Federal Ministry
for Economic Affairs
and Energy

Energie wende
Switch to the Future

Fifth "Energy Transition" Monitoring Report

The Energy of the Future

2015 Reporting Year

Imprint

Publisher
The Federal Ministry for
Economic Affairs and Energy (BMWi)
Public Relations
11019 Berlin
www.bmwi.de

Text and editing
BMWi

Design and production
PRpetuum GmbH, Munich

Status
December 2016

Print
MKL Druck GmbH & Co.KG, Ostbevern

Illustration
igorr1, LL28, Gyuszko, Ivansmuk, Ridofranz, Warchi – all iStock; science photo, Artur Marciniec, Petair, kasto, xerox123, frank peters – all fotolia; Bundesnetzagentur/ © GeoBasis-DE (title, p. 1);
UMB-O (p. 18), Phadventure (p. 70), elenabsl (p. 83), industrieblick (p. 86), Gina Sanders (p. 95), AA+W (p. 98), Composer (p. 101), science photo (p. 125) – all fotolia;
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Content

Central messages from the Fifth Monitoring Report

Renewables are Germany's number-one source of electricity. With a share of 31.6% in gross electricity consumption, almost one kilowatt hour of electricity in three was derived from renewable sources in 2015.

After the record low of the previous year, primary energy consumption crept up slightly by 0.9% to 13,293 petajoules. Economic growth and colder weather conditions contributed to this increase. The central measures of the National Action Plan on Energy Efficiency adopted in 2014 are implemented by now, or have been introduced and are starting to work.

Having risen 1.3% from 2005 levels, the development of final energy consumption in the transport sector continued to run counter to the goals of the Energy Concept. The aim is to cut final energy consumption by 10% by 2020 compared with figures for 2005. Further efforts are required.

Greenhouse gas emissions increased slightly in 2015 and have dropped by an estimated 27.2% in total compared with 1990 levels. The aim is to reduce greenhouse gas emissions by at least 40% from 1990 levels by the year 2020. In light of this, the consistent implementation of the 2020 Climate Action Programme is of central importance.

The 2050 Climate Action Plan contains fundamental principles and provides orientation for delivery on the global goals set out in the Paris Agreement. For the first time, it defines target corridors for emissions reduction in individual sectors by 2030. These will undergo a comprehensive impact assessment and then be discussed with the social partners. If necessary, adjustments can be made to the sectoral targets in 2018.

The supply of electricity in Germany is secure. Demand for energy in Germany is always met, guaranteeing a high level of supply security. By international standards Germany is also at the forefront, with supply quality consistently at a very high level.

In 2015, electricity prices for household customers fell slightly by an average of 1.4% on the previous year. A slight increase in electricity prices was recorded in 2016. For industrial customers not covered by special compensation arrangements, electricity prices fell by 2.1% in 2015.

In 2015, energy costs from the use of imported primary fossil fuels were down on the previous year, falling from around €77 billion to roughly €55 billion. This was mainly a result of the low prices on the global commodity markets, which fell again significantly in 2015.

1 Introduction

The Energy for the Future monitoring process tracks progress towards goals and checks the implementation of measures to transition the energy system with a view to establishing a secure, economic and environmentally friendly energy supply, so that adjustments can be made if necessary. The focus is on three tasks:

Overview: The monitoring process provides a fact-based overview of the current status of progress with regard to implementation of the energy reforms. It condenses the reams of statistical information on energy that have been collected into selected indicators.

Evaluation: Based on the status quo, the annual monitoring reports analyse to what extent targets set out in the Federal Government's Energy Concept are being met and what effect the measures are having. In areas where the targets are likely to be missed, consolidated progress reports, which are produced every three years, propose measures on the basis of the multi-year data then available in order to remove barriers and reach the targets.

Outlook: The monitoring process also looks ahead to the likely development of key indicators. The progress reports capture and visualise reliable trends to this end.

The Fifth Monitoring Report documents the status of the energy transition in 2015. At the heart of the monitoring process for the energy transition is the annual monitoring report, which provides new facts and figures about the energy transition. The structure of the current report and the topics addressed are based on the energy transition target architecture adopted by the Federal Government in December 2014.

