction in the use of materials, there will be a decrease in the emission of greenhouse gases which would otherwise have been caused in the mining, processing and transport of raw materials.

CO_2 EMISSIONS IN THE GERMAN POWER MIX

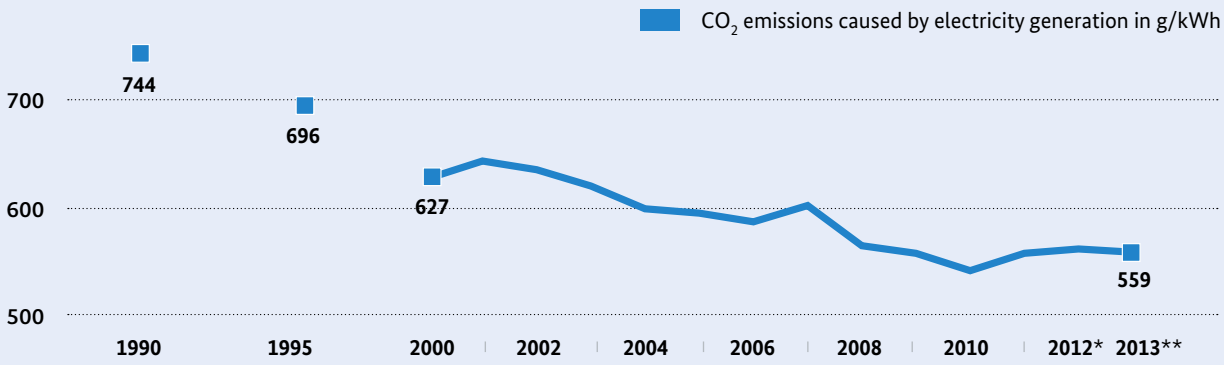
The intensity of CO_2 emissions in the German power mix has decreased significantly since 1990. In 2013, the generation of one kilowatt hour of electricity for end consumption caused an average of 559 grams of direct CO_2 emissions via the burning of fossil fuels. The figure for 1990 was 744 grams. Indirect emissions from upstream production levels were not included in these calculations. Thus, in comparison to 1990, the intensity of CO_2 emissions has reduced by around 25 per cent. In the 1990s, this was achieved primarily through improvements to conventional power plants and the removal of out-of-date, inefficient plants in the East from the grid.

Since 2003, reduction in the intensity of CO_2 emissions has been mainly due to the increased proportion of renewable energies in the total power mix. CO_2 emissions saw a cyclical decline in 2008 and 2009 but subsequently grew again in recent years. This can be principally attributed to increased power generation from coal and increased electricity exports.

Burning lignite is particularly CO_2-intensive, and causes approximately 1,150 grams of CO_2 per kilowatt hour. If climate targets are to be reached, it will be imperative to reduce the use of lignite used to supply power, and to effect a general reshaping of the power supply. In addition, burning coal causes the release of airborne pollutants and toxic metals amounting to 10.75 cent per kilowatt hour that is produced, higher than with any other fossil fuel. In contrast, natural gas causes only 390 grams per kilowatt hour and is, at least amongst fossil fuels, responsible for the lowest amount of CO_2 emissions. This can be attributed to the efficiency of gas-fired plants, but also due to the fact that, when natural gas is burned, it releases less CO_2 per unit of energy than other fossil fuels. Coal causes around 900 CO_2 pro per kilowatt hour.

Despite reconstruction of energy supplies, conventional power stations remain necessary for a transitional period. In the future, however, they must be able to be implemented in a more efficient and flexible manner. The most up-to-date lignite and coal power plants have already achieved efficiency grades of 43 to 46 per cent.

Figure 12: **CO_2 emissions factors in the power mix**



Source: Federal Environment Agency, Entwicklung der spezifischen Kohlendioxidemissionen des deutschen Strommix in den Jahren 1990-2013

* preliminary data ** estimated data

Industry

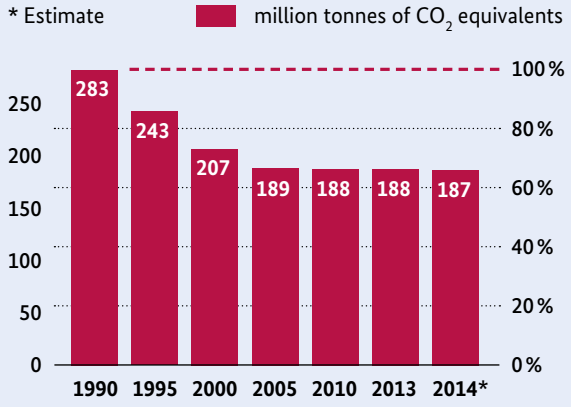
Thanks to legal requirements and modern production technology, bellowing furnaces and sooty chimneys have become a rarity in Germany. Nevertheless, industry makes a considerable contribution to national greenhouse gas emissions. The sector includes both combustion processes and self-supply with electrical power in the manufacturing industry. In addition, there are also the emissions caused by industrial processes, the main sources of which are the metal and chemical industries and factories that produce mineral-based products such as cement.

In 2013, emissions grew by almost three per cent in comparison to 2012. As in previous years, the industrial sector was, after the energy sector, the cause of the largest amount of emissions. Since 2005, there have been hardly any appreciable improvements. The long-term focus of research and financial support is to reduce environmental impacts and, at the same time, to maintain competitiveness. To this end, energy efficiency in the industrial sector must improve markedly. In addition, heat required in industrial processes must come from renewable energy sources. Furthermore, the German Federal Government plans to bring forward the introduction of low-carbon technologies and recyclables. Energy management systems *(see page 69)* can also contribute to the reduction of industrial emissions.

The German Federal Government's support projects

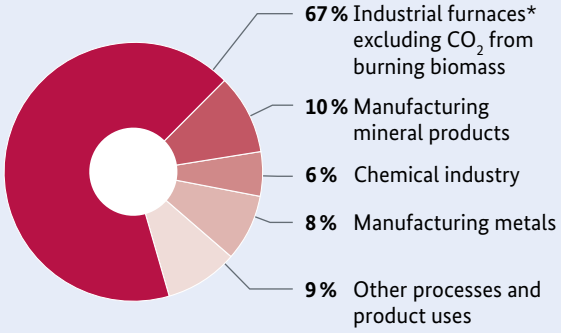
At the national level, several projects are supporting such developments; one example is provided by Learning Energy Efficient Networks (LEEN). Supported by the Federal Environment Ministry as part of the National Climate Initiative, the project serves to reduce energy costs. A total of 30 pilot networks emerged during the course of the project, with the participation of 360 companies. Companies with a minimum of 500,000 euros of annual energy costs benefit from an energy evaluation. Other advantages include an ISO-50001-compliant task overview, annual monitoring and moderated meetings for each network. The result has been that businesses have reduced their energy costs by a good two per cent a year. This represents two times the average improvements achieved in the industrial sector. Through investments totalling 200 million euros, approximately 350,000 tonnes of CO_2 emissions per year have been avoided.

Figure 13: Emission trends in industry



Source: Federal Environment Agency (March 2015)

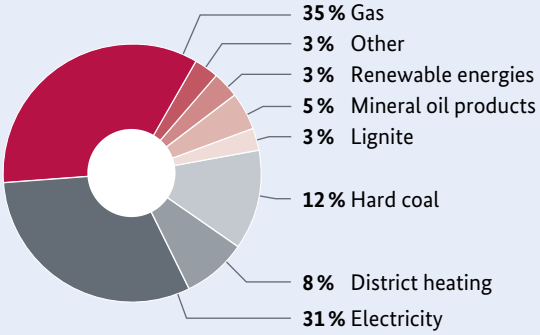
Figure 14: Emission sources in industry 2013



Source: Federal Environment Agency (March 2015)

* Industrial furnaces: combustion processes, e.g. firing rotary kilns

Figure 15: Final energy consumption in industry 2013*



* preliminary data

Source: Working Group on Energy Balances (AGEB) Auswertungstabellen 1990-2013 (September 2014)

Households

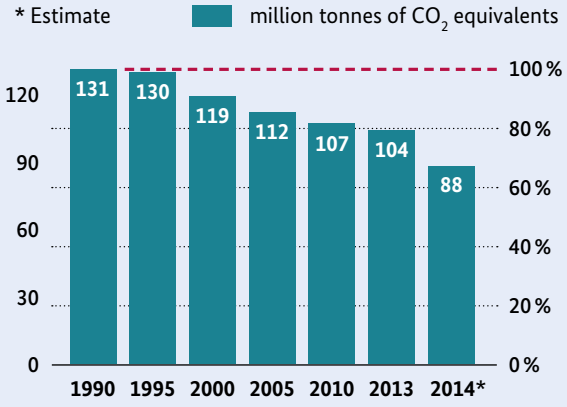
The private household sector includes all combustion processes that occur within households. This covers space heating and hot water. Over two thirds of greenhouse gas emissions in this sector are caused by heating. The quantity of emissions in this sector is thus strongly dependent on the weather, and is subject to significant fluctuations.

Around three-quarters of older German buildings were built before the first Thermal Insulation Ordinance of 1979. These buildings, if not renovated, need considerably more power for heating than new buildings constructed following the Energy Saving Ordinance (Energieeinsparverordnung). The 2014 amendment to this law increased requirements for new buildings: from 1 January 2016, the primary energy demands for new buildings must be 25 per cent lower than today's levels and the quality of the building envelope be improved by an additional 20 per cent.

There is only one change for older buildings, constant-temperature boilers installed prior to 1985 or older than 30 years must be taken out of operation, in contrast to the previous directive, which stated boilers installed before 1978 must be removed.

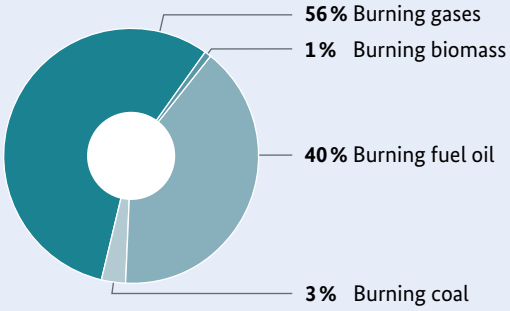
Several legislative measures are aiming to improve energy efficiency in existing buildings. Reductions have proven difficult in recent years, however, as heated areas have generally increased. The trend towards households with larger surface areas and fewer members per household means – despite improved energy standards – that heating demands have increased. In comparison to 2012, household greenhouse gas emissions in 2013 rose slightly due to weather conditions. In contrast, early estimates for 2014 predict a significant reduction: in comparison to 2013, household-related emissions could have decreased by 15 per cent. This can be mostly explained by the late start, short duration and mild conditions of the 2012-2013 winter.

Figure 16: **Emission trends in households**



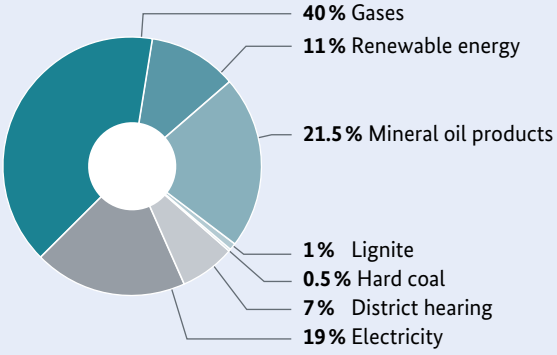
Source: Federal Environment Agency (March 2015)

Figure 17: **Energy sources in households 2013** (excluding CO_2 from biomass)



Source: Federal Environment Agency (March 2015)

Figure 18: **Structure of final energy consumption in households 2013***



* preliminary data

Source: Working Group on Energy Balances (AGEB): Auswertungstabellen 1990-2013 (September 2014)

Transport

In 2013, emissions caused by vehicles grew by around three per cent in comparison to 2012. These figures include fuel consumed on roads, railways, waterways and in national aviation. The share of total greenhouse gas emissions accounted for by transport was around 17 per cent in 2013. Transport was thus one of the main causes of greenhouse gas emissions.

In recent years, legislators in Germany have issued a number of measures to reduce the level of CO_2 emissions caused by transport. The most important of these are fleet target values for passenger cars and light commercial vehicles, limits to greenhouse gas emissions from mobile air conditioning systems, tyre labelling and gear-shift indicators. Road traffic itself has continued to grow: in comparison to 1995, passenger cars emitted nine per cent less, but CO_2 emissions from road-based freight transport increased.

Triad: Avoid – Displace – Improve

In the long term, the German Federal Government plants to use the Avoid – Displace – Improve triad to strengthen climate action in the transport section even further. This should be achieved principally via multimodal (across all modes of transport) services and spatial structures that encourage short distance travel. Since the amount of traffic is nevertheless steadily increasing, it is of the greatest importance to shift passengers and goods transport towards low-emission modes of transport. At the same time, it will be necessary to increase the emphasis on renewable energy sources – perhaps using electricity as a major drive. In the future, freight should be increasingly transported using railways and waterways. Road transport should see a renewed focus on electric vehicles. If the goal of one million electric vehicles by 2020 is reached, then 700,000 tonnes of CO_2 equivalents could be avoided. A precondition for this, however, is that the electricity used to charge these vehicles comes from renewable sources. By early 2015, around 25,000 electric vehicles (plug-in hybrids and battery electric vehicles) had been approved in Germany.

Climate Action Programme 2020

Several measures to further reduce greenhouse gas emissions caused by transport are to be found in the Climate Action Programme 2020. The most important of these are increased energy efficiency in road freight transport and the introduction of new and more efficient technologies like hybrid drive technology. Rail transport should also be bolstered through the removal of bottlenecks, amongst other measures such as the revival of regional economic circular flows, encouraging more walking and cycling, and the promotion of public transport.

In the case of public transport, the German Federal Government has supported the introduction of new technologies like hybrid and plug-in buses for several years. The next stage will be the introduction of electric buses. The introduction of a single European airspace should make energy efficiency gains possible, as air traffic will also be subject to mobility taxation.

Forecasts for transport and emissions

The Federal Ministry of Transport and Digital Infrastructure's traffic integration forecasts predict growth in passenger and freight activity. Nevertheless, forecasts also suggest that transport-related CO_2 emissions will have sunk by 2030. Emissions directly caused by transportation[11] should, according to these forecasts, be reduced by 22 per cent between 2010 and 2030, a reduction in which road traffic will play the major role, emissions in this respect are predicted to see a reduction of 23 per cent by 2030. This will be made possible by lower fuel consumption and more energy efficient modes of driving. However, once total transport emissions (including those caused by the manufacture of fuels) and total air traffic is taken into account, there is a significantly lower reduction of 16 per cent. One precondition, however, that these forecasts come to pass is that the assumptions upon which they are based actually hold true. Most importantly, these include assumptions that fuel prices and fuel tax will rise.

TRAFFIC DEVELOPMENT PLANS FOR THE HANOVER REGION*

The Pro-Climate Traffic Development Plan targets a 40 per cent reduction in CO_2 emissions caused by passenger traffic by 2020 in comparison to 1990 levels. A new concept for climate-friendly commercial transport is planned for 2015. Four sets of measures have been set out:

Settlement development and local mobility
The motto here is "region of short paths". This means not building settlements where this could lead to higher traffic. The greatest potential for prevention of traffic-related emissions is to be found by encouraging cycling.

Public transport
Public transport should use green electricity and alternative drive systems. These improvements can also reduce waiting times. This, alongside a plan to provide job tickets, should encourage more people to use public transport.

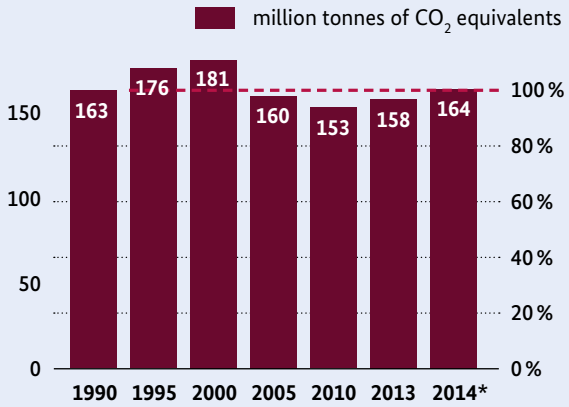
Traffic management
The region reviewed and discussed which measures can encourage the use of electric cars. A reduction in emissions could follow from universal traffic control, an increase in traffic flow and parking space management.

Mobility management
A campaign named All Together To Fight CO_2 and a mobility management package both aim to reduce emissions by 2020. Mobility services (like cycle hire and car-sharing) can also help in reaching these goals.

Initial estimates show increased use of bicycles and public transport. There is already a plan in place for cyclists, and public transport has become more regular. The use of e-buses was trialled successfully, and there are plans for the city to purchase three e-buses in 2016. The project is supported by the National Climate Initiative.

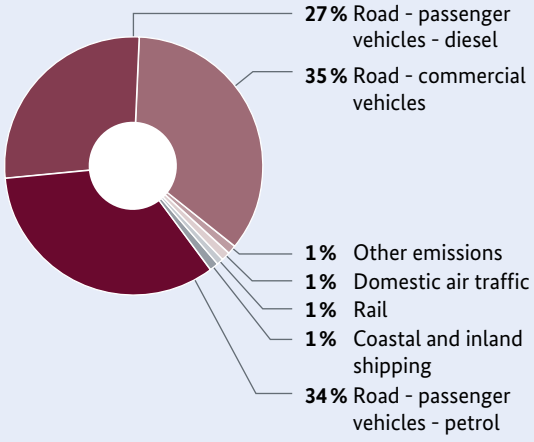
* Source: Region Hannover: Team Verkehrsentwicklung und Verkehrsmanagement and Service- und Kompetenzzentrum, Kommunaler Klimaschutz beim Deutschen Institut für Urbanistik gGmbH (Difu), Klimaschutz und Mobilität

Figure 19: **Emission trends in the transport sector**



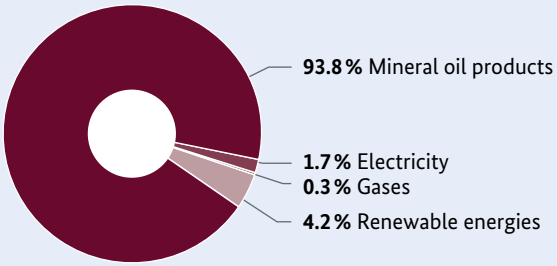
Source: Federal Environment Agency (March 2015) * Estimate

Figure 20: **Sources of transport-related emissions 2013** (excluding CO_2 from biofuels)



Source: Federal Environment Agency (March 2015)

Figure 21: **Final energy use in transport 2013***



* preliminary data

Source: Working Group on Energy Balances (AGEB): Auswertungstabellen 1990-2013 (September 2014)

Business, trade and services

As is the case with private households, heating is of decisive importance in the business, trade and services sector. Around half of final energy consumption in this sector is used to generate space heating. Heating thus has a fundamental influence on the amount of emissions caused by this sector. The majority of electricity used is caused by the use of mechanical energy and in lighting. In 2014, the sector emitted around 35 million tonnes of CO_2 equivalents according to initial estimates. This represents a decrease of around 17 per cent in comparison to 2013, when total emissions of 42 million tonnes represented a similarly high figure to that of 2010. This calculation does not include emissions caused in the production of electricity and heat in power plants: these figures are assigned to the energy sector.