Part I summarises current progress towards the quantitative targets of the energy transition in the following areas:

- Progress in the expansion of renewable energy (Chapter 3)
- Development of energy consumption and energy efficiency (Chapter 4) with a specific focus on the three areas of electricity, heating and transport
- Energy policy targets and measures in the buildings sector (Chapter 5) and in the transport sector (Chapter 6)
- Development of greenhouse gas emissions (Chapter 7)

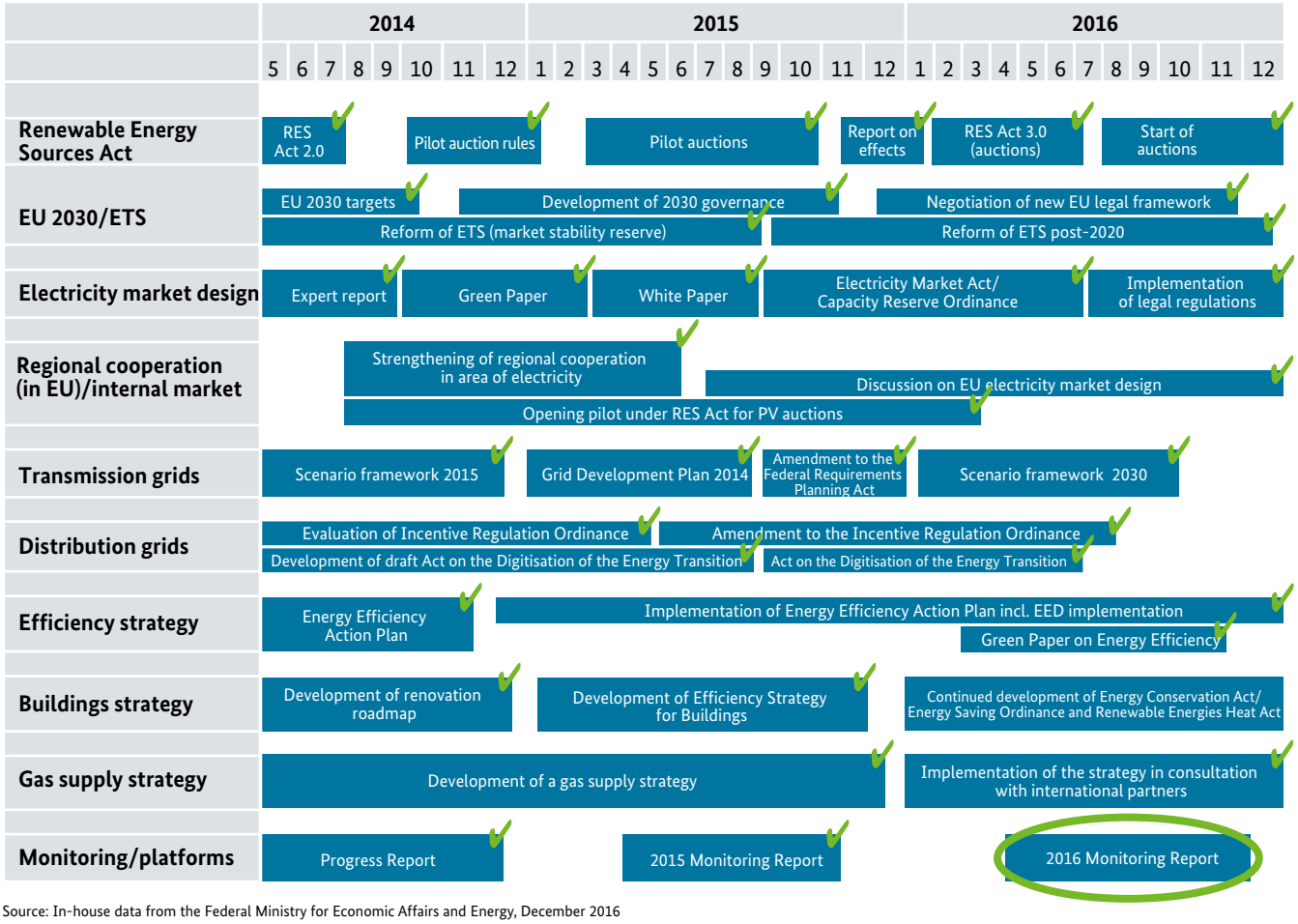
Part II looks at other targets and policies affecting the energy transition:

- Development of the power plant fleet with regard to security of supply, the nuclear phase-out and compatibility with the energy transition (electricity market 2.0) (Chapter 8)
- Affordability of energy for private households and businesses (Chapter 9)
- Expansion of the electricity transmission and distribution grids (Chapter 10)
- Integrated development of the energy system (Chapter 11)
- The energy transition in the European and international context (Chapter 12)
- Energy research and innovation (Chapter 13)
- Correlation of the energy transition with investment, growth and employment (Chapter 14)