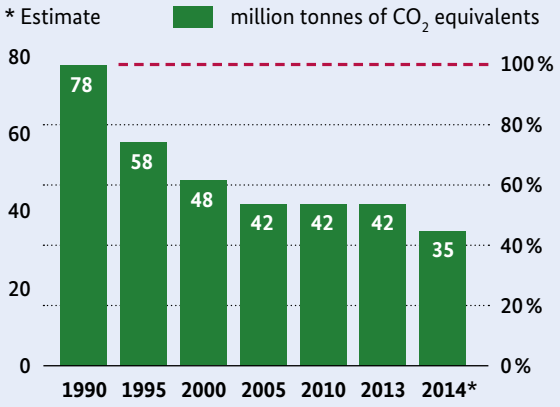
The highest (absolute) consumption in the business, trade and services sector can be attributed to office-like businesses, accommodation services, restaurants, care homes and commercial enterprises. This is especially true with respect to heating. Cooling, however, also plays a major role: around 8.6 per cent of office-like enterprises have air-conditioning.

Improved energy management

In recent years, an ever-growing number of companies in this sector have invested in energy management *(see page 69)*. Approximately half of these companies also embraced energy-saving measures. In total, around 37 per cent of companies either have an energy management system or at least monitor their energy consumption. 30 per cent see a need for further action. Companies tend to prefer organisational to technical measures.

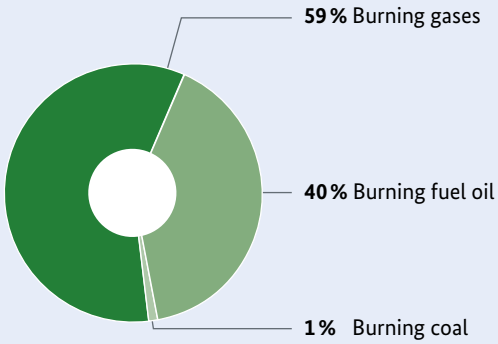
Energy saving activities can be observed in hospitals, schools and swimming baths in particular, with hotels and restaurants seeing a slightly smaller figure. Deutsche Hotel- und Gaststättenverband e.V. – the German hotel and restaurant association – set up the initiative Energiekampagne Gastgewerbe (energy campaign for the hospitality industry) with the aim that energy saving activities can continue to rise in the German tourist industry. This will help restaurants and hotels to steadily increase their energy efficiency, and is thus being supported by the Federal Environment Ministry and the Federal Environment Agency. In addition, the Viabono label is used to indicate climate and environmentally friendly travel. It also certifies sustainable accommodations as Climate Hotels.

Figure 22: Emission trends in business, trade and services



Source: Federal Environment Agency (March 2015)

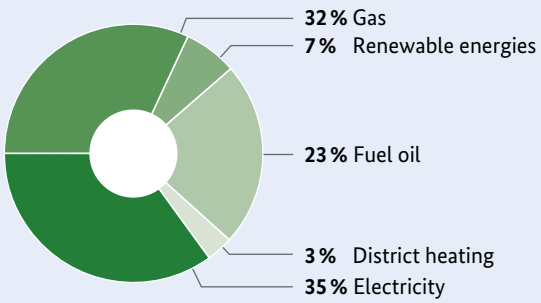
Figure 23: Energy sources in the business, trade and services sector 2013*



*excluding CO_2 from biomass

Source: Federal Environment Agency (March 2015)

Figure 24: Final energy consumption in business, trade and services 2013*



*preliminary data

Source: Working Group on Energy Balances (AGEB): Auswertungstabellen 1990-2013 (September 2014)

Agriculture

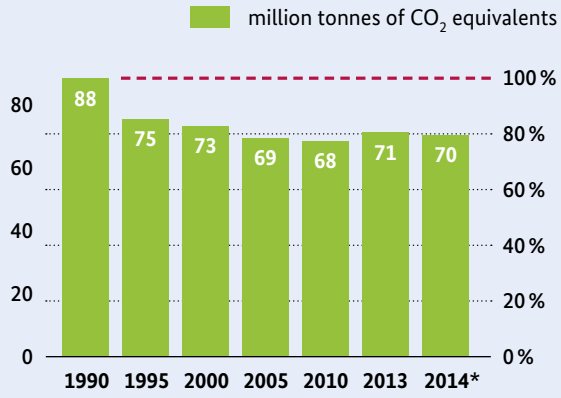
This section covers emissions from livestock, fertiliser use and the use of ammonia in agriculture. In comparison to 2012, the level of greenhouse gas emissions in this sector grew by two million tonnes of CO_2 equivalents in 2013. In 2014, initial estimates suggest that around 70 million tonnes of CO_2 equivalents will be emitted. In contrast to other usual sectors, the majority of the greenhouse gas emissions are made up of CH_4 and N_2O.

The greenhouse gas CH_4 is emitted mainly by the digestion of ruminant animals, especially by dairy cows. As their numbers remain stable, the amount of CH_4 emissions has remained largely constant. In 2012, agriculture accounted for around 53 per cent of CH_4 emissions across Germany. In contrast, N_2O in agriculture is caused mostly through the use of nitrogen fertilisers, accounting for more than three quarters of total N_2O emissions in this sector. For this reason, the stemming of N_2O emissions is a major item on the political agenda *(see box page 37)*.

Opportunities in organic farming

Organic farming provides us with a resource-compatible, environmentally and animal friendly form of agriculture. In 2013, 23,271 farms in Germany were operating according to these principles – about one per cent more than in 2012. Unlike conventional agriculture, organic farming relies on closed nutrient cycles and has dispensed with mineral fertilisers and synthetic chemical pesticides. In addition, the number of animals is determined (and limited) by available space. In particular, dispensing with chemicals means that CO_2 emissions are reduced by up to 50 per cent per hectare. In 2013, approximately 6.4 per cent of Germany's total agricultural area in use was subject to organic management. The German Federal Government is aiming to increase this share to 20 per cent.

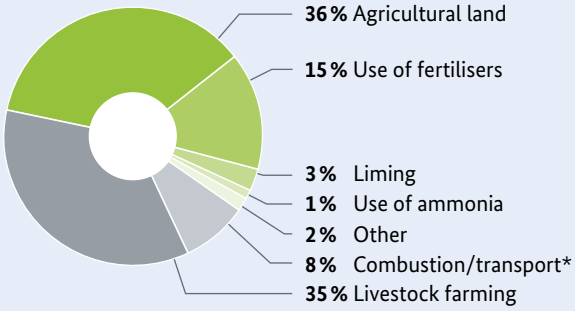
Figure 25: **Emission trends in agriculture**



Source: Federal Environment Agency (March 2015)

* Estimate

Figure 26: **Emission sources in agriculture 2013** (excluding CO_2 from biomass)



* Stationary combustion (stables, greenhouses, etc.) and agricultural transport

Source: Federal Environment Agency (March 2015)

Land use, land use change and forestry

Soils and vegetation act as natural storage vessels for carbon and carbon compounds. They are thus referred to as natural sinks. With heavy use – such as in the conversion of grassland– the CO_2 stored in carbon sinks is released once again into the air. This means that the natural sink has been changed into a source of emissions. Soil-conserving processing methods during cultivation reduce the discharge of stored CO_2 emissions. Sustainable, close-to-nature forest management allows a forest to remain as a CO_2 sink.

Improved protection of peatlands

Arable land is the main source of emissions from soils. Around 80 per cent of these emissions originate in peatlands in agricultural use, although only six per cent of all agricultural land is made up of peatland; its share of total emissions caused by agriculture is thus disproportionately high. A total of around four per cent of greenhouse gases in Germany can be accounted for this way.

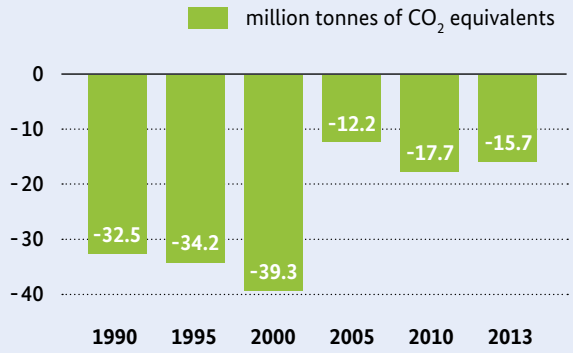
For this reason, the German Federal Government is aiming to protect peatlands. A firm commitment to this was placed in the Climate Action Programme 2020. By increasing water levels, greenhouse gas emissions from drained peatlands should be reduced, resulting in a concomitant reduction in their share of total emissions. A further item on the political agenda will be the maintenance of permanent grassland. When such surfaces are disturbed, significantly more CO_2 is released than can be taken up by the creation of new grassland. Irrespective of this, grassland was reduced by around 13 per cent between 1991 and 2013.

Actual results

The agricultural use of arable land released around 14.21 million tonnes of CO_2 equivalents in 2013. Conversion of grassland, settlements, wetlands and the liming of forest soils ('other') resulted in 29.16 million tonnes of CO_2 equivalents. The land use, land use change and forestry sector thus emitted 43.37 tonnes of CO_2 equivalents. In contrast, wood products and forests stored around 59.06 million tonnes in 2013.

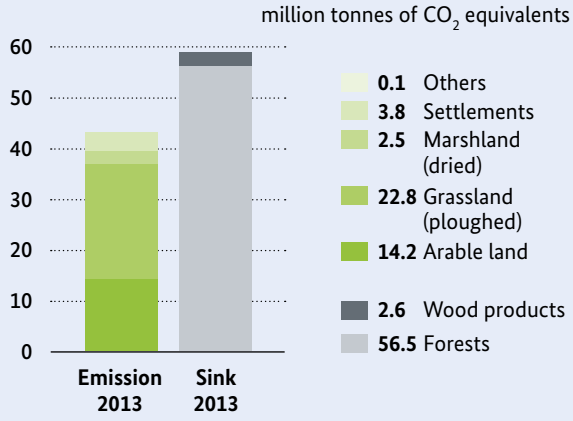
In comparison with in other sectors, achieving a balance in emissions in this sector presents considerable methodological difficulties. The risk of forest fires, for example, means that storage capacity can be suddenly decreased, which often cannot clearly be attributed to an anthropogenic or natural cause. It is almost impossible to separate natural storage processes and the climate mitigation efforts that arise as a result from forestry activities.

Figure 27: **Emission trends in LULUCF**



Source: Federal Environment Agency (March 2015)

Figure 28: **Emissions and reductions LULUCF 2013**



Source: Federal Environment Agency (March 2015)

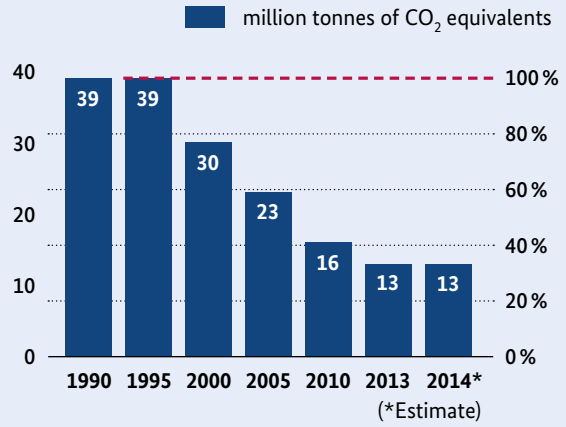
EXCESSIVE USE OF NITROGEN

Nitrogen is an essential nutrient for all forms of life. In large amounts, however, it damages both the environment and the climate; in the form of nitrate, it causes particular damage to groundwater and drinking water. It leads to an oversupply of nutrients (eutrophication) in surface waters and in terrestrial ecosystems. It also impacts upon the climate in the form of N_2O. More than 50 per cent of nitrogen compounds and 77 per cent of N_2O emissions in Germany enter into the environment via agriculture, the fertilisers used to improve crop yield and quality being the principal cause.

In order to curb the damage caused by nitrogen, the German Federal Government used the Sustainability Strategy to set a goal of limiting the excessive use of nitrogen to 80 kilograms per hectare by 2010. This goal, however, has not thus far been reached. In 2012 the overuse of nitrogen (in the overall balance) was at 98 kilograms per hectare. In the North-west of Germany, this number is much higher due to the intensive livestock farming in the region.

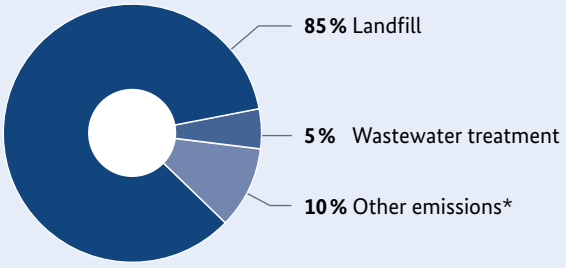
N_2O emissions in agriculture can be most easily curbed by improving productivity in terms of nitrogen fertiliser use. This means that optimised nitrogen fertilisation can, alongside reduced use of fertiliser material, achieve the same yields. The amendment to the Fertiliser Ordinance in the Climate Action Programme 2020 should help in efforts to reduce N_2O emissions. Amongst other things, the focus will be on step-by-step increases in manure storage capacities, extending the vesting periods for fertiliser application and improving application techniques.

Figure 29: **Emission trends in waste management**[12]



Source: Federal Environment Agency (March 2015)

Figure 30: **Emissions sources in waste management 2013**



* Waste treatment, mechanical-biological waste treatment, composting and sewage sludge use

Source: Federal Environment Agency (March 2015)

Waste and recycling management

Since 1990, emissions in waste and recycling management – arising from landfill gases and waste water management – have been reduced by more than two thirds and today make only a marginal contribution to climate-related emissions in Germany. This was primarily due to measures which greatly reduced the release of CH_4. Also key was the ban on dumping untreated municipal waste and the recycling of valuable materials such as paper, glass, packaging and organic waste. More than half of household waste is now reclaimed. This conserves, amongst other things, resources and reduces the use of primary energy. Domestic waste that is not reclaimed is used in the production of energy, thus replacing fossil fuels in power production.

Further developments

Both reclamation and energy-related use increase the economic utility of raw materials. This should continue to increase in the long term. By 2050, the circuits should be largely closed: it is predicted that municipal, industrial and commercial waste will be recycled more consistently.

LANDFILL VENTILATION (AEROBIC-IN-SITU STABILISATION)

In order to continue to reduce emissions from municipal waste landfills, municipalities and landfill operators are moving towards landfill aeration. This makes clear decreases to substance conversion at landfills. As the constant supply of air accelerates biological processes, the decomposition of organic carbons to CO_2 rather than CH_4, which is a far more harmful greenhouse gas, is in turn sped up. Ventilation also reduces the potential for the production of methane by about 90 per cent.

Residual amounts of methane can be almost completely eliminated by a regenerative thermal oxidation plant. According to the Climate Action Programme 2020, greenhouse gas emissions across Germany should be reduced by anything from 0.5 to 2.5 million tonnes of CO_2 equivalents as a result of landfill ventilation. In order to realise this potential and overcome financial hurdles, the National Climate Initiative has been supporting the practice since early 2013.

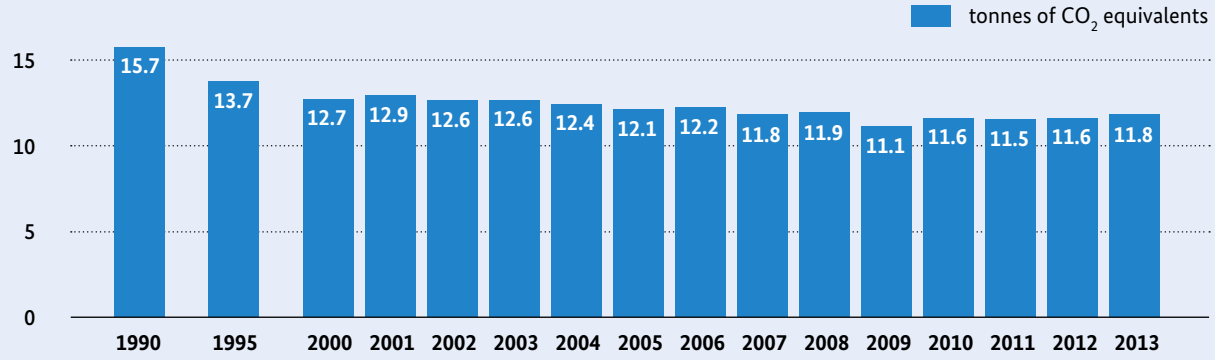
Trends in per capita emissions in Germany

In 2013, there was a small increase in per capita emissions in comparison to 2012. After reaching a low in 2009, greenhouse gas emissions have now once again reached the per capita level of 2007. Since 1990, this has sunk by around 25 per cent. In comparison to other EU Member States, Germany is still well above the average having emitted 11.8 tonnes of CO_2 equivalents per capita in 2013. In 2012, the 28 EU Member States emitted 9.9 tonnes of CO_2 equivalents per capita.

Greenhouse gas emissions by Federal State

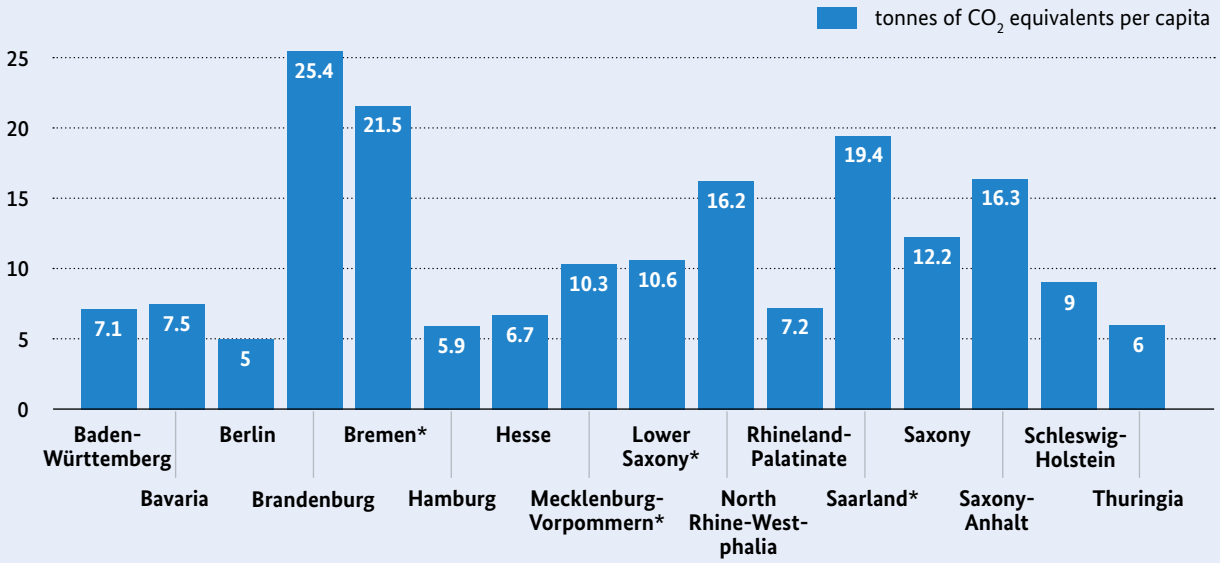
The breakdown of greenhouse gas emissions according to federal state reveals clear differences. Whilst in Berlin the per capita average is five tonnes of CO_2 equivalents, Brandenburg's figure is 25.4 tonnes. The cause of these differences is the difference in factory capacity and in economic structures.

Figure 31: **Trends in per capita emissions in Germany**



Source: Federal Environment Agency (March 2015) and Federal Statistical Office, population census

Figure 32: **Breakdown of greenhouse gas emissions per capita by federal state 2011 (2010)**



Source: Statistical Offices of the Länder (February 2015)

* 2010

Decisive factors

Energy generating capacity is not evenly distributed throughout Germany. Some states still produce the majority of their electricity in conventional power plants. Others, however, already draw the majority of theirs from renewable sources. Approximately half of the federal states mainly use renewables, in particular Lower Saxony and Bavaria. In 2013, these two states had a combined output of 28 gigawatts. This accounted for more than one third of total output in renewable energies in Germany. Fossil fuels dominate the picture in North Rhine-Westphalia: 35.6 gigawatts were generated from conventional energy sources; markedly lower are Baden-Württemberg (8.7 gigawatts), Lower Saxony (7.4 gigawatts) and Bavaria (6.9 gigawatts). In four states (Schleswig-Holstein, Lower Saxony, Bavaria and Baden-Württemberg), nuclear power plants are also used to generate electricity.

Economic structures also influence the level of emissions: steel production in the Saarland and in Bremen is one of the causes of the high CO_2 emissions in those regions.

Emission trends inside and outside the emissions trading system

Trends within the emissions trading system

In the first year of the third trading period, the sectors participating in emissions trading emitted around 481 million tonnes of CO_2 equivalents. Thus, on the one hand, emissions rose, but on the other hand, the number of plants taking part grew from 400 to 1,929 between 2012 and 2013. This is a result of the expansion of the scope of emissions trading. Overall, German industrial and energy facilities caused around 25.4 per cent of emissions subject to the European Emissions Trading Scheme in 2013.

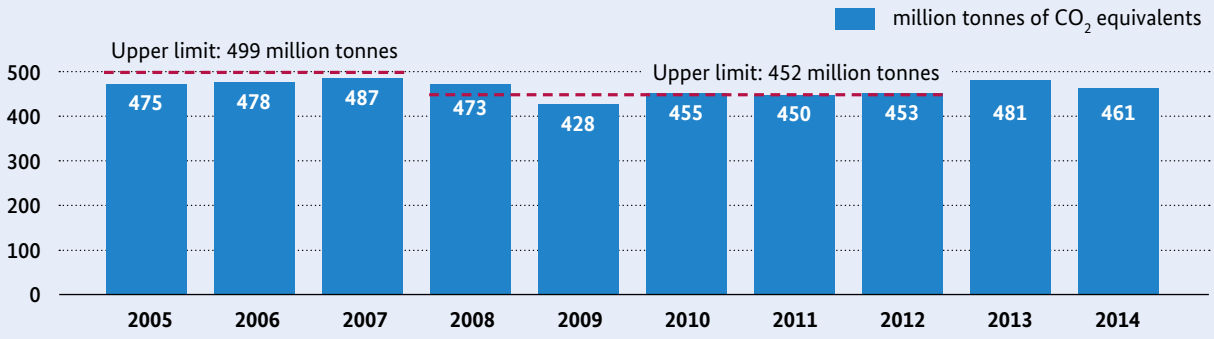
The numbers in detail

The energy sector was one of the reasons for the increases seen in 2012-2013 and came as a result of increased use of coal to generate power. Emissions thus increased by two per cent. In addition, facilities for non-ferrous metal processing, aluminium production, ammonia, adipic acid and nitric acid have been subject to reporting requirements and other obligations since 2013. As a result of broad applications, N_2O emissions originating from nitric and adipic acid production also came into the picture. The same is true for PFC emissions from primary aluminium production. These sectors caused an additional 22.5 million tonnes of CO_2 equivalents. In contrast, energy-intensive industries were able to reduce their emissions by around one per cent.

Overall, 169 million CO_2 allowances were allocated free of charge; 194 million were sold at auction. The sum total of emissions in Germany thus exceeded the number of allowances by 118 million.

In 2014, emissions from a total of 1,900 stationary installations decreased by approximately 461 million tonnes of CO_2 equivalents. This decrease is due to the reduction of greenhouse gas emissions in the energy sector by about 5.4 per cent. In contrast, emissions caused by the industrial sector remained roughly constant in comparison to 2013.

Figure 33: **Trends in emissions trading within Germany**



Sources: DEHSt, VET Report 2013 and press report from 22.04.2015

Prices

German carbon allowances are sold through the energy futures market European Energy Exchange AG, headquartered in Leipzig, at which certificates are sold weekly as part of an EU-wide process. All approved bids are sorted on a descending basis. This is the unit price method and it determines how the selling price – which applies uniformly to all successful bidders – is set. Due to the high EU-wide surplus in allowances, the price of a certificate has been drastically reduced since emissions trading began. It increased slightly in 2014 (in comparison to 2013). Nevertheless, the price decline is presenting the emissions trading system with major challenges. The EU plans to remedy this via structural reform.

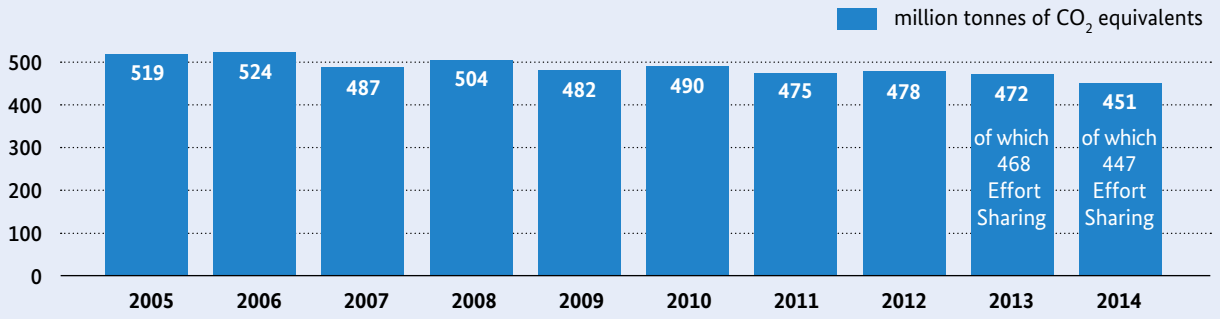
Trends outside the emissions trading system

In sectors not subject to emissions trading, greenhouse gas emissions fell by around 1.3 per cent between 2012 and 2013. Around 99 per cent of emissions occurring outside of emissions trading were subject to effort sharing, which excludes, amongst other things, emissions from domestic aviation.

Figure 34: **EU emissions allowance prices (futures): periodical mean values**

Sources: ICE and Thomson Reuters (January 2015)

Figure 35: **Emission trends outside of emissions trading**



Sources: Federal Environment Agency (March 2015) and DEHSt, VET-Bericht 2013 and press report from 22.04.2015

STRUCTURAL REFORMS WITHIN EMISSIONS TRADING

By the end of 2013 there was a surplus of 2.2 billion carbon allowances in the EU. This means a difference between the number of carbon allowances available and verified emissions. This is due to the decline in production caused by the economic and financial crisis. As a consequence of this, EU-wide emissions were significantly lower than predicted. The European Commission expects that this difference will continue to grow up until the end of the third trading period.

The surplus of emissions allowances contributed significantly to their price decrease in recent years, which in turn decreased the incentive for plant operators to invest in climate-friendly technologies. In order to make emissions trading more effective in the short term, the European Council and the European Parliament accepted the European Commission's "backloading" proposal. This provides for a reduction in carbon allowances of 900 million between 2014 and 2016. This reduction is however to be recycled back into the market by the end of 2020, and thus the surplus situation should be maintained.

Market stability reserve
In early 2014, the European Commission proposed the introduction of a market stability reserve with which to ensure the effectiveness of emissions trading in the long term. The reserve should make it possible to adjust the number of annual auctions according to demand and reduce long-term surpluses. At the same time, it should also ensure the ability to react more flexibly to fluctuations in demand in the future. Other methods already use similar mechanisms to control supply within trading periods.

With the introduction of the market stability reserve, the number of surplus certificates in circulation will be calculated and published by the European Commission annually on 15 May. The crucial factor in this regard will be the amount of certificates that were in circulation on 31 December of the previous year. This European Commission proposal envisages the following mechanisms.

Firstly, if the number of allowances in circulation exceeds the threshold of 833 million, the Commission proposes reducing the number sold at auction the following year by twelve per cent of the number in circulation the previous year (a minimum 100 million certificates).

Secondly, and if in contrast the number of allowances in circulation on 31 December falls short of the threshold of 400 million, or if there are strong price hikes, 100 million allowances will be returned to the market.

The European Parliament and the European Council have agreed to start market stability reserve from the 01.01.2019. Backloading amounts and other unused surplus amounts are to be transferred directly to the reserve.

Emissions in international comparison

2012 saw a slight increase in global emissions in comparison to 2011, from 53 gigatons to about 54 gigatons of CO_2 equivalents. Of this, 34.5 gigatons were made up of CO_2. This represented a worldwide increase in CO_2 emissions of 1.4 per cent in 2012 in comparison to 2011. Despite this ascent, it can be assumed that CO_2 emissions and economic growth are being increasingly decoupled worldwide. This trend is due to decreases to energy-intensive activities, increased use of renewable energies and energy saving measures. CO_2 intensity varies according to region. China, the US and Europe alone are responsible for 55 per cent of global CO_2 emissions.

With a share of more than 23 per cent, China was cause of the largest portion of greenhouse gas emissions worldwide. Considerably behind came the US, the EU28 and India. Whilst the US and the EU28 were able to reduce their emissions in comparison to 2011, emissions in China and India grew slightly. The picture is very different in per capita terms: countries such as Qatar and Australia lead, with China and India lagging some way behind.

Calculating according to the territorial principle

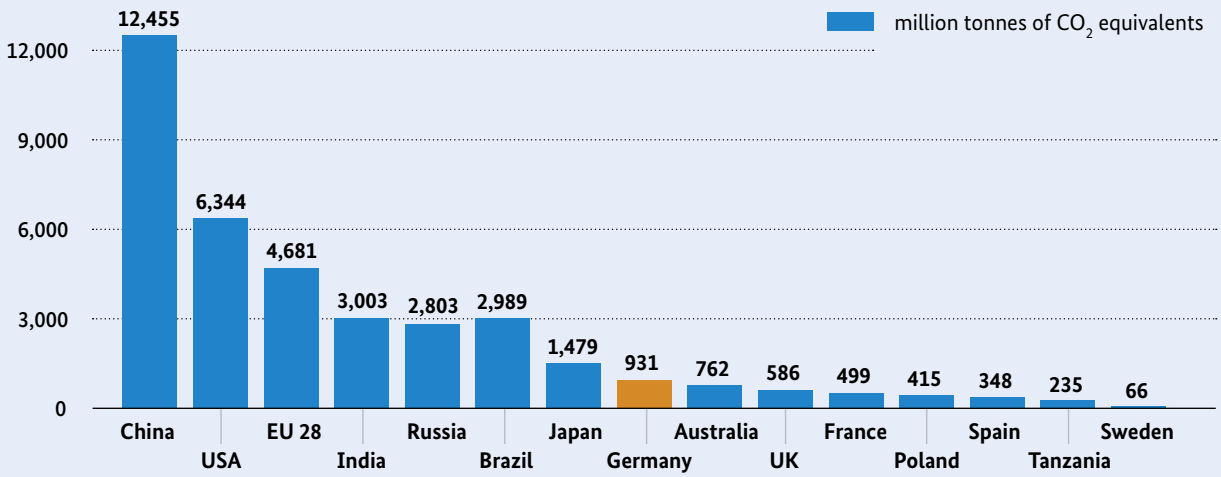
In national and international reporting, greenhouse gas emissions are reported on the emergence side. In practice, this means according to the state in which they arise – via, for example, industrial production. Fossil fuels represent an exception: they impact upon the greenhouse gas balance of the sales market (i.e. the country) in which they are burned.

However, for additional information, states can also measure emissions on the consumption side. In this case, they are ascertained as a commodity and attributed to the consumer. This means that in addition to emissions released within national borders, the balance also includes those emissions caused during the production of imports to Germany. Conversely, greenhouse gases released during the production of export goods in Germany are attributed to the importer. Greenhouse gases caused in association with a country's consumption of goods are termed grey emissions.

Reasons for applying the territorial principle

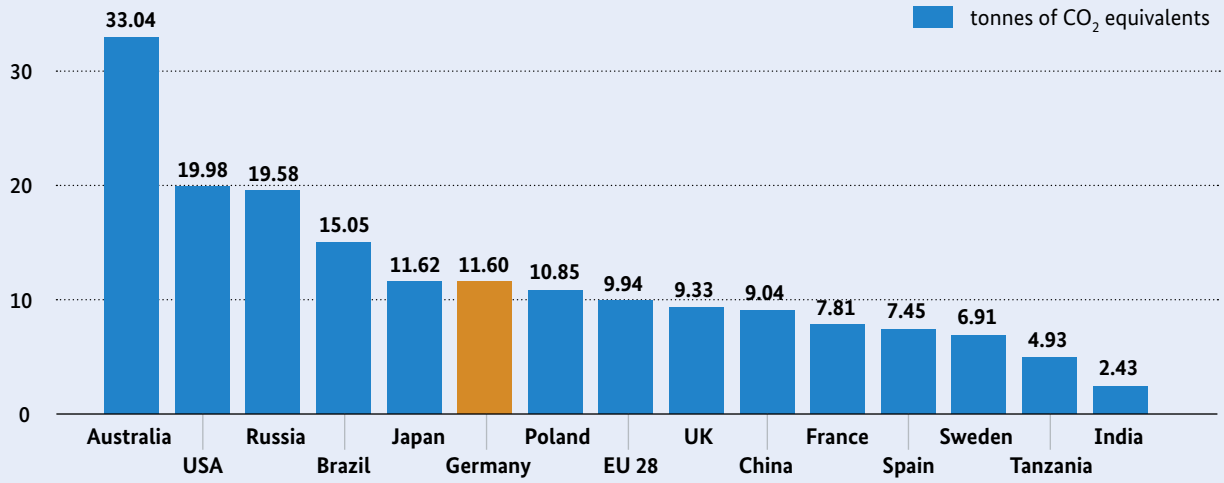
The principle reason for applying the territorial principle is that all states have a sovereign right to their data. If consumption is to be measured, then an exchange of data would become necessary. However, reporting requirements do not set any obligations in this respect.

Figure 36: **Emissions in international comparison 2012**



Source: http://edgar.jrc.ec.europa.eu and Federal Environment Agency (March 2015)

Figure 37: **Per capita emissions in international comparison 2012**



Source: http://edgar.jrc.ec.europa.eu and Federal Environment Agency (March 2015); Federal Statistical Office, population census

As world trade continues to grow and the territorial principle remains in sole use, there is the theoretical danger that emissions-intensive industries might move abroad, especially to countries that have not publically declared any climate targets. To prevent this, several trade policy measures – such as CO_2 tariffs – have been discussed. This would comprise of imports being taxed according to their carbon content. A look at Germany's CO_2 balance reveals a relatively balanced picture. The goods exported by Germany in 2010 contributed 519 million tonnes of CO_2 to the national greenhouse balance. In contrast, the goods imported caused around 411 million tonnes of CO_2 in their countries of origin. In order to achieve the two-degree target in the most cost-effective way, worldwide emissions should not have exceeded 44 gigatons of CO_2 equivalents by 2020. However, current forecasts predict 52 to 54 gigatons of CO_2 equivalents by this time. It can be deduced from this that there is a huge gap in terms of reaching this target and that additional measures will therefore be necessary.

Emission trends: a possible scenario

In order to predict how current measures will impact upon greenhouse gas emissions, the German Federal Government had a prognosis drawn up in the autumn of 2014, based upon all climate and energy-related measures which had been implemented up until 31 August 2014. As a result, that which was agreed in December 2014 as part of the Climate Action Programme 2020 and the national Energy Efficiency Action Plan *(see pages 20 and 22)* did not form part of the prognosis.

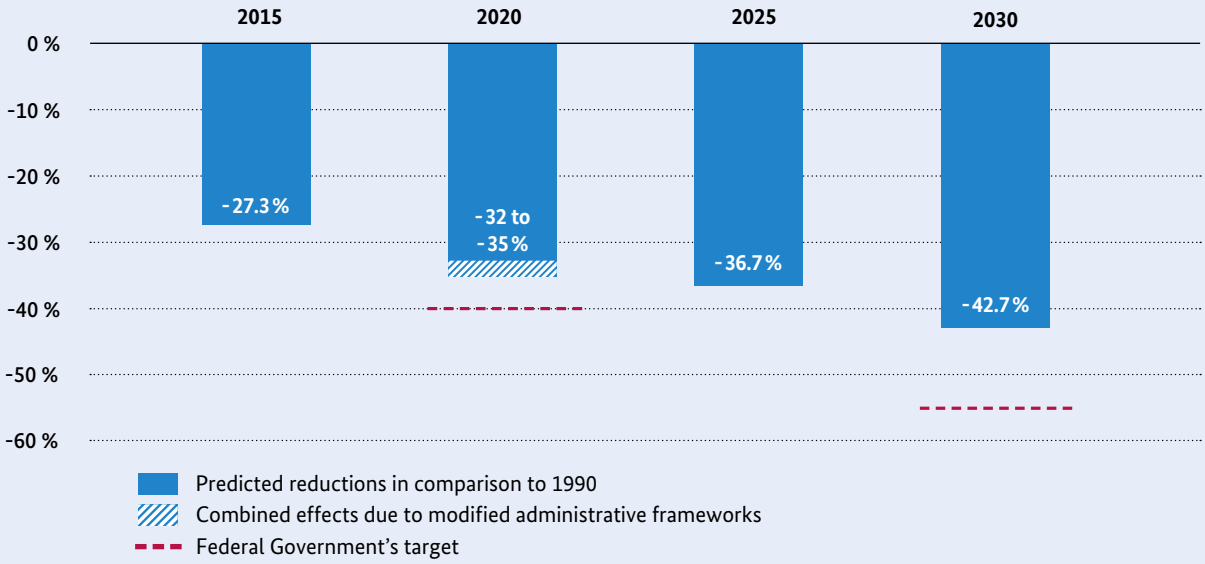
Findings from the prognosis

Without the decisions made by the German Federal Government in December 2014, greenhouse gas emissions in 2020 would see a reduction of 32.7 per cent in comparison to 1990.[13] This would represent a seven per cent shortfall in respect to the German Federal Government's reduction target. These calculations are, however, highly dependent upon assumed conditions. Results indicate that there is some flexibility as regards reductions for 2020. There is scope for reductions to lie anywhere between minus 35 per cent (in the case of low economic growth and lower electricity export balance) and minus 31.9 per cent (in the event of strong population growth and high fuel prices).

Significant reductions can be achieved most of all in the power industry, households, business, trade and services, and transport sectors. By contrast, industrial emissions will likely only be able to achieve levels slightly lower than those observed today. Emissions from international civil aviation and international maritime traffic (which previously were not considered as part of national climate targets) are expected to increase: without additional measures, this increase may be as much as 40 per cent above 2005 levels by 2030.

The greatest savings are most likely to be reached by increasing the levels of renewable energies being fed into the grid. Another key source is lower electricity consumption via greater efficiency within individual sectors. The inclusion of industrial N_2O emitters in emissions trading, CO_2 emission standards for passenger cars and climate-orientated modifications to motor vehicle tax are also capable of making substantial contributions.