A commission of independent energy experts oversees the monitoring process. Working on a scientific basis, the commission of experts comments on the Federal Government's monitoring and progress reports. Prof. Dr. Andreas Löschel (University of Münster) is the chair of the commission. Other members are Prof. Dr. Georg Erdmann (Technical University of Berlin), Prof. Dr. Frithjof Staiß (Centre for Solar and Hydrogen Research) and Dr. Hans-Joachim Ziesing (Working Group on Energy Balances). The opinions of the commission of experts are published on the website of the Federal Ministry for Economic Affairs and Energy, together with the monitoring reports and progress reports.

By making the energy transition more transparent, the monitoring process helps boost public acceptance for it. The Federal Government publishes central data on the energy transition in regular reports. Dialogue with the commission of experts and the high-level energy transition platforms that focus on the electricity market, energy efficiency, buildings, energy grids and research and innovation promotes exchange with representatives from the *Länder*, the business community, society and academia. Common solutions and strategies for the central action areas of the energy transition can be developed in this way.

Diagram 1.1: Monitoring as part of the "10-point energy agenda" of the Federal Ministry for Economic Affairs and Energy



Source: In-house data from the Federal Ministry for Economic Affairs and Energy, December 2016

The monitoring process also encompasses the "10-point energy agenda" of the Federal Ministry for Economic Affairs and Energy. The agenda identifies the Federal Government's central energy transition projects in the 18th legislative term and dovetails the content and timing of the various action areas. The monitoring and progress reports evaluate the adopted measures and their impact on an ongoing basis.

In addition, the Federal Government has also been reporting on current greenhouse gas emission trends since 2015 in annual climate reports. The report provides information on the state of implementation of measures defined in the 2020 Climate Action Programme, current trends and the effects of emissions reduction.

2 Objectives of the energy transition and monitoring indicators

By pursuing the energy transition, Germany is heading towards a future with a secure, economic and environmentally friendly energy supply. The orientation for the energy transition – and thus the basis for its monitoring – is provided by the Federal Government's Energy Concept, further decisions by the Bundestag, and European rules. The triple objective of security of supply, affordability and environmental compatibility remains the guiding principle for Germany's energy policy.

Part I of the Monitoring Report examines the quantitative targets of the energy transition. As Table 2.1 shows, these targets extend through to 2050, with some milestones set for 2020, 2030 and 2040.

Table 2.1: Quantitative targets of the energy transition and status quo (2015)

	2015	2020	2030	2040	2050
Greenhouse gas emissions					
Greenhouse gas emissions (compared with 1990)	-27.2%*	at least -40%	at least -55%	at least -70%	-80% to -95%
Renewable energy					
Share of gross final energy consumption	14.9%	18%	30%	45%	60%
Share of gross electricity consumption	31.6%	at least 35%	at least 50% Renewable Energy Sources Act 2025: 40 to 45%	at least 65% Renewable Energy Sources Act 2035: 55 to 60%	at least 80%
Share of heat consumption	13.2%	14%			
Share in transport sector	5.2%	10%**			
Efficiency and consumption					
Primary energy consumption (compared with 2008)	-7.6%	-20% → -50%			
Final energy productivity (2008–2050)	1.3%/year (2008–2015)	2.1%/year (2008–2050)			
Gross electricity consumption (compared with 2008)	-4.0%	-10% → -25%			
Primary energy consumption in buildings (compared with 2008)	-15.9%	→ -80%			
Heat consumption in buildings (compared with 2008)	-11.1%	-20%			
Final energy consumption: transport (compared with 2005)	1.3%	-10% → -40%			

Source: In-house figures from the Federal Ministry for Economic Affairs and Energy, December 2016
* Provisional figure for 2015
** Target set by Directive 2009/28/EC.

Table 2.2: Targets and policies affecting the energy transition

Security of supply	Covering Germany's energy needs at all times.
Nuclear energy phase-out	Switching off the last nuclear power plants at the end of 2022.
Affordability Competitiveness	Maintaining affordability of energy and ensuring Germany's competitiveness.
Grid expansion	Expanding and modernising grids to meet demand.
Sector coupling Digitisation	Unlocking the potential of efficient sector coupling and digitisation for a successful energy transition.
Europe International	Establishing a reliable European and international framework for more climate change mitigation, renewables and energy efficiency.
Research Innovation	Fostering forward-looking innovations for the restructuring of the energy supply.
Investment Growth Employment	Retaining and creating jobs in Germany and laying the foundations for sustainable prosperity and quality of life.