Figure 38: **Emission trend scenarios for Germany 2015-2030**



Source: German Federal Government, Projektionsbericht 2015

4. Energy trends

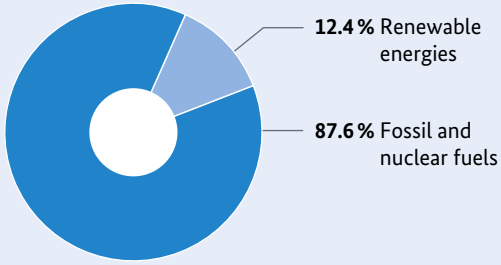
Renewable energies

Final energy consumption: proportion of renewable energies

Since 2000, renewable energies have grown from being a niche product to a key energy source. In 2013, the proportion of renewables in gross final energy consumption was 12.4 per cent. By 2013, they were the second most important energy source in the electricity sector. One year later, in 2014, they overtook lignite since then are recognised as the most important source of power.

In 2014, renewable energies accounted for a total of 27.8 per cent of gross energy consumption. One year earlier, this figure was closer to a quarter. The share of renewables in the final energy consumption for heating remained a constant 9.9 per cent in comparison with 2013. In contrast, final energy consumption in transport showed a decline, falling from 6.1 per cent (2012) to 5.5 per cent (2013) and, by 2014, to 5.4 per cent.

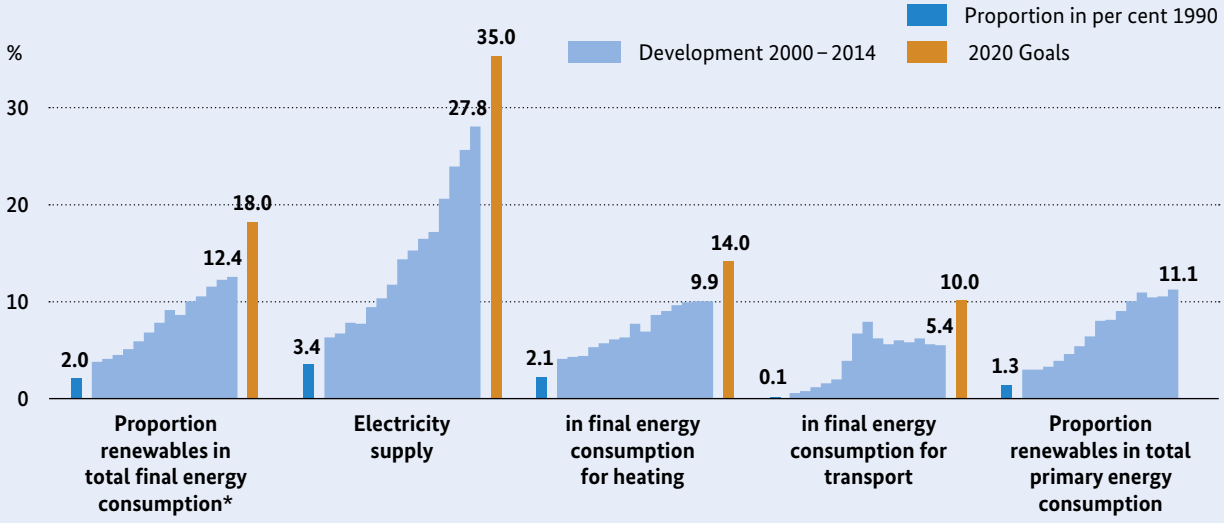
Figure 39: **Gross final energy consumption 2013**



Source: Eurostat (April 2015)

In the absence of statistics from the Working Group on Renewable Energy, Eurostat data serve here as a basis. Preliminary data for 2014 will not be available until summer 2015.

Figure 40: **Proportion of renewable energy sources in energy supply**



Sources: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Erneuerbare Energien 2012, page 9; Working Group on Renewable Energies Statistics (AGEE-Stat) (February 2015)

* As the Working Group on Renewable Energy's statistics have as of yet not provided data on gross final energy consumption, Eurostat's statistics will be used here. Preliminary data for 2014 will not be available before summer 2015.

Trends in final energy consumption from renewable sources

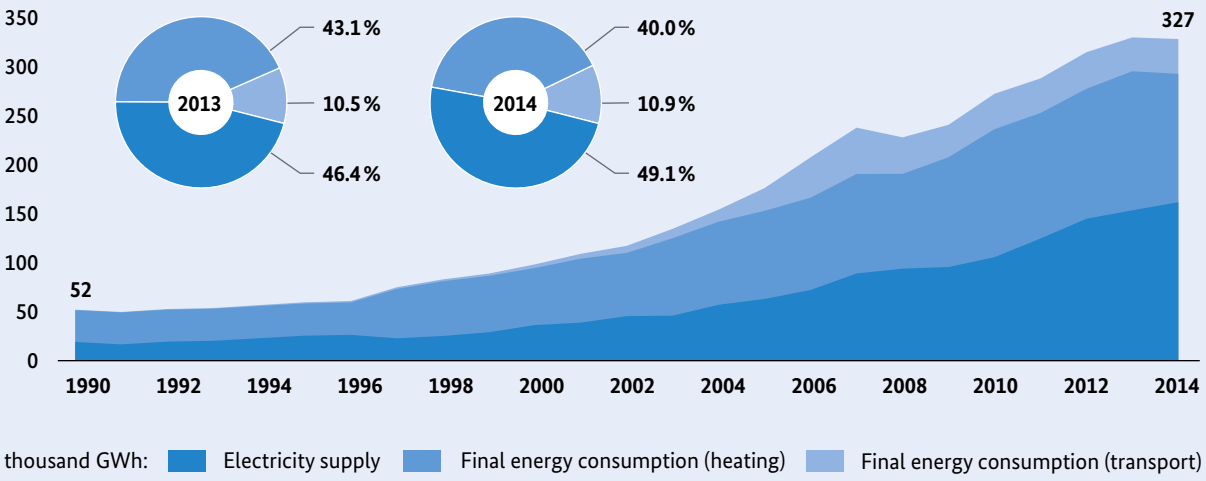
Since the beginning of the 1990s, final energy consumption from renewables has increased more than six fold. With an increase of just under five per cent in comparison to 2012, this trend continued in 2013, falling again slightly in 2014.

- **Gross electricity production:**
  Here, renewables made up the largest share of final energy consumption with over 152,000 gigawatt hours generated. This increased to 160,610 in 2014, meaning an increase of around 5.5 per cent in comparison to 2013. Since the introduction of EEG (Renewable Energy Sources Act), electricity production from renewables has more than quadrupled and is on target to meet the 2020 goal of a minimum of 35 per cent.

- **Final energy consumption in heating:**
  Renewables' contribution sank here by almost eight per cent to 130,890 gigawatt hours. This had increased by almost 10,000 gigawatt hours in 2013. Overall, the sector is on track to achieve an expansion target of 14 per cent, as set out in EEWärmeG (Renewable Energies Heat Act) for 2020. Alongside energy consumed in heating, this goal also includes energy used in cooling systems. These systems' share of renewable energies is still low, however.

- **Final energy consumption in transport:**
  In 2014, renewables made a somewhat larger contribution in this regard, supplying around 35,500 gigawatt hours. One year earlier in 2013, this had stood at around 34,500 gigawatt hours. The proportion of renewable energies in the transport sector saw the first marked increase since 2000. In 2012, this stood at 6.9 per cent.[14] Renewables are not only found in the form of biofuels in the transport sector; it also provides the sector with electricity. In rail transport (excluding green services), Deutsche Bahn AG drew 26.1 per cent of its energy mix from renewables.[15] E-Mobility based on renewable energy offers enormous potential to reduce transport emissions.

Figure 41: **Final energy supply from renewable sources**



Source: Working Group on Renewable Energy's Statistics (AGEE-Stat) (February 2015)

Structure of final energy provision from renewable energies

Final energy provision *(Figure 42):*

As in previous years, biomass made renewables' greatest contribution to final energy provision in 2013 and 2014. In comparison to 2012, the share of biomass sank by 1.3 per cent, while photovoltaics was able to expand its share. With almost ten per cent in 2013, it made the third largest contribution, climbing further to 11.1 per cent in 2014. Germany-wide, there were almost 1.5 million photovoltaics systems connected to the grid by the end of 2014. Internationally, there is currently an oversupply of production capacity, forcing manufacturers to cut prices even further. One of the main challenges is to realise cost-saving potentials and to improve efficiency. Only in this way can photovoltaics continue to move forward and survive on the international market.

With almost 16 per cent in 2013 and almost 18 per cent in 2014, wind energy was the second largest provider of renewable energies. In the future, wind energy can play a fundamental role in final energy provision. For this reason, land sites are being further expanded, old and smaller installations are being replaced, and offshore expansion is being expedited.

Hydropower makes up Germany's fourth largest renewable energy in terms of final energy consumption. Future potential is most of all to be found in the modernisation and reactivation of existing facilities, including new constructions on existing transverse structures: in this case, the major challenge will be to take environmental concerns into account.

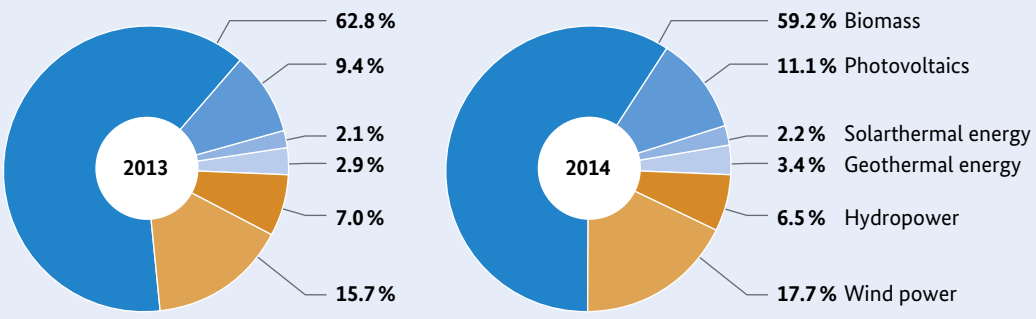
Geothermal energy's contribution is small, but is growing slightly.

Amongst the renewable energies, solar thermal energy made the smallest contribution, of around two per cent in both 2013 and 2014. In Germany's case, most solar energy was derived from low-temperature solarthermics.

Gross electricity generation *(Figure 44):*

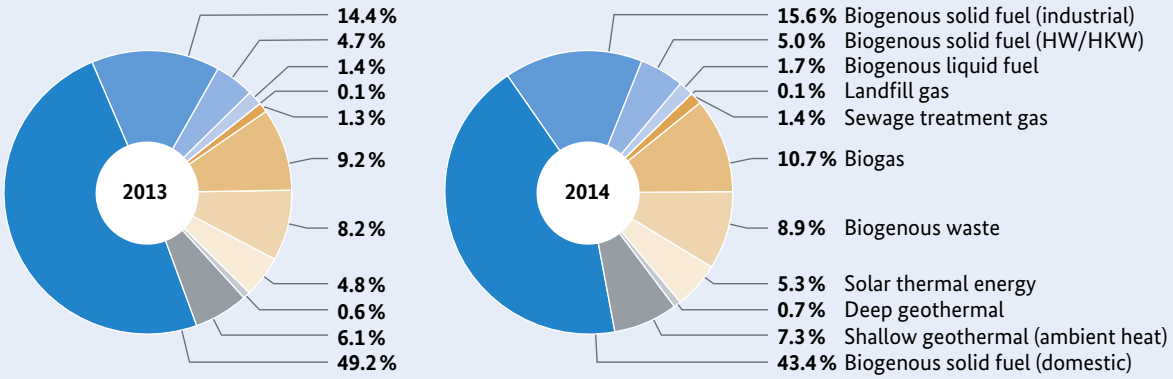
As in previous years, 2013 and 2014 saw wind turbines play the principal role in electricity generated from renewable sources. At 51,708 gigawatts, wind energy contributed a share of almost 34 per cent, rising to 35 per cent (55,970 gigawatts) in 2014. At 0.6 per cent (2013) and 0.8 per cent (2014), wind turbines at sea made only minimal contributions to this success. The second largest share of gloss electricity produced from renewables was supplied by photovoltaics. As a result of continual expansion, it grew by nearly 5,000 gigawatt hours in 2013 and by a further 4,000 in 2014. In total, around 152,367 gigawatt hours came from renewable sources in 2013. Initial calculations suggest that this had reached 160,610 gigawatts by 2014. The total gross electricity generation (from all energy sources) was 633,200 gigawatt hours in 2013. Around a quarter of this came from renewables, which were thus Germany's second most important energy source after lignite. In 2014, renewables overtook lignite and, at 26.2 per cent, were Germany's most important energy source.[16]

Figure 42: **Structure of final energy provision from renewable energies**



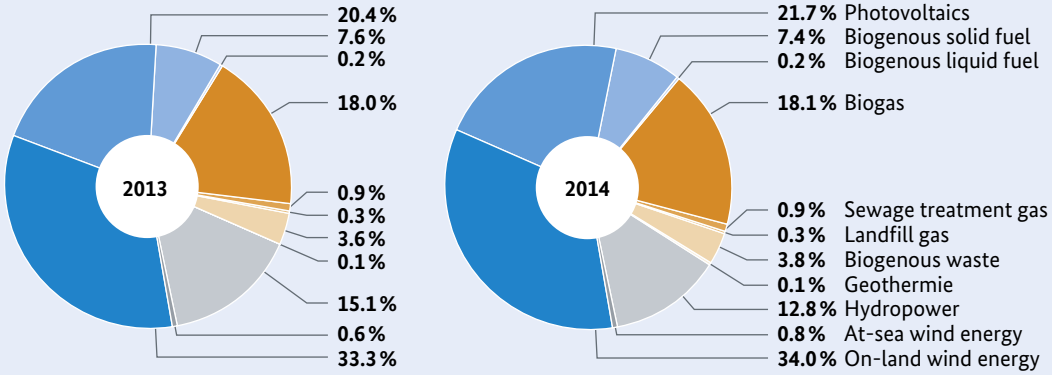
Source: Working Group on Renewable Energies' Statistics (AGEE-Stat) (February 2015)

Figure 43: **Structure of heat supply from renewables 2013 and 2014**



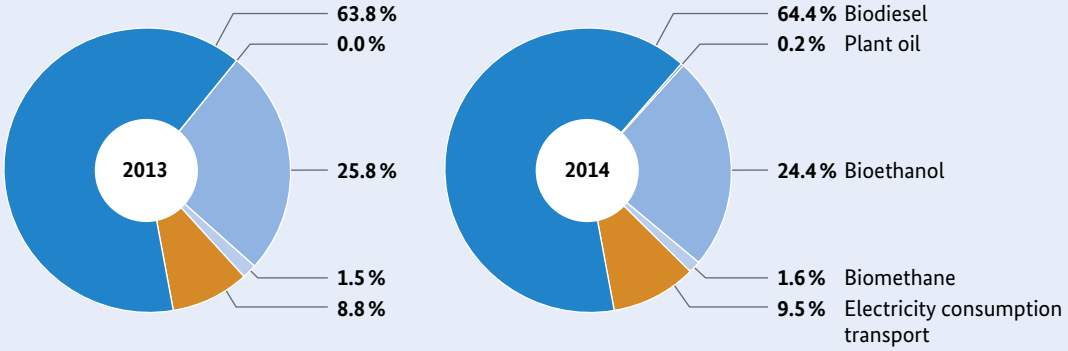
Source: Working Group on Renewable Energies' Statistics (AGEE-Stat) (February 2015)

Figure 44: **Structure of electricity supply from renewables 2013 and 2014**



Source: Working Group on Renewable Energies' Statistics (AGEE-Stat) (February 2015)

Figure 45: **Structure of transport fuel supply from renewables 2013 and 2014**



Source: Working Group on Renewable Energies' Statistics (AGEE-Stat) (February 2015)

Final energy consumption in heating *(Figure 43):*

In 2014, final energy consumption in heating sank to 130,890 gigawatt hours. One year prior (2013) the figure had been around 11,000 gigawatt hours higher. At almost 70 per cent, solid biofuels supplied a majority of heating from renewable sources. In 2014, the use of solid biofuels in private households fell markedly. In contrast, the proportion of solid biofuels used in industry, biogenous waste and near-surface geothermal energy saw an increase.

Final energy consumption in transport *(Figure 45):*

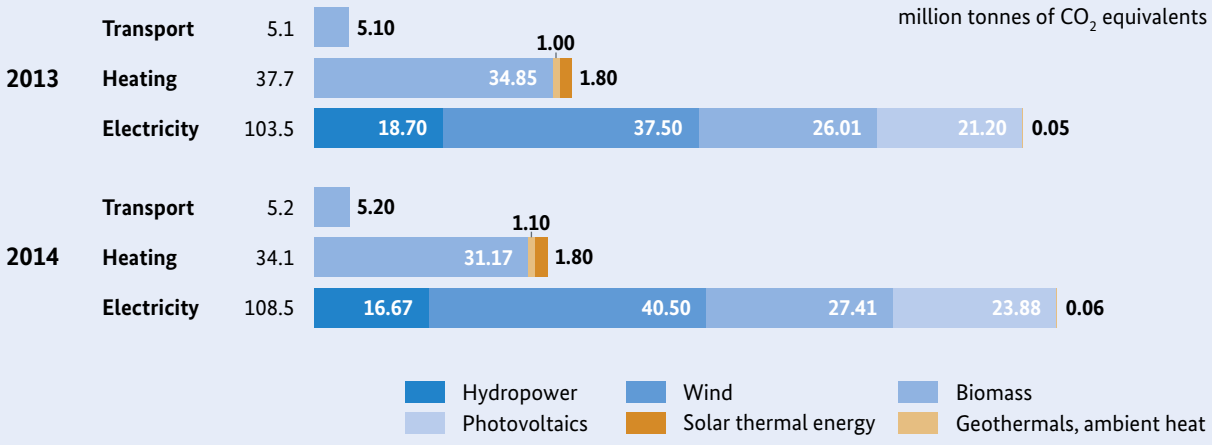
In 2014, renewable energies covered 35,440 gigawatt hours of final energy in transport. One year earlier (2013), this contribution had been 34,466 gigawatt hours. Biodiesel made the largest contribution at around 64 per cent. Despite this, biodiesel continued the declining trend it began in 2007. However, consumption in 2014 grew again slightly. The same is true for plant oil: the use of bioethanol – which is principally used in the production of E10 fuel – was largely constant in 2013 and 2014 (in comparison to 2012). In contrast, electricity consumption in the transport sector made small increases in both years.

Greenhouse gases avoided by use of renewable energies

The use of renewable energies meant that in 2013, around 146.1 million tonnes of CO_2 equivalents were avoided. In 2014, this figure increased by around one per cent to 147.9 million tonnes.

The prevention effect is calculated by deducting all emissions caused during the production of renewables from the emissions that are prevented via the non-use of fossil fuels. The amount of emissions avoided in the electricity and heating sectors is thus significantly dependent on which fossil fuels are replaced with renewables. With biofuels, it is the type and origin of the raw materials used which plays the decisive role.

Figure 46: **Emissions avoided through use of renewables 2013 und 2014**



Source: Working Group on Renewable Energies' Statistics (AGEE-Stat) (February 2015)

Reductions

In comparison with total emissions in 2013, 2014 saw almost 16 per cent of greenhouse gas emissions avoided:

Electricity

As in previous years, this sector enjoyed the majority of greenhouse gas reductions in 2013 and 2014. With a figure of 108.5 million tonnes of CO_2 equivalents, this grew by around five million tonnes from 2013 to 2014.

Heating

37.7 million tonnes of greenhouse gases were avoided in 2013. In 2014, this was closer to 34.1 million tonnes.

Transport

Reductions here amounted to around 5.1 million tonnes of CO_2 equivalents in 2013, and 5.2 million tonnes in 2014.

Individual contributions

The various forms of renewable energy contributed to the reduction of greenhouse gases as follows:

Biomass

As in the past, 2013 and 2014 biomass had the largest share of emissions avoided. In 2013, 66 million tonnes of CO_2 equivalents represented a figure of 45 per cent; in 2014, this was 43 per cent.

Wind energy

With 37.5 (2013) and 40.5 (2014) million tonnes of CO_2 equivalents, wind energy made the second most significant contribution. The contribution to emissions avoided through the use of renewables was around 26 per cent in 2013 and 27 per cent in 2014.

Photovoltaics

Here, around 21.2 million tonnes of CO_2 equivalents were avoided in 2013, increasing to 23.9 million tonnes in 2014. These figures represented a 15 per cent contribution to emissions avoided in 2013, and 16 per cent in 2014.

Hydropower

In 2013, 18.7 million tonnes of CO_2 equivalents were avoided via the use of hydropower – however, this sank to 16.7 million tonnes in 2014, representing a downward percentile shift of 13 to around eleven per cent.

Solarthermal energy and geothermal energy

Together, these led to the avoidance of around three million tonnes of greenhouse gases in 2013 and 2014. At around two per cent, only succeeded in making a small contribution to avoidance of emissions.

Energy efficiency

Primary energy consumption

Primary energy consumption is the total energy content of all energy sources which are put to use. Losses incurred during the conversion of source to energy are also taken into account. Previous successes in reducing primary energy consumption were achieved due to increased use of renewable energy, increased energy efficiency and the effects of structural change.

In 2013, total primary energy consumption amounted to 13,828 petajoules (pj). In comparison to 2012, this was a rise of almost three per cent. This was mainly due to the cold weather in Germany in the first half of 2013. Adjusted for temperature, energy consumption grew by a significantly smaller rate, as the weak economy at the time caused hardly any increase in consumption.

The German Federal Government's Energy Concept includes the goal of reducing primary energy consumption by 20 per cent by 2020 compared to 2008 levels. By 2013, it had been reduced by only 3.8 per cent. If the 2020 target is to be achieved, or, to be more exact, if energy needs are to be reduced to 11,500 petajoules, it will be necessary to reduce primary energy consumption by around two per cent a year from 2013 onwards.

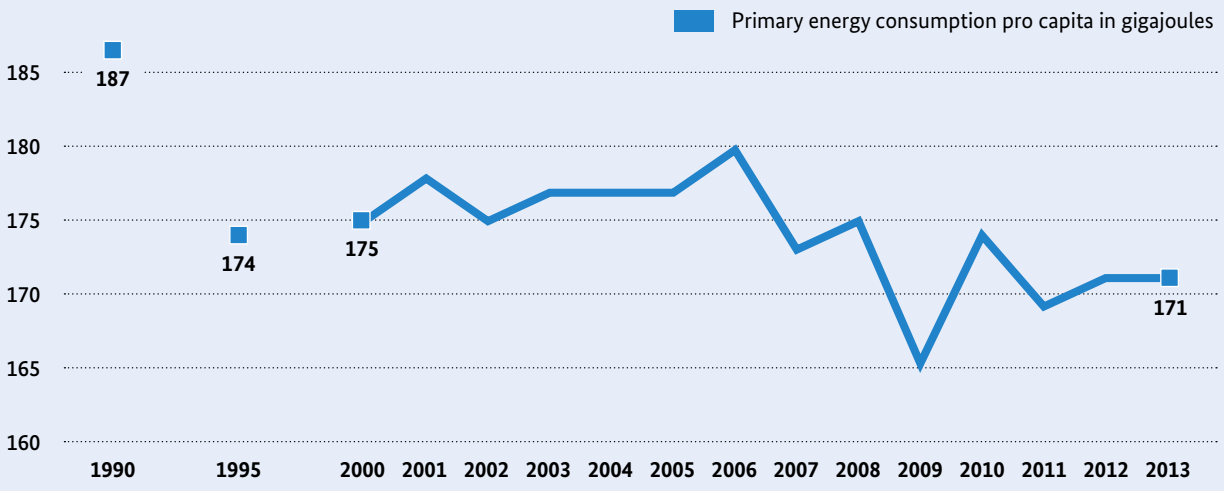
A key tool in achieving this goal will be improvements to energy efficiency made possible through more energy efficient technologies. However, progress such as this does not always lead to the desired goal. This may be due, amongst other things, to rebound effects.

- **Direct rebound effects:**
  These come about as a result of changed user behaviour. One example would be a new domestic appliance which, being more efficient that the previous model, is used more often.

- **Indirect rebound effects:**
  These arise when demand patterns change as a result of savings. For example, money saved due to efficient devices' reduced energy costs is used to purchase a second device, which subsequently cancels out the energy savings.

Rebound effects are sometimes difficult to differentiate from the effects of growth and structural change. As a consequence, they are also very difficult to quantify. Alongside rebound effects, there are a variety of significant barriers, (organisational, financial, technological, information-related, etc.), which can, to a greater or lesser degree, hinder progress in energy efficiency. Further progress in energy efficiency is key to reaching climate and energy policy objectives, and may possibly enable savings of 30 to 40 per cent of current energy needs in the long term.

Figure 47: **Trends in primary energy consumption**



Sources: Federal Ministry for Economic Affairs and Energy, Zahlen und Fakten Energiedaten, Tabelle 5 (August 2014); Federal Statistical Office, Population census

Energy productivity

Energy productivity is a common indicator in the measurement of energy efficiency. It tracks economic performance per unit of energy used and can be calculated as follows[17]:

- **Method 1**
  via the relationship between GDP and primary energy consumption
- **Method 2**
  via the relationship between GDP and final energy consumption

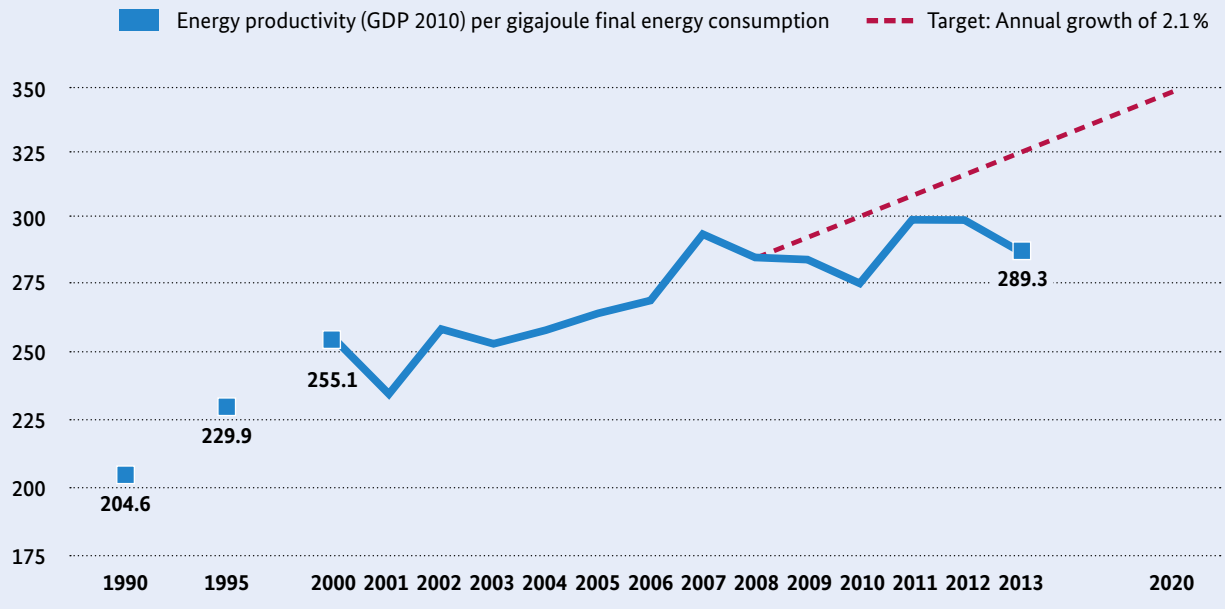
Figure 48 uses the second method, as does the German Federal Government's energy concept. Representing productivity by way of final energy consumption prevents inclusion of alterations to power plant fleets in the calculation, thus preventing these alterations from influencing the overall picture. Another advantage is that the focus is placed on the origin of demand for power, meaning that consumption can be reduced, especially by way of increased efficiency.

Strong fluctuations

In comparison to 2008, energy productivity in 2010 decreased by 3.4 per cent. However, when 2012 is compared with 2008, we observe an increase of five per cent. Such fluctuations have many different causes. These include economic influences, prices, structural changes, behavioural factors, climate factors, changes in industrial production methods or, in terms of energy-intensive industries, production volumes. These explanations could also account for the slight decline observed between 2011 and 2012. In 2013, energy productivity declined by almost four per cent in comparison to 2012, despite strong savings in electricity. Even after adjustment for temperature and inventory levels, energy productivity fell by nearly two per cent in comparison to the previous year.

The strong influence of weather on productivity once again highlights how much energy is used for heating, thereby underlining the key role that energy-focused renovations can play, as these can drastically reduce energy consumption. Fundamentally, this means that an increase in energy productivity does not necessarily lead to an increase in energy efficiency. A variety of different factors can influence both energy productivity and energy efficiency. Thus, for example, the production of products that aim towards increased sales revenue can increase energy productivity alone, despite energy demand itself remaining the same.

Figure 48: **Trends in energy productivity**



Source: Federal Ministry for Economic Affairs and Energy, Zahlen und Fakten Energiedaten, Tabelle 8 (September 2014)

Energy demand trends: industry and business/trade/services

In 2013, the business, trade and services sector and the industry sector saw little change in energy demands per gross value added.

Further efficiency improvements

The aim is to make energy use more efficient in the industrial sector and in the business, trade and services sector. Cross-cutting technologies, such as thermal processing, technical production of cooling and thermal separation processes, are particularly promising.[18] In 2013, the German Federal Government made government funds of a total of 36.23 million euros available.[19] This sum was used to support 254 projects to improve energy efficiency in industry and in business, trade and services. Furthermore, the German Federal Government wants to overcome barriers and ensure that untapped supporting factors are put to use. Information provision and training measures should also be put in place to increase acceptance.

Energy demand trends: transport

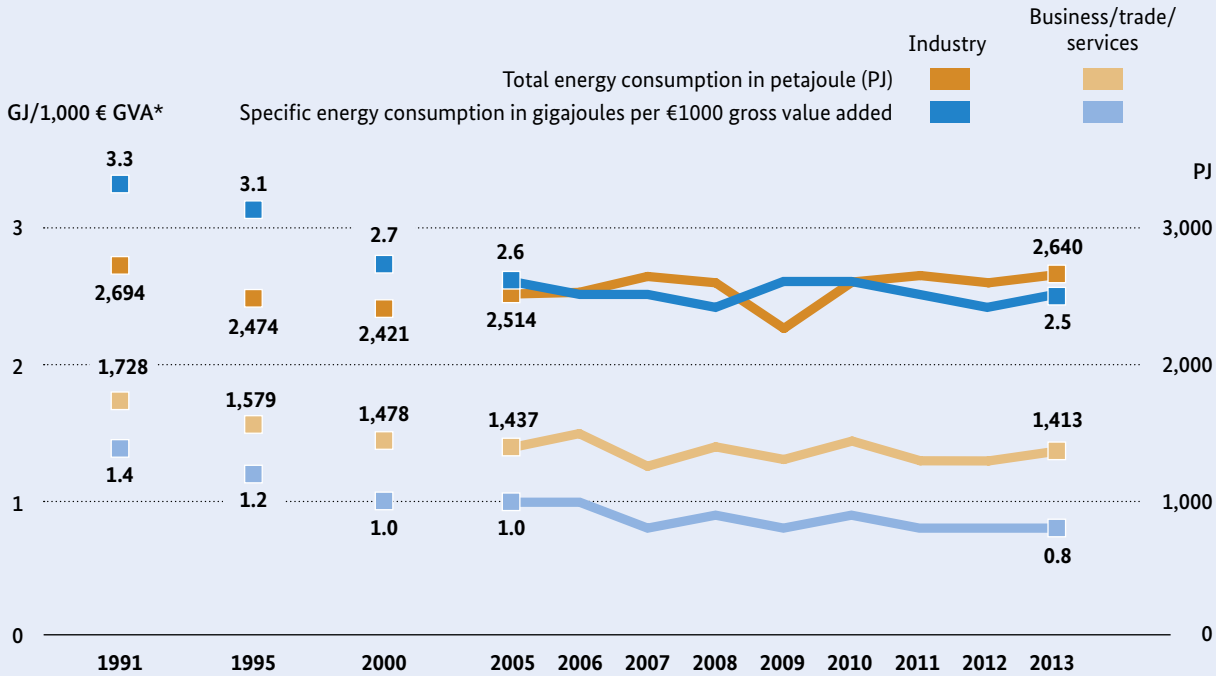
In 2013, energy consumption per passenger kilometre in passenger and goods transport grew once again, this time by almost two per cent in comparison to 2012. Overall, this figure has declined by around 46 per cent since 1990. A somewhat different picture emerges with traffic-related final energy consumption: this has grown by almost ten per cent since 1990.

Almost all measures which limit CO_2 output also reduce final energy consumption. Amongst the various modes of transport, CO_2 emissions vary substantially. When the various modes of local travel in Germany are considered (namely road, rail and air), cars are found to cause the most emissions per passenger kilometre, at around 139 grams of CO_2 equivalents. These are differentiated as follows:

1. Direct emissions: Caused directly by the burning of fuel.

2. Indirect emissions: Caused indirectly by evaporation and upstream production processes.

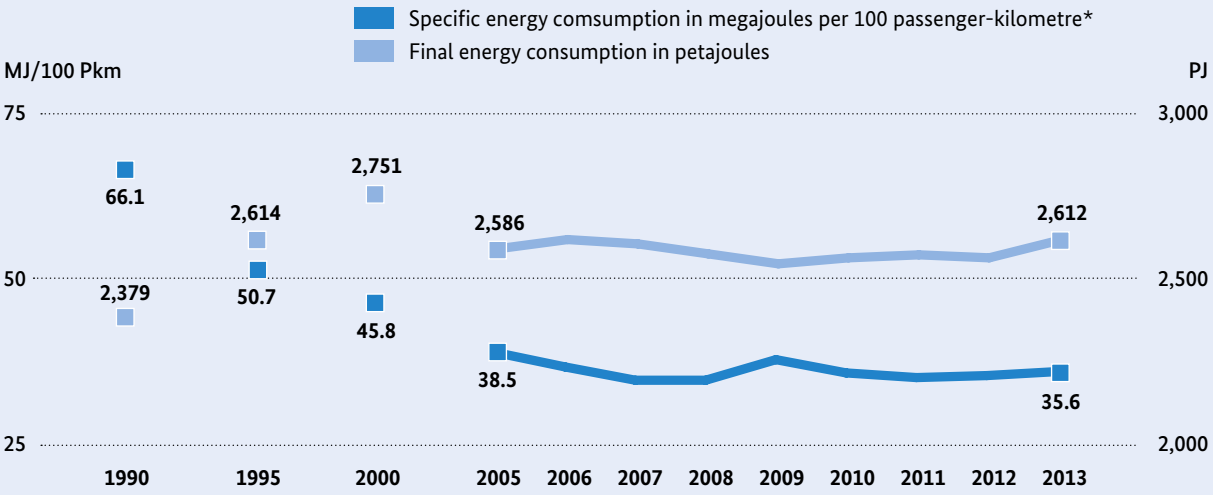
Figure 49: **Energy use and energy consumption by industry and business/trade/services**



Sources: Federal Ministry for Economic Affairs and Energy, Zahlen und Fakten Energiedaten, Tabelle 5 (October 2014); Working Group on Energy Balances, Ausgewählte Effizienzindikatoren zur Energiebilanz Deutschland 1990-2013 (September 2014)

* gross value added

Figure 50: **Energy efficiency in passenger and goods transport**



Sources: Federal Ministry for Economic Affairs and Energy, Zahlen und Fakten Energiedaten, Tabelle 5 (October 2014); Working Group on Energy Balances, Ausgewählte Effizienzindikatoren zur Energiebilanz Deutschland 1990-2013 (September 2014)
*One tonne-kilometre equals ten passenger kilometres

Breakdown of findings

In short-distance transport, rail travel causes almost 50 per cent less greenhouse gas per passenger kilometre than passenger cars. At 74 grams per person kilometre, buses, trams, suburban and underground rail services together cause just two grams of CO_2 equivalents more than regional rail transport.

In terms of long-distance transport, the differences are somewhat more apparent. Air traffic caused 196 grams of CO_2 equivalents per passenger kilometre; rail, in contrast, around 43 grams and coaches only 30 grams per passenger kilometre.

The modal split – i.e. the distribution of passenger numbers around the various modes of transport – has a decisive influence on the energy efficiency of transport. In 2012, personal motor transport accounted for 82.4 per cent of passenger numbers. Rail, public road transport and air travel together accounted for only 13.9 per cent, with freight, road transport accounting for the largest share of 83 per cent (excluding air transport). Rail came in second place at 9.2 per cent, with domestic shipping at 5.6 per cent.[20]

If final energy consumption and CO_2 emissions are to be reduced, it makes sense to shift transport to the most efficient kind of energy. Further potential for reductions can be found in more efficient drive technologies and optimised processing of shipments. Integrated land-use and transport planning (the Stadt der kurzen Wege or city of short paths) can also contribute to avoiding or shortening routes.

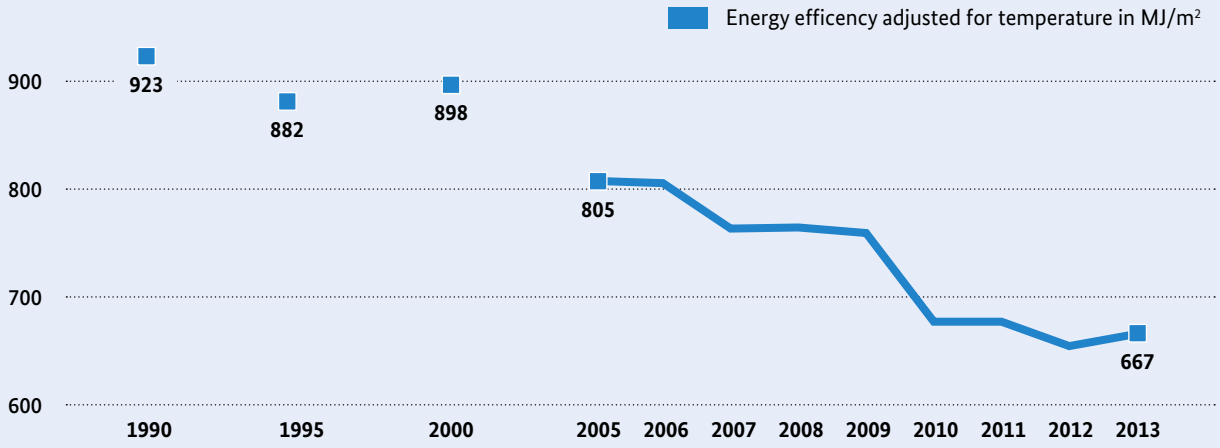
Energy demand trends: households

Energy intensity per square metre of living space decreased by around 1.7 per cent in 2013 in comparison to 2012. Fuel efficiency in private households also declined. However, there was a general increase seen in electricity efficiency. Since 1990, energy efficiency in the private household sector has, on the whole, grown by 28 per cent. The future may see considerable growth in this regard. Reductions in demand for electricity are mainly due to the use of more energy-efficient household appliances.