Source: In-house data from the Federal Ministry for Economic Affairs and Energy, December 2016

Part II of the Monitoring Report looks at other targets and policies affecting the energy transition. As quantitative targets have not been agreed for some of these topics, these areas also focus on qualitative targets (Table 2.2).

2.1 Target architecture for the energy transition

The target architecture structures the individual goals of the energy transition. The Cabinet adopted a target architecture for the energy transition with the First Energy Transition Progress Report (see Diagram 2.1). This target architecture structures and prioritises the existing individual goals of the Energy Concept, distinguishing between multiple goal levels:

The **policy goals** define the framework for the restructuring of our energy supply and comprise:

- Climate targets, including a 40% reduction in greenhouse gas emissions by 2020,
- The phase-out of nuclear energy for electricity generation by 2022, and
- Goals to guarantee competitiveness and security of supply.

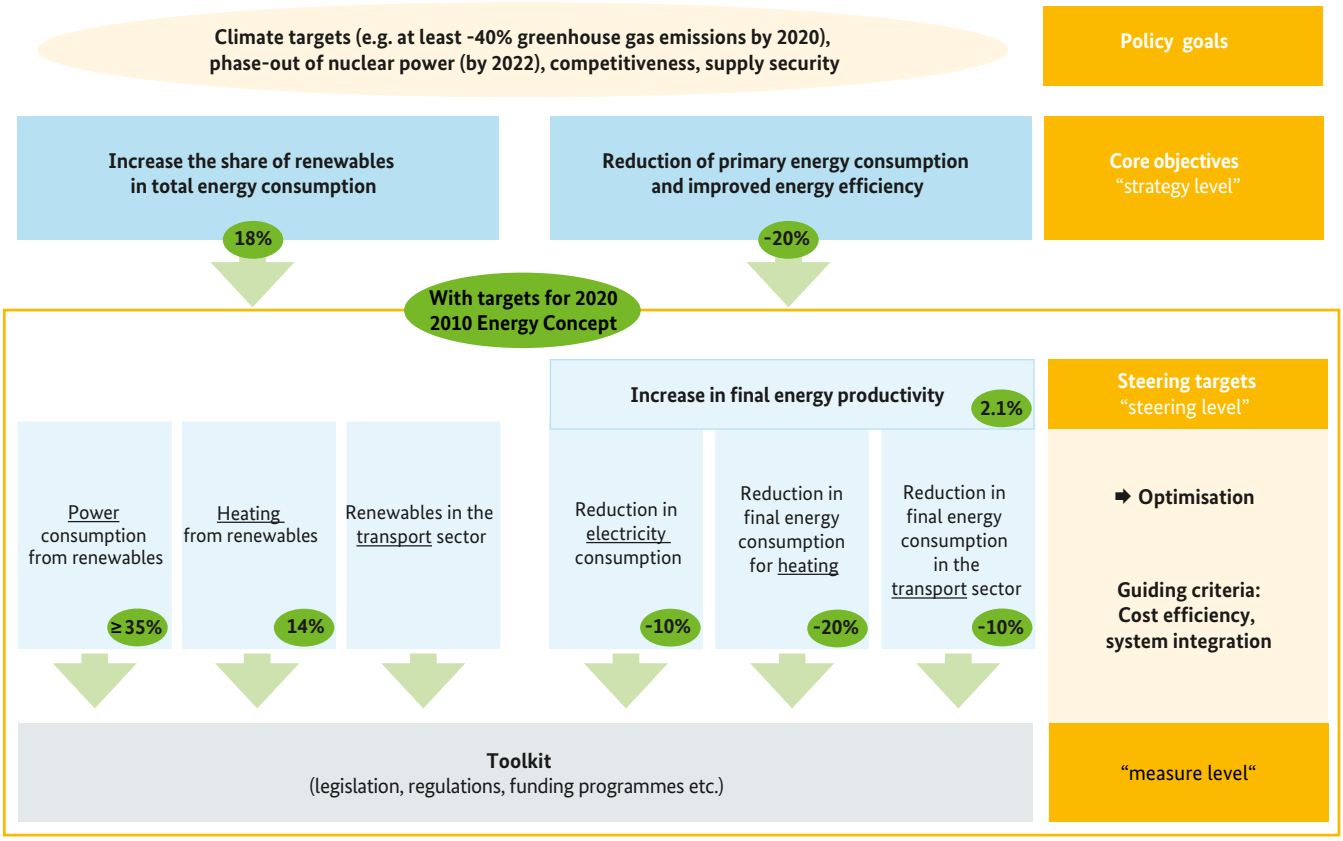
The **core objectives** describe the central strategies of the Energy Concept to drive the energy transition forward. The focus here is on expanding renewables and reducing primary energy consumption/increasing energy efficiency. Both core objectives are defined in concrete terms by **steering targets** for the three action areas of electricity, heating and transport. The steering targets and the **corresponding measures** are aligned so that – by taking an integrated approach – the overarching goals can be achieved in the most reliable, cost-effective manner possible.