Key factor: space heating

Around two thirds of final energy consumption in private households can be attributed to heating, and one sixth to water heating. In recent years, living space per person has increased. This in turn counteracts the reductions in energy consumption achieved in terms of heating per square metre. In the future, energy efficiency improvements in plant technology will contribute to reduced heating requirements, as will the reduction of energy losses through building envelopes.

Figure 51: **Energy efficiency in households**



Source: Working Group on Energy Balances, Ausgewählte Effizienzindikatoren zur Energiebilanz Deutschland 1990-2013 (September 2014)

ECODESIGN AND ENERGY CONSUMPTION LABELLING REGULATIONS

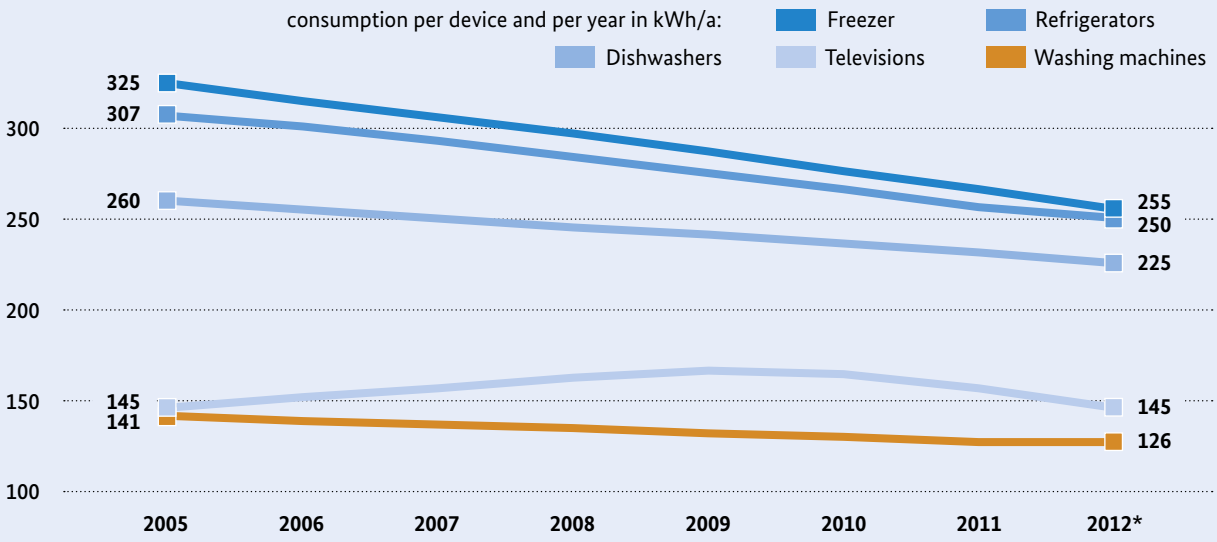
The Energy-Using Products Act (Energiebetriebene-Produkte-Gesetz) implements the EC Ecodesign Directive into German law. It provides that products associated with significant energy consumption are designed according to environmental regulations. The top runner approach applies, setting minimum efficiency standards and thus promoting market penetration for higher-efficiency products. It also stimulates innovation. The European Commission is also ensuring – in cooperation with the EU Member States – that requirements for individual products are standardised. Product groups are only subject to the Ecodesign Directive when their use has an influence on energy consumption and they have a minimum annual market volume of 200,000 units in the respective EU Member State.

According to the EU Energy Consumption Labelling regulations, implementation measures include an obligation to label specific product groups according to their power and resource consumption during use. This label allows consumers to compare products more easily and thus decide which products to purchase.

Since September 2014, vacuum cleaners have been subject to the EC Ecodesign Directive and may have a maximum rated power of no more than 1,600 watts. This minimum requirement will extend to a maximum 900 watts on the 1 September 2017.

Other product groups affected by both directives include televisions, dishwashers, washing machines and refrigerators. Up until now only computers and external power plugs were subject to the Ecodesign Directive but there are plans to extend the guidelines to encompass other product groups. Vacuum cleaners must be labelled with the European energy label, in accordance with energy consumption labelling regulations.

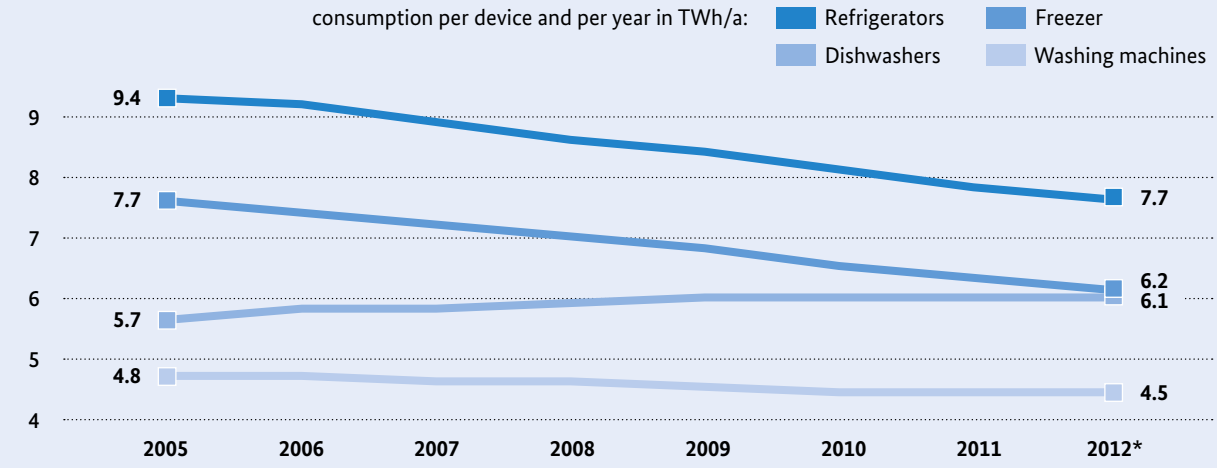
Figure 52: **Large electrical appliances: specific energy consumption**



Source: Prognos, Fraunhofer ISI and TU-München IfE (2014), Datenbasis zur Bewertung von Energieeffizienzmaßnahmen in der Zeitreihe, Zwischenbericht November 2014; Forschungsvorhaben im Auftrag des Umweltbundesamtes (FKZ 3712 12 102), Berlin, Karlsruhe, Munich

*data partially extrapolated

Figure 53: **Large electrical appliances: total energy consumption**



Source: Prognos, Fraunhofer ISI and TU-München IfE (2014), Datenbasis zur Bewertung von Energieeffizienzmaßnahmen in der Zeitreihe, Zwischenbericht November 2014; Forschungsvorhaben im Auftrag des Umweltbundesamtes (FKZ 3712 12 102), Berlin, Karlsruhe, Munich

*data partially extrapolated

5. Economic effects

Research and funding

Research funding

The German Federal Government supports energy research and development in businesses, higher education institutions and research facilities.

In comparison to 2006, the resources available via Research for an Environmentally Friendly, Reliable and Affordable Energy Supply – the German Federal Government's 6th Energy Research Programme – have multiplied by almost 2.5. In 2013, a total of 298.1 million euros was invested in research into renewable energies. A further 296.6 million flowed into research on energy efficiency. In the renewable energies sector, most funding went into photovoltaics, followed by wind energy, bioenergy and deep geothermal energy. In addition, the German Federal Government is supporting research into climate sciences and sustainability.

Investment incentives

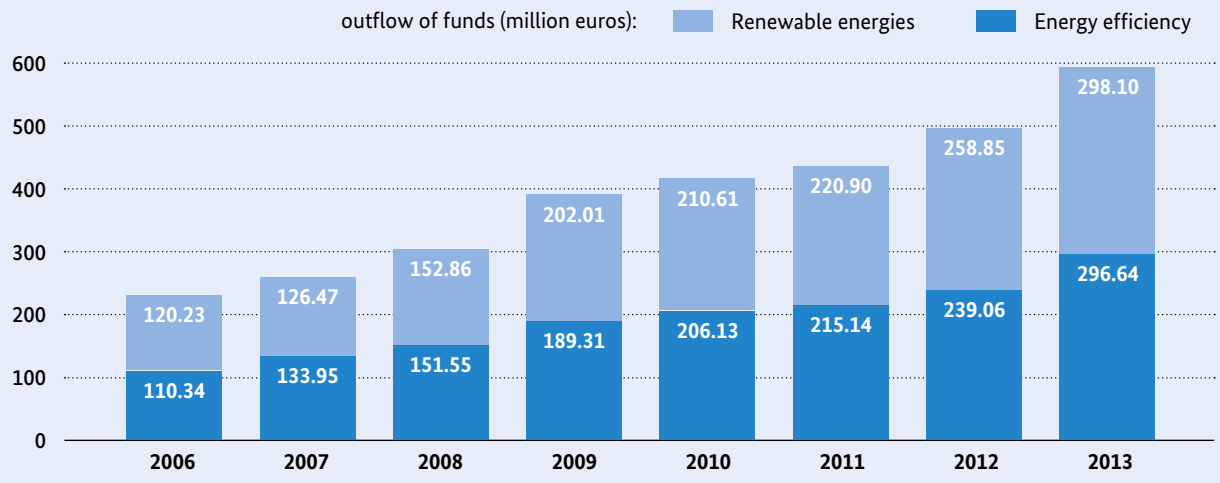
So that energy and climate targets can be achieved, Germany is also promoting the use of renewable energies and energy efficiency measures.

In 2013, grants totalling 321 million euros were distributed via the Market Investment Programme (MAP) for renewable energies in the heating market. These triggered investments of 1.23 billion euros in the same year, meaning that the subsidy programme sparked investments more than four times greater than the subsidy amount. With the CO_2 Building Improvement Programme, Germany is promoting measures to ensure that legal minimum standards are exceeded, in order to support the introduction of new technologies to the market. In 2012, around 1.5 billion euros of climate and energy funds were made available.

Further funding

The German Government is also promoting energy efficiency and climate action measures via numerous programmes and projects. These include subsidies for technical energy planning and the supervision of private building renovation measures. The National Climate Initiative also runs various projects and programmes for businesses, municipalities, consumers, educational institutions and energy consultancies. KfW, the federal-owned development bank, also offers low-interest loans for efficiency measures in the building sector.

Figure 54: **Resources for energy research programmes**



Source: Federal Ministry for Economic Affairs and Energy, Bundesbericht Energieforschung 2014

Investments

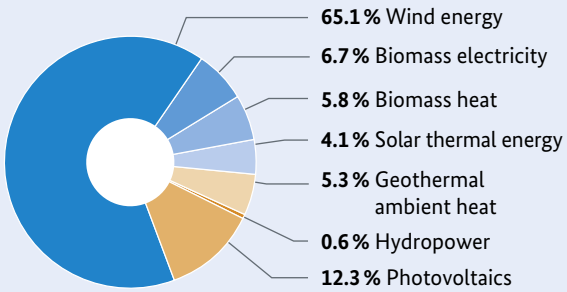
Growing investments in 2014: Renewable energies are a major factor in the German economy. In 2014, around 18.8 billion euros were invested in building facilities for the use of renewable energies. In comparison to 2013, this meant an increase in investments of almost 20 per cent, around two thirds of which were put into wind energy. Around 12.3 per cent went to photovoltaics, a further 12.5 per cent went to biomass and about 4.1 per cent to solar thermal energy. Geothermal energy saw 5.3 per cent of investments, hydropower just 0.6 per cent. Increased investments in 2014 reversed a decline that had persisted since 2010. In 2013, this was mainly due to a collapse in investments in photovoltaics, which in 2012 had made up almost half of all nominal investments in renewable energies. The slump can mainly be attributed to two factors: firstly, the prices of photovoltaics systems fell. Thus the same capacity could be installed using substantially less money. Secondly, remuneration rates for photovoltaics decreased, halving new installations.

Declines and shifts in worldwide investments in renewables: In 2013, worldwide investments sank once again. Whilst the international community invested 244 billion US dollars in 2012, this sank to 214 billion US dollars in 2013. The principal causes of this are uncertain funding requisites and declines in the price of technology.

2013 saw a 44 per cent reduction in European investments in renewables in comparison to 2012. For the first time, China invested more than all European states put together. Developments in Japan were also significant: here there was an 80 per cent increase in investments in renewables from 2012 to 2013. The main reason for this was a boom in the solar sector.

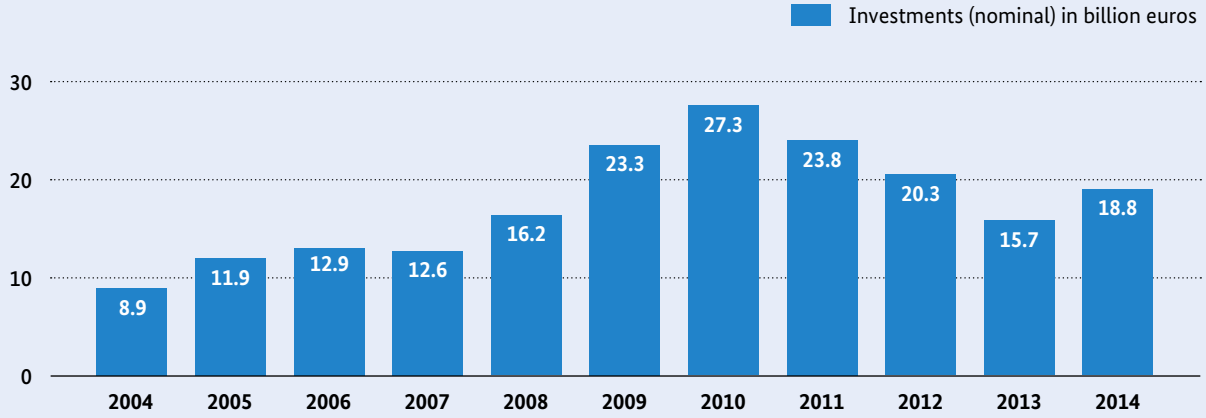
Investments in energy efficiency measures: According to the German Institute for Economic Research, around 39 billion euros were invested in energy efficiency renovations for existing residential buildings in 2013. A further 15 billion was put into

Figure 56: **Distribution of Investments 2014**



Source: Working Group on Renewable Energies' Statistics (AGEE-Stat) (February 2015)

Figure 55: **Investment trends in renewable energy**



Source: Federal Ministry for Economic Affairs and Energy, Entwicklung der erneuerbaren Energien in Deutschland im Jahr 2014. (February 2015)

non-residential buildings. Government-run efficiency measures introduced in 2010 also played a role, triggering additional investments of four billion euros in 2012 and five billion in 2013.[21]

Investments by the manufacturing sector

2012 saw businesses in this sector increase their investments in fixed assets for environmental protection.[22] In comparison to 2011, funds rose by 1.7 per cent to 7.36 billion euros: almost ten per cent of total investments made by this sector were put into environmental protection. As part of this, firms invested almost 2.5 billion euros in climate action. The main part of this sum – around 43 per cent – went into measures towards the use of renewables. Almost 38 per cent went into increasing energy efficiency and energy savings. Climate action investments aimed at improving efficiency and saving energy thus grew substantially in comparison to 2011, from 646.5 million to 930.8 million.

Figure 57: **Investments by the manufacturing sector**

	2008	2009	2010	2011	2012
Total business investment (billions of euros)	76.13	63.73	65.07	73.47	74.36
Capital expenditure on environmental protection (billions of euros) ...	5.99	5.58	6.03	7.1	7.22
... of which invested in climate change mitigation (billions of euros)	**1.62**	**1.63**	**1.88**	**2.38**	**2.46**
Climate action investments as percentage of environmental protection investments (per cent)	27.1	29.2	31.2	33.6	34.1

Source: Federal Statistical Office, Fachserie 19 Reihe 3.1: Investitionen für den Umweltschutz im Produzierenden Gewerbe

Job market

In 2013, there were around 371,400 jobs in the field of renewables. In comparison to 2012, this was a reduction of 28,400 jobs, around seven per cent. This was almost exclusively due to developments in photovoltaics, which saw new installations across German reduced by half. Employment in this area thus decreased by 113,900 to 68,500 jobs. The wind power sector saw more success: across Germany, installations had almost 28 per cent higher capacity than in 2012. Employment grew here by about 13 per cent. Changes were less noticeable in the other renewable technology sectors. Around 98 per cent of jobs in renewables arose due to economic activities. Around 74 per cent of jobs were in the area of installation and use of electricity production facilities. Around 19 per cent were in heat generation, with seven per cent in biofuel production.

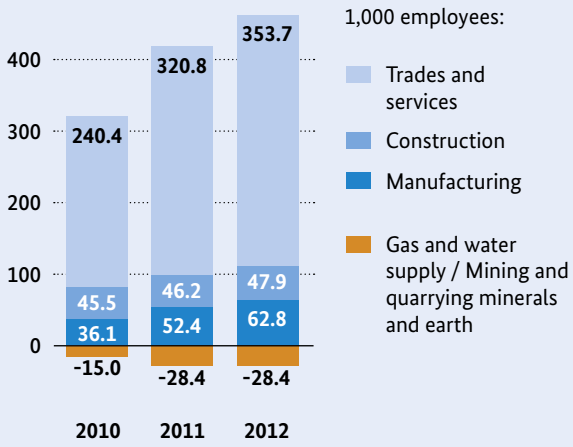
Energy efficiency impacts

Measures designed to improve energy efficiency also deliver positive impacts in terms of employment. By 2012 around 436,000 jobs had been created as a result of measures in the second National Energy Efficiency Action Plan.[23] These impacts were principally seen in the investment goods industry, installation and maintenance industries, and in the trade, services, construction and manufacturing sectors. In contrast, there have been job losses in energy and water supply, mining and mineral extraction.

Impact of structural change

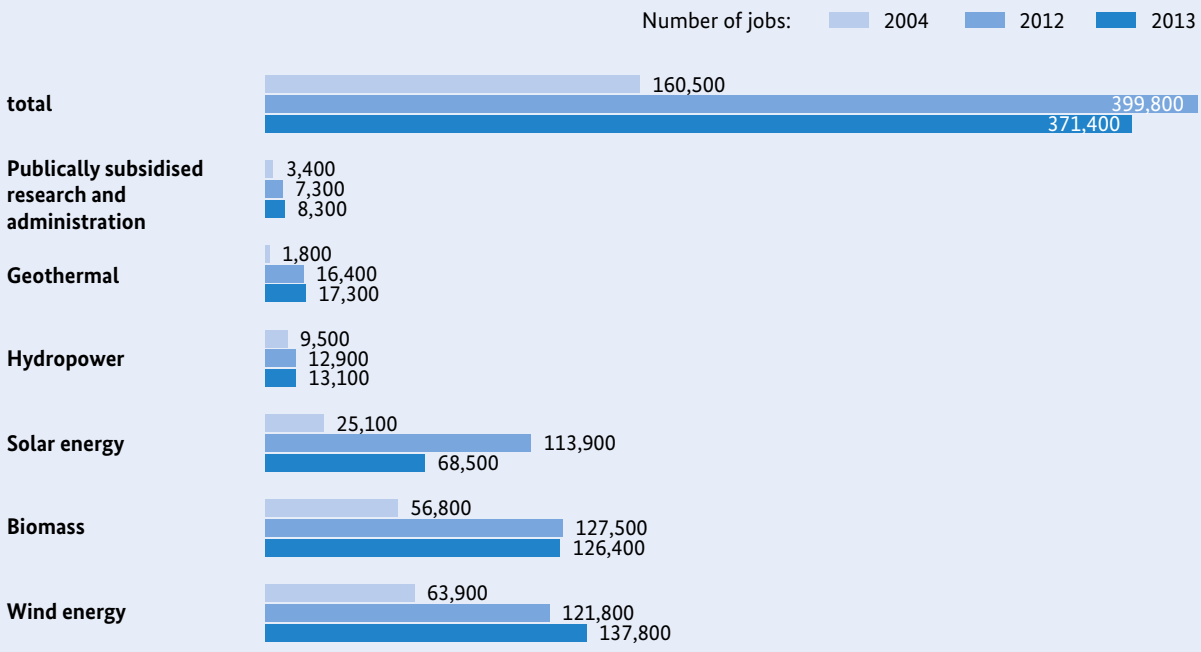
Parallel to these positive impacts on employment, the conventional energy sector is undergoing extensive structural change, observing a reduction in the number of employees from around 240,000 in 2006 to around 210,000 in 2012. In 2013, the number of employees working in conventional power plants rose by just over one per cent in comparison to 2012. The most dramatic decrease in employment in this sector took place prior to the start of Germany's transformation of its energy system. In the 1990s, the number of employees reduced by almost half. Coal and lignite mining/processing were the areas most affected. The petroleum sector was also affected, albeit to a somewhat lesser extent.

Figure 59: **Energy efficiency measures: impacts on employment**



Source: GWS, Gesamtwirtschaftliche Effekte energie- und klimapolitischer Maßnahmen der Jahre 1995 bis 2012

Figure 58: **Impact of renewable energies on the jobs market**



Source: Federal Ministry for Economic Affairs and Energy, Bruttobeschäftigung durch erneuerbare Energien in Deutschland im Jahr 2013 (May 2014)

Global market for climate products

The market for potential climate products[24] has seen steady growth in recent years. Per year, it grew an average of 13.2 per cent (calculated in US dollars) across the globe between 2002 and 2011. This represented far more dynamic growth than was observed in goods trade in general, which grew by around 10.3 per cent annually over this time period. Germany's share of the total global market was 13.2 per cent. Only China and Hong Kong had a greater share, together accounting for 19.1 per cent. A major reason for China's leading position is its renewable energy act, which aims to increase the share of renewables to 15 per cent by 2020. As the world's largest consumer of power, China is responding to its steady increase in consumption, which tripled just between 2001 and 2010.

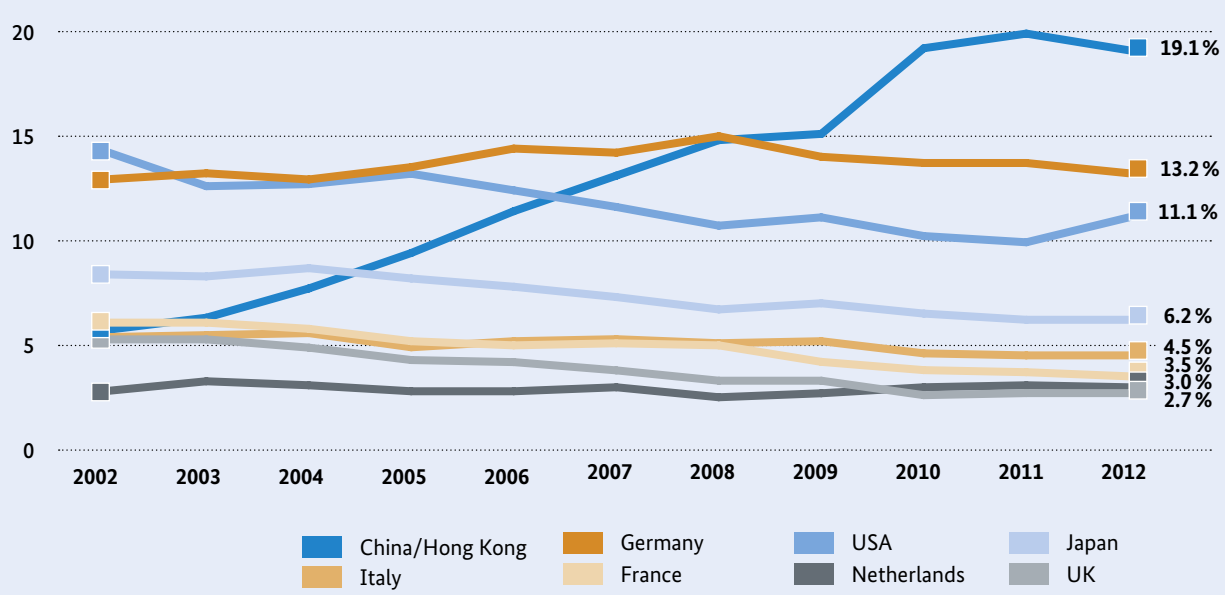
The situation in Germany

Germany's successful worldwide export sector stands across from massive import growth. In 2011, almost half of renewables' import value was accounted for by solar cells, around a third by other solar energy products and 15 per cent by wind power turbines and their components.

Further developments

The world market for renewable energies and energy efficiency will continue to grow in the future, according to prognoses made by the consulting firm Roland Berger. These foresee an average annual growth of 9.1 per cent for environmentally friendly energy and energy storage in the years up until 2025, and 3.9 per cent in energy efficient goods. Throughout Germany, the market for environmentally friendly energy and energy storage will see an annual average growth of around 8.4 per cent in the years leading up to 2025, alongside growth of 4.5 per cent in the energy efficiency sector.[25]

Figure 60: **Global trade share - providers of potential climate products**



Source: Gehrke, Schasse, Ostertag (2014), "Wirtschaftsfaktor Umweltschutz, Produktion -Außenhandel - Forschung - Patente: Die Leistungen der Umweltschutzwirtschaft in Deutschland", in BMUB/UBA (eds.), Reihe Umwelt, Innovation, Beschäftigung 01/2014 (Analysen bis 2011); UN-Comtrade, Berechnungen des Niedersächsisches Institut für Wirtschaftsforschung (Fortschreibung für 2012)

Decline in energy imports

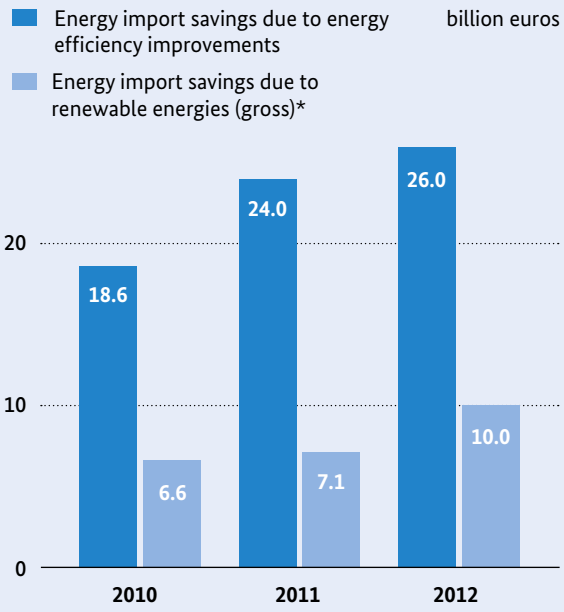
The expansion of renewable energies and increased energy efficiency are also having an impact on fossil fuel imports, meaning that in 2012, a value of 36 billion euros of fuel imports were avoided, around 26 billion of which were saved due to increases in energy efficiency. In turn, around a third of these successes can be attributed to energy efficiency measures such as the Energy Saving Ordinance and the Market Incentive Programme.

Nevertheless, Germany's fossil fuel imports are growing, driven by a shortage of raw materials. 97 billion euros' worth of energy was imported to Germany in 2012. In 2011, 89 billion euros of fossil fuels were imported.

The importance of energy imports

For the German economy – which has had a trade balance surplus for several years – imports of fossil fuels are not especially problematic, as they help to reduce trade imbalances. Energy imports are, however, more significant in terms of supply security, as they lead to a dependence on a small number of exporting countries. In addition, it can be expected that international demand for fossil fuels will grow. This, in turn, may lead to higher prices.

Figure 61: **Decrease of power imports**



Source: GWS, Gesamtwirtschaftliche Effekte energie- und klimapolitischer Maßnahmen der Jahre 1995 bis 2012; www.erneuerbare-energien.de

*This shows gross values. For net vaules, biogenous fuels imported to Germany must be deducted (Lehr: Methodenüberblick zur Abschätzung der Veränderungen von Energieimporten durch den Ausbau erneuerbarer Energien.)

6. Climate and society

Climate consciousness

The issue of climate change mitigation is gaining importance in society at large. These trends can be clearly seen in the 2014 environmental consciousness study[26], which paints the following picture: around 63 per cent of respondents were of the opinion that an adequate environmental protection and climate mitigation programme is a fundamental condition of being able to deal with future challenges. In 2012, this was an issue significant to only 40 per cent of respondents. This shows that society at large is increasingly less likely to see climate mitigation and environmental protection as an isolated problem. Instead, this issue is seen as a cross-cutting issue of overarching strategic importance. 56 per cent thus see climate action and environmental protection as a basic precondition to ensuring prosperity. Moreover, around 48 per cent consider the issue to be fundamental to maintaining a competitive position.

Impacts upon behaviour

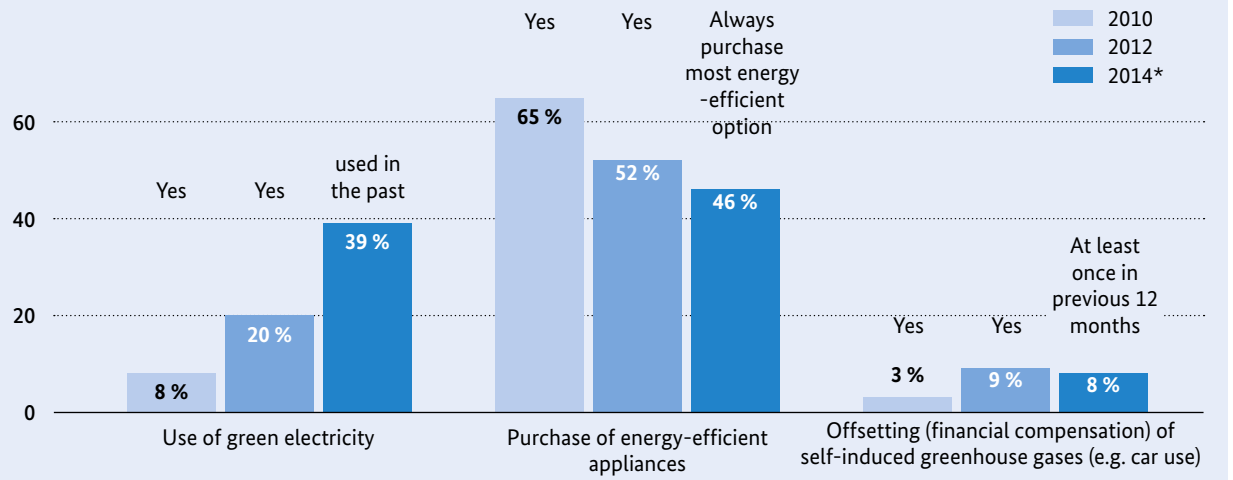
These changes in opinion are mirrored in the behaviours of respondents. In 2014, around 39 per cent said that they had used green electricity in the past. Responding to slightly different questions in 2012, only 20 per cent had said something similar. The Federal Grid Agency put the actual figure at 15 per cent across Germany in 2012. Furthermore, around 46 per cent said in 2014 that they always select the most energy efficient option when purchasing household appliances. A further 25 per cent said they frequently chose the most energy efficient option. On the question of offsetting greenhouse gases, eight per cent said they had made compensation payments within the previous twelve months. This was almost the same number as in 2012. The 2014 number increased to 18 per cent, however, when only those respondents to whom offsetting payments apply are included (57 per cent).

Respondents' expectations

More is being expected of various stakeholders: this can be seen in how the significance of environmental protection and climate action is growing in society at large, and in how this issue is increasingly being perceived as a key task. Approximately one third of respondents believe that the German Federal Government is already doing enough. Only 14 per cent think industry is showing sufficient commitment. Respondents' personal testimony also suggests that they are quite critical: just over one-third is satisfied with efforts being made by the rest of the population.

Political efforts are also being made to motivate social participation in combating climate change and to offer up more possibilities for such participation.

Figure 62: **Climate change mitigation activities in society**



Source: Federal Environment Agency, Umweltbewusstsein in Deutschland 2012; Umweltbewusstsein in Deutschland 2015

*In 2014, questioning methods changed slightly in comparison to previous years: in 2010 and 2012, respondents were asked about current habits. 2014 saw respondents also asked about actions taken in the past.

Climate action projects in municipalities

Municipalities have particularly strong potential to reduce greenhouse gas emissions. This is true especially in the cases of energy, municipal buildings, transport, water, sewage and management of municipal enterprises. Communities can become directly active and apply minimisation measures in all contexts and are supported in these efforts by the National Climate Initiative. Municipalities can also set a good example: by putting climate change mitigation into practice, they can motivate citizens to take action themselves. This is important because climate targets can only be reached when the population at large is involved. Municipalities can also make long and medium term cost savings: this helps to consolidate public finances. Climate action can also help create additional jobs.

Funding municipal climate action

As of summer 2008, the Federal Environment Ministry supports municipalities' implementation of climate projects via the Guidelines on Climate Projects in Social, Cultural and Public Institutions (municipal guidelines). By the end of 2014, around 3,000 municipalities have already taken advantage of this opportunity and realised more than 7,000 projects. The municipal guidelines have funded start-up advice (particularly for small municipalities) for local climate action, the creation of climate action concepts and the hiring of climate managers, energy-saving models at schools/child-care centres, also offering technical support to *Masterplan-Kommunen* (municipalities implementing large climate action projects). Funding is also being offered for investment measures, which can help in the renovation of indoor and hall lighting, ventilation systems and waste disposal sites, and to make improvements to mobility infrastructure in terms of sustainability.

Renewing urban energy systems

Alongside the municipal directive, the KfW's Urban Energy Renewal (Energetische Stadtsanierung) programme supports measures to improve neighbourhood energy efficiency. The same applies with respect to infrastructure. The German Federal Government hopes to strengthen municipalities in attempts to deal with renovation as a matter of urban planning, rather than a case of repairing a single building. Greenhouse gas emissions from buildings – which account for a total of 20 per cent of CO_2 emissions – should thus continue to fall. For this purpose, the first step will be to fund the creation of integrated concepts for neighbourhoods. In addition, financing will be provided for renovation management, providing supervision of neighbourhood-level implementation of renovations. Urban Energy Renewal and District Supply, a programme run by KfW, offers low-interest loans to make sustainable improvements to municipal supply systems' energy efficiency. 50 million euros have been earmarked to go to the Urban Energy Renewal programme from the Climate and Energy Fund in 2015.

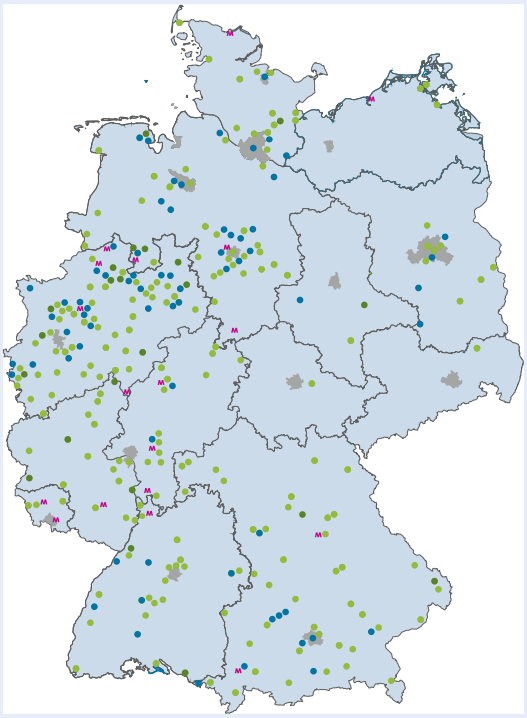
MUNICIPAL CLIMATE MANAGERS

To provide a better link up between the tasks faced by municipalities in their climate action activities, the municipal guidelines encourage the establishment of climate change management bodies. Municipalities can receive subsidies of up to 65 per cent of total material and personnel costs. Climate managers are responsible for the public presentation of what is possible in terms of municipal climate mitigation, collecting information and ensuring that climate action is anchored at the municipal level. In addition, they should motivate and mobilise local stakeholders and provide guidance in terms of collaborative efforts. They must also have knowledge of legal frameworks and technical feasibility. Today, there are already around 450 climate managers on the job.

Municipalities that have already introduced such positions can also submit a funding application to help make a selected investment measure a reality. Municipalities can receive subsidies of up to 200,000 euros, on the precondition that greenhouse gas emissions are reduced by 70 per cent. The municipal regulation programme was set up by the National Climate Initiative (NKI). Since 2008, The Federal Environment Ministry has been using this to initiate and fund numerous programmes and projects that contribute to reduction of greenhouse gas emissions. Through this the NKI is helping to embed climate action at local levels, which can profit consumers, companies, municipalities and educational institutions alike.

Figure 63: **Climate management in Germany**

- Climate Project Manager
- Follow-up project
- Energy-saving models at schools and child-care centres
- M Masterplan 100 % Climate Action



Source: Service- und Kompetenzstelle: Kommunaler Klimaschutz

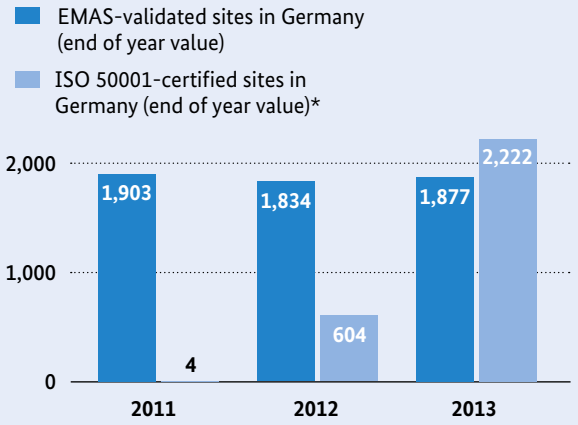
Climate action in businesses

Many companies have recognised the economic opportunities that come with climate action and have thus introduced operational environmental management. This brings numerous advantages in the long run, such as lower costs and improved competitiveness. An environment and energy management system improves energy efficiency and promotes energy-saving behaviour. There are many specialised approaches: most demanding is the Eco-Management and Audit Scheme (EMAS). The European Community introduced this voluntary environmental management system in 1993 for companies who want to improve their environmental performance. Validation is linked to performance and requires businesses to continually make improvements with respect to environmental issues, particularly energy and resource consumption, waste and emissions. Companies keep a record of the respective performance indicators and subject them to internal and external audits. In addition, they publish their environmentally-relevant activities and data via an environmental statement.