2.2 Indicators and evaluation scheme

The monitoring process for the energy transition is based on publicly available, verifiable data. It is undertaken using selected indicators which visualise progress made in the energy transition over time. They are informed, wherever possible, by official and publicly accessible data. The Energy Statistics Act is the national legal basis for official energy statistics. In September 2016 the Federal Cabinet adopted a bill to amend the Energy Statistics Act to adapt it to current circumstances. The indicators used for the various topics are illustrated in Diagram 2.2.

A points system is used to assess the progress made in terms of the quantitative targets of the energy transition. Firstly, the development of the indicators since 2008 is

Diagram 2.1: Structure of the goals of the Energy Concept



Source: In-house data from the Federal Ministry for Economic Affairs and Energy, October 2016.

extrapolated on a linear basis. On the basis of percentage deviations of the extrapolated figures from the target figures in 2020, points are awarded as follows for this report: 5 points if, according to the extrapolation, the target is met or the deviation is less than 10%; 4 points if the deviation is between 10 and 20%; 3 points if the deviation is between 20 and 40%; 2 points if the calculated deviation is between 40 and 60%; and 1 point if the deviation from the target exceeds 60%.

The evaluation scheme applied here cannot replace complex, model-based forecasts. But this system offers the advantage of a comparatively simple and comprehensible depiction of the current status of key energy transition indicators at a glance.

The future impact of measures which are currently being implemented is not reflected in this assessment of whether targets are met. They may yet have an impact, and the actual development can deviate in response to political and economic influences. Therefore such an assessment always carries a certain degree of uncertainty.

The values indicated in this Report generally reflect the data available on 14 November 2016; the electricity generation figures reflect the situation in August 2016. The data on the Energy of the Future monitoring process are publicly accessible on the websites of the Federal Ministry for Economic Affairs and Energy and the Federal Network Agency. The year under review is 2015. By issuing this report, the Federal Government is also meeting its reporting obligations pursuant to Section 63 (1) sentence 1 of the Energy Industry Act and Section 98 (1) of the Renewable Energy Sources Act as well as the National Action Plan on Energy Efficiency (NAPE) and the Efficiency Strategy for Buildings.

Diagramm 2.2: Indicators*

Renewable energy	• Share of renewable energy sources (RES) in gross final energy consumption • Share of RES in gross electricity consumption • Renewable electricity generation by technology • Gross electricity generation by energy source • Share of RES in heating and cooling consumption • Share of RES in the transport sector • EEG surcharge • Sum total of EEG surcharge plus electricity price on the exchange
Efficiency and consumption	• Primary energy consumption • Primary and final energy productivity • Gross electricity consumption
Buildings	• Share of final energy consumption of buildings in total energy consumption • Final energy consumption of buildings/heating final energy consumption • Specific final energy consumption for space heating • Primary energy consumption in buildings
Transport	• Final energy consumption in the transport sector • Specific final energy consumption of the transport sector • Number of 3-wheel-plus vehicles with an electric drive • Number of 3-wheel-plus vehicles powered by fuel cells and natural gas • Shift to rail transport • Shift to public transport
Greenhouse gas emissions	• Greenhouse gas emissions • Greenhouse gas emissions by source group • Energy-related CO_2 emissions by sector • Greenhouse gas emissions avoided through use of renewables • Specific greenhouse gas emissions in relation to the population and GDP
Security of supply	• Installed capacity of power generation plants • Distribution of power plant capacity across the *Länder* • CHP electricity generation • Conventional generation capacities: new plant construction and dismantling of plants • Capacity of pumped storage power stations • Nuclear phase-out roadmap • SAIDI index • Electricity outage duration compared to other countries
Affordability Competitive-ness	• Energy spending of private households • Electricity prices of private households • Energy costs for industry • Oil and gas prices • Electricity prices on the exchange • Electricity prices of non-privileged industrial enterprises • Macroeconomic energy spending • Energy prices compared to other countries
Grid expansion	• Projects under the Energy Line Expansion Act and Federal Requirements Planning • Grid investment • Grid charges • Costs for ancillary services
Sector coupling Digitisation	• Number and electricity consumption of heat pumps • Number and electricity consumption of electric cars • Digitisation of the energy transition • Remote controllability and remote readability of RES installations • Metering and measuring technology among domestic customers • Metering and measuring technology in industry
Europe Inter-national	• EU 20-20-20 targets • Trade-related flows of electricity • Physical flows of electricity • Emissions trading in the EU-ETS • Effort sharing in the non-ETS sector • Global investment in renewable energy and energy efficiency • Global installed renewable capacity
Research innovation	• Industry spending on R&D • Federal research spending in the Energy Research Programme • Project funding from EU funds • Patents • Market uptake of innovative technologies in energy consumption
Investment Growth Employment	• Investment in renewable energy and energy efficiency • Investment in grids and electricity supply • Primary energy sources saved as a result of the use of renewable energy • Numbers employed in conventional electricity supply • Numbers employed in renewable energy sector