Environment and energy management systems

The structure and course of EMAS broadly resemble the international environmental standard ISO 14001 with respect to requirements as a management system. EMAS requirements go somewhat further, however: unlike ISO 14001, EMAS validation requires the publication of an environmental statement, validation via an accredited environmental verifier and publication of key indicators. In addition, and once again in contrast to ISO 14001, validation and registration in the EMAS register can only occur once legal compliance has been checked and confirmed. During the process necessary to achieving this, the enforcement authorities concerned (*Behördenschleife* or

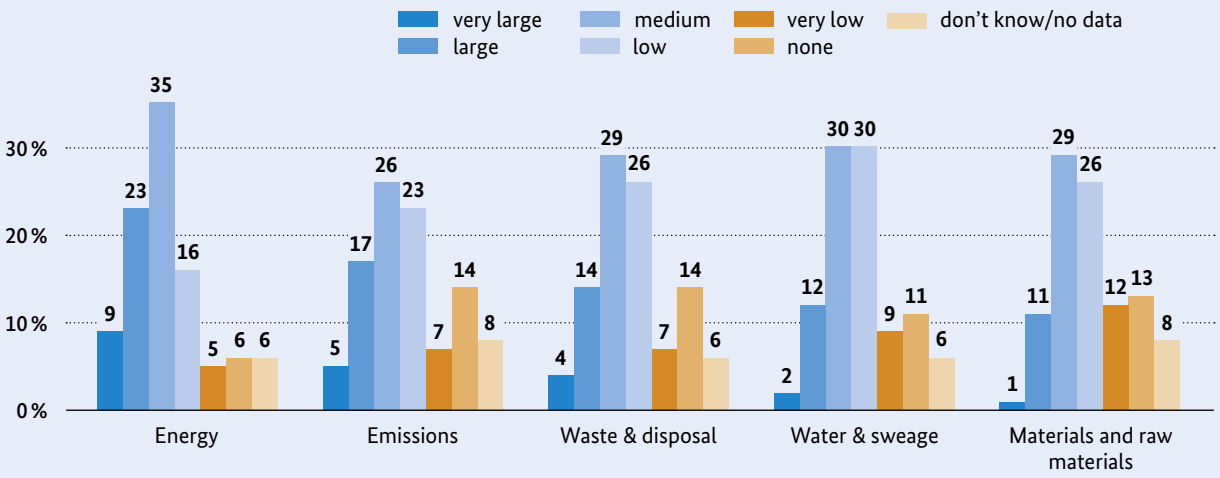
Figure 64: **EMAS and ISO certifications in Germany**



Sources: Federal Environment Agency and German Chambers of Commerce and Industry

*Since no registration is available for ISO 50001, the number of businesses with a certificate is difficult to estimate. The EMAS register offers a constantly updated overview of the actual number of EMAS-certified companies.

Figure 65: **Cost savings via EMAS – Survey of EMAS-verified organisations in Germany***



Sources: Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and Federal Environment Agency, EMAS in Deutschland Evaluierung 2012

* How high were cost savings in the following sectors?

"authority loop") are brought into play. Higher requirements mean that EMAS certificated companies benefit from some reliefs: these concern, for example, enforcement of environmental law and tax breaks. The legal basis for this is the EMAS Privilege Ordinance. The ISO 50001 standard is another classic management system. Wherever an energy management system is required, companies comply with the preconditions in question via their EMAS registration. Examples of this include EEG exemptions and revenue peak adjustment and the respective requirements of the Energy Services Act, which was altered in 2015.

Number of participating companies

By the end of 2013, more than 2,000 sites across Germany were ISO 5001-accredited. By May 2014, this had already reached around 3,500. This is almost half of the 7,300 accreditations worldwide. Currently (February 2015) around 1,200 businesses at 1,900 sites in Germany are verified by EMAS. Most of these are located in Bavaria or Baden-Württemberg. EU-wide, approximately 10,400 sites are EMAS-verified.
A survey, in which all EMAS registered companies participated, shows that participants see significant saving potentials in terms of energy and emissions, alongside accordant possibilities to reduce costs.

Climate projects in schools

Climate protection is also a major topic in German schools. The www.klimaschutzschulenatlas.de portal alone shows 3,403 schools as of March 2015. Most are involved as part of the National Climate Initiative run by the Federal Environment Ministry. Around 24.3 per cent of the Klimaschutzschulen are equipped with solar energy systems, and 11.2 per cent are considered to be energy-saving schools. Aktion Klima! Mobil, Soko Klima and Green Day are three examples of successful projects that emerged in the context of the National Climate Initiative.

AKTION KLIMA! MOBIL

This project was launched in 2012. It aims to network various partners in the vicinity of the schools, thus enabling climate action projects. The project's main activity is the AktionKlimaMobil toolbox. This is fully mobile and is equipped with a set of wheels. It also has a modular design. It contains measuring instruments and tools, alongside a box containing materials on four topics: recognising, seeing, knowledge and action. By 2014, around 450 schools and educational institutions had taken part in this project. Several climate action measures arose from this: the Julius Spielberg Gymnasium in Vechelde planted around 3,970 trees as part of efforts to build a "climate forest" for their school. The Radko Stöckl Schule in Melsungen set up its own cinema with bicycle-powered generators. The list goes on and on. The project will run until mid-2015.

SOKO KLIMA

This project offers schools, educational institutions and planning offices a Methodenkoffer – a "box of methods." This contains basic knowledge, methods and work materials for practical project work and lessons. This makes it possible for teenagers and children to get involved in local planning and to shape the future in a climate-sensitive way. Overall, the project is making 1,000 boxes available. The Primo Levi Gymnasium used the box to develop ideas for a nearby public square, which were subsequently passed on to the district council. In Heidelberg, a youth climate summit took place, in which teenagers developed ideas to make Heidelberg carbon neutral by 2050.

GREEN DAY

This project emerged in 2012. It is designed to motivate pupils to take part in extra-curricular climate-related activities. At the core of this project is a nationwide Vocational Orientation Day, which takes place annually on the 12th of November. The Green Day is intended to arouse interest in climate-related occupations and academic subjects. In 2014, around 3,500 young people took part in more than 130 businesses and research institutes. Since 2012, more than 10,000 young people have been involved.

7. Appendix

Glossary

Biofuel
These are liquid or gaseous fuels produced from biomass (biodiesel, bioethanol, biogas).

Biogenic proportion of waste
This refers to the proportion of waste that can be composted under anaerobic or aerobic conditions, and arises in agriculture, fisheries and forestry, in industry, and in private households. It can include waste and residual wood, straw, garden waste, slurry, biowaste and fatty waste. Municipal waste in particular includes household waste, household-type commercial waste, bulky waste, road sweepings, market waste, compostable waste from recycling bins, garden and park waste and, finally, waste collected in separate containers for paper, cardboard, glass, plastics, wood 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. It is released by consumers (people and animals) when they breathe and by producers (plants and green algae) through photosynthesis, in which it is converted it into energy-rich organic compounds. It is also a waste product in energy production, primarily caused during the complete combustion of carbon fuels. Amongst the atmospheric trace gases, which have an impact on the environment, it is the most significant. It is also "opaque" to long-wave thermal radiation; it thus prevents equivalent re-radiation of short-wave solar radiation reaching the earth, increasing the risk of a rise in temperature at the surface of the earth. It is also a reference gas, used to determine the CO_2 equivalency of other greenhouse gases, and is thus assigned a global warming potential of one.

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

CO_2 equivalent
This term denotes a unit that measures a gas's potential to cause global warming. It indicates how much CO_2 would achieve the same greenhouse effect as the gas to which it is being compared, over an observation period of 100 years. The unit is used to compare different greenhouse gases in terms of their greenhouse effect, and to express their contribution to the greenhouse effect. The equivalence factors here deployed are used in accordance with the values specified in the IPCC's 4th Assessment Report for national emissions reporting. Methane (CH_4), for example, has a CO_2 equivalent of 25: this means that its impact on the environment is around 25 times stronger than that of carbon dioxide.

EEG: Renewable Energy Sources Act
The *Gesetz für den Vorrang Erneuerbarer Energien* (Priority to Renewable Energy Sources Act) of 2000 grants priority to renewable energy sources by obliging owners to purchase electricity from renewable sources. It also regulates (degressive) remuneration rates for (1) the various forms of energy productions and (2) the distribution procedure of resulting additional costs amongst all electricity consumers. The law was amended in 2004,2009, 2012 and most recently in 2014.

EEWärmeG: Renewable Energies Heating Act
The *Gesetz zur Förderung Erneuerbarer Energien im Wärmebereich* (Promoting Renewable Energies in the Heating Sector Act) was put in place in 2009. It obliges owners of new buildings to partially meet demand for heating and cooling using energy from renewable sources. The first amendment to this law came into force on the 1st of May 2011.

Effort Sharing
Sectors unaffected by European emissions trading are subject to binding targets set by the EU in 2009 for each EU Member State in accordance with the Effort Sharing Decision. Across the EU, greenhouse gas emissions should see a ten per cent reduction by 2020 in comparison to 2005 levels. The split is based on the economic performance of the respective member state. Germany must hereby reduce its greenhouse gases in the transport, business, trade, services and agricultural sectors by 14 per cent by 2020 (in comparison to 2005 levels).

Emission allowance
This concerns a legal right to emit a certain amount of a pollutant within a specific timeframe. This is one of the Kyoto Protocol's most important greenhouse gas-limiting tools. Emissions certificates can be traded. Emissions certificates (allowances, EUA) are also dispensed as part of EU emissions trading.

Energy efficiency
The ratio between a particular use scenario and the energy input required.

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

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
The Kyoto Protocol provides several flexible mechanisms for inter-state emissions trading. This is the basis upon which the EU has introduced emissions trading. Until now, it has only applied to companies in the energy and industrial sectors within the EU. The EC directive (EU ETS) has regulated implementation of emissions trading since it began on the 1st of January 2005. The emissions allowances are awarded either free of charge or sold at auction. The number of allowances sold is also reduced with every new trading period. Companies which have already made significant efforts to combat climate change, or who have used particularly innovative technologies, may sell off excess permits free of charge. This offers them an additional source of income. If the permits a company has been allocated do not suffice to meet the company's obligations, they must either make extra efforts or purchase extra allowances or be subject to a fine. The result of this mechanism is that reductions in emissions are achieved primarily where abatement costs are lowest.

EU White Paper
The European Commission uses White Papers to publish strategic proposals and suggested courses of action.

Final energy
This is the amount of primary energy which reaches the consumer (after deductions for transmission and conversion losses) and is thus available for heating, warm water and ventilation etc. The various forms of final energy include district heating, electricity, liquid hydrocarbons like petrol, kerosene and fuel oil, as well as various gases like natural gas, biogas and hydrogen.

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

Geothermal energy
This includes use of renewable terrestrial heat at various depths. In the case of near-surface geothermal energy, the sun supplies heat to the earth, gradually heating the soil from the top down. In 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 (CO_2 GWP=1). A substance's GWP depends on the length of the period – usually 100 years – upon which the parameter is based.

Greenhouse gases
Atmospheric trace gases, of both natural and anthropogenic origin, which contribute to the greenhouse effect. These include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulphur hexaflouride (SF_6), hydro-flourocarbons (HFCs) and perfluorocarbons (PFCs).

Gross electricity consumption
Gross electricity consumption is the sum of total domestic energy production (wind, water, solar, coal, oil, natural gas and other) plus current flows from abroad, and minus current flows to abroad.

Gross final energy consumption
This includes those quantities of energy consumed during conversion of energy, as well as losses incurred during transmission or distribution. For this reason, this sum is always higher than final energy consumption.

IPCC
An intergovernmental board of experts on climate issues under the auspices of the United Nations, founded in 1988. The IPCC's Fourth Assessment Report of 2007 confirms a rise in mean global temperatures of 0.6 to 0.8 degrees Celsius in comparison to preindustrial levels. The report provides undeniable evidence of global warming and shows human intervention to be the principal cause of climate change.

Methane
Methane (CH_4) is a non-toxic, colourless and odourless gas. After CO_2, it is the most significant greenhouse gas released by human activity. According to the IPCC's Second Assessment Report (1995), its impact on the climate is 25 times that of CO_2. However, it occurs in much smaller quantities.

Nitrous oxide
N_2O (Nitrous oxide/laughing gas) is a colourless gas and one of the nitrous gases. Alongside carbon dioxide (CO_2) and methane (CH_4), it is considered to be a gas which has a direct impact on the climate. The IPCC's second report (1995) states that N_2O's impact on the climate is up to 310 times stronger than that of carbon dioxide. However, it occurs in far smaller quantities in the atmosphere. The largest anthropogenic source of nitrous oxide emissions is the agricultural use of nitrogen fertilisers.

Photovoltaics
Technology used for the direct conversion of solar radiation into electrical energy by means of semiconductors, which are known as solar cells.

Primary energy
Primary energy is the amount of energy calculated as being available from a natural energy source before it undergoes conversion to another form or level of energy. Primary energy sources include finite ones such as lignite and hard coal, petroleum, natural gas and fissile material such as uranium ore, as well as renewable sources such as solar, wind, hydropower, geothermal energy and tidal energy. Primary energy is converted to the next energy stage in power plants or refineries. Conversion losses occur in this process; parts of some energy sources are also used for non-energy purposes (e.g. petroleum for the plastic industry).

Primary energy consumption
Primary energy consumption is the total consumption of all primary energy sources, irrespective of the form in which they occur in nature. It can be understood as the sum of inventory charges and the balance of amounts received and supplied. It includes the energy needed for conversion and final consumption.

Rebound effect
The phenomenon in which savings achieved as a result of increased efficiency do not bring about a corresponding reduction in resource usage, as increased efficiency brings about an unintended increase in usage. There are both direct and direct rebound effects. A direct rebound effect means that usage (of a particularly energy efficient device, for example) increases. With indirect effects, the cost savings that result from efficiency gains are used to create a new market; a second TV in the home, for instance. In extreme examples (higher resource use though energy efficiency), this effect is known as the Jevons Paradox.

Renewable energies
Energy sources, which, on a human time scale, are available for an infinite period of time. The sun ultimately fuels nearly all renewable energy sources. The sun will eventually burn out, so, strictly speaking, is not a renewable energy source. However, current scientific knowledge indicates that the sun is likely to be in existence for at over a billion more years, which is virtually unlimited in human terms. 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 net emissions via the absorption and storage of CO_2 by, for example, plants and soils.

Smart Grids
An intelligent power grid system that comprises communicative networking and control of electricity generating units, storage facilities and other consumers within the grid.

Transport intensity
Transport intensity is the ratio of passenger and freight transport compared to GDP.

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 was the first international agreement to define climate change as a serious concern, and to make the global community commit to taking action. It provides the framework for the climate change negotiations, which take place at conferences between the signatory states.

Footnotes

1. www.bmz.de/de/was_wir_machen/themen/klimaschutz/hintergrund/Klimafinanzierung/index.html

2. http://ec.europa.eu/clima/policies/package/index_en.htm

3. Excluding sea journeys.

4. With regard to quality (depth) and quantity (extent and number).

5. As the Working Group on Renewable Energy Statistics present no current data on gross final energy consumption, Eurostat data are used here. Preliminary data for 2014 will not be available before summer 2015.

6. German Federal Government, Projektionsbericht 2015.

7. Federal Ministry for Economic Affairs and Energy, Jahreswirtschaftsbericht 2015.

8. The following sectors are not included in these figures: land use, land-use change and forestry. For more information, see p.36 and the section titled Land Use, Land-Use Change and Forestry.

9. Numbers have been rounded.

10. All entries on the pie charts have been rounded up. Thus it is possible that the overall amount deviates slightly from 100 per cent.

11. According to the Kyoto definition, this does not apply to emissions caused by production chains or biofuels. In respect to air traffic, only the amounts relating domestic flights within Germany are included.

12. Not including credits from recycling and waste recovery.

13. Excluding the land use, land use change and forestry sector.

14. Calculated in accordance with Article 3, Paragraph 4 of the 2009 EC Renewable.

15. Deutsche Bahn AG, Kennzahlen und Fakten zur Nachhaltigkeit 2013.

16. Arbeitsgemeinschaft Energiebilanzen e.V., February 2015.

17. In principle, the trend towards high-end products should be deducted when calculating energy productivity.

18. www.ptj.de/energieeffizienz-industrie

19. Federal Ministry for Economic Affairs and Energy, Bundesbericht Energieforschung 2014.

20. DIW, Verkehr in Zahlen 2013/2014, p.221 and p.246.

21. Nationaler Aktionsplan Energieeffizienz, p.12.

22. Investments that contribute to environmental protection activities in the areas of waste management, water protection, noise abatement, air pollution, nature conservation, landscape management, soil remediation or climate change mitigation.

23. GWS, Gesamtwirtschaftliche Effekte energie- und klimapolitischer Maßnahmen der Jahre 1995-2012.

24. The potential climate product is based on the idea of the potential environmental protection product. This concept was developed in the 1990s by various research institutes and the German Federal Statistical Office. Since then it has been used in several studies. A list has been prepared, detailing environmental protection goods which serve other functions alongside their environmental protection role. This concept was extended to take in climate products in 2006 and further updated in 2013. More information can be found here (German): www.umweltbundesamt.de/publikationen/umweltschutzgueter-wie-abgrenzen-methodik-liste

25. German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, GreenTech made in Germany 3.0.

26. Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Umweltbewusstsein in Deutschland 2014.

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List of abbreviations

a	year/anno
AGEB	Working Group on Energy Balances (Arbeitsgemeinschaft Energiebilanzen)
AGEE-Stat	Working Group on Renewable Energy Statistics (Arbeitsgruppe Erneuerbare Energien-Statistik)
CDM	clean development mechanism
CHP	combined heat and power
CH_4	methane
CO_2	carbon dioxide
EEA	European Economic Area
EEG	Renewable Energy Sources Act (Erneuerbare-Energien-Gesetz)
EEWärmeG	Renewable Energies Heat Act (Erneuerbare-Energien-Wärmegesetz)
EnEV	Energy Saving Ordinance (Energieeinsparverordnung)
EMAS	Eco-Management and Audit Scheme
ETS	Emissions Trading System
EUA	European Union Allowances
EU28	28 Member states of the European Union
F-gas	fluorinated greenhouse gas
GDP	gross domestic product
GJ	gigajoule
GVA	gross value added
GWh	gigawatt hour
GWP	Global Warming Potential
HFC	hydrofluorocarbons

HW/HKW	heating plant/cogeneration plant
ICAO	International Civil Aviation Organisation
IKI	International Climate Initiative (Internationale Klimaschutz Initiative)
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
JI	Joint Implementation
KfW	Kreditanstalt für Wiederaufbau, a federally-owned development bank
kWh	kilowatt hour
LEEN	Learning Energy Efficiency Network (Lernende Energieeffizienz Netzwerke)
LULUCF	land use, land-use change and forestry
MAP	Market Incentive Programme (Marktanreizprogramm)
MJ	megajoule
NABEG	Grid Expansion Acceleration Act
NAPE	National Energy Efficiency Action Plan (Nationaler Aktionsplan Energieeffizienz)
NKI	National Climate Initiative (Nationale Klimaschutz Initiative)
N_2O	nitrous oxide
PFC	perfluorocarbon
PJ	petajoule
Pkm	passenger kilometre
ppm	parts per million
ProgRess	German Resource Efficiency Programme
REED+	Reducing emissions from deforestation and forest degradation
SF_6	sulphur hexafluoride
TWh	terrawatt hours
UNFCCC	United Nation Framework Convention on Climate Change

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