Source: In-house data of the Federal Ministry for Economic Affairs and Energy, December 2016
*Compared with the Fourth Monitoring Report, Part II of this report has indicator fields for two new chapters which have been added: Chapter 11 "Integrated development of the energy system" (sector coupling and digitisation) and Chapter 12 "The energy transition in the European and international context".

Part I: Quantitative targets of the energy transition

The quantitative targets of the energy transition refer to five thematic areas

Renewable energy

Energy consumption and energy efficiency

Buildings

Transport

Greenhouse gas emissions and environmental impact

3 Renewable energy

Where do we stand?

With a renewable energy share of 31.6% in gross electricity consumption, almost one kilowatt hour of electricity in three was derived from renewable sources in 2015. Record growth in wind energy is moving the energy transition forward.

With a renewable energy share of 13.2% in the heating sector in 2015, the 2020 goal has almost been reached.

The share of renewables in the transport sector has dropped to 5.2%.

What is new?

The expansion of renewables is making good headway in the electricity and heating sector. Germany is making its energy supply system ready for the future, whilst also ensuring cost efficiency.

The Renewable Energy Sources Act 2017 marks the transition to a competitive auction system. It is designed to guarantee compliance with the deployment corridor for renewable energy, whilst ensuring the cost-efficient further expansion of renewables. In so doing, it makes renewable energy ready for the electricity market.

	2015	2020	2030	2040	2050
Renewable energy					
Share of gross final energy consumption	14.9%	18%	30%	45%	60%
Share of gross electricity consumption	31.6%	at least 35%	at least 50% Renewable Energy Sources Act 2025: 40 to 45%	at least 65% Renewable Energy Sources Act 2035: 55 to 60%	at least 80%
Share of heat consumption	13.2%	14%			
Share in transport sector	5.2%	10%*			

*Target set by Directive 2009/28/EC

3.1 Share of renewables in gross final energy consumption

The share of renewables in total energy consumption is rising steadily. Gross final energy consumption comprises the final energy delivered to final consumers before deduction of losses incurred in conversion and transmission in the three sectors of electricity, heating and transport (fuels). Electricity covers around one quarter of our total demand for energy, while process heating and space heating cover around one half, and fuels cover roughly one quarter. In 2015, the gross final energy provided by renewable sources amounted to 377.5 TWh, thereby covering 14.9% of total gross final energy consumption. This is an increase of 1.3 percentage points on the previous year (see Diagram 3.1).

The share of renewables in gross final energy consumption has increased by roughly 6 percentage points in total since 2008. Overall, the share of renewables across all three sectors has even trebled since 2000. This dynamic development has primarily been driven by the strong increase in renewable generation in the electricity sector. In contrast, the increase in renewables in the heating sector was less pronounced, and the share of renewables in the transport sector has been falling since 2006. A gap of around 3.1 percentage points must be closed to reach the 18% target by 2020. This can only be achieved by continuing the ambitious expansion of renewables in the electricity and heating sectors, and by stepping up efforts significantly in the transport sector.

Additional steps in implementing the energy transition build increasingly on the integrated development of the electricity, heating and transport sectors. The importance of renewables can be expected to increase in all three sectors over the coming years also. In addition to increased energy efficiency and the expansion of renewables, there will also be greater interaction between the energy, transport and buildings sectors (sector coupling) in the future, (see Chapter 11).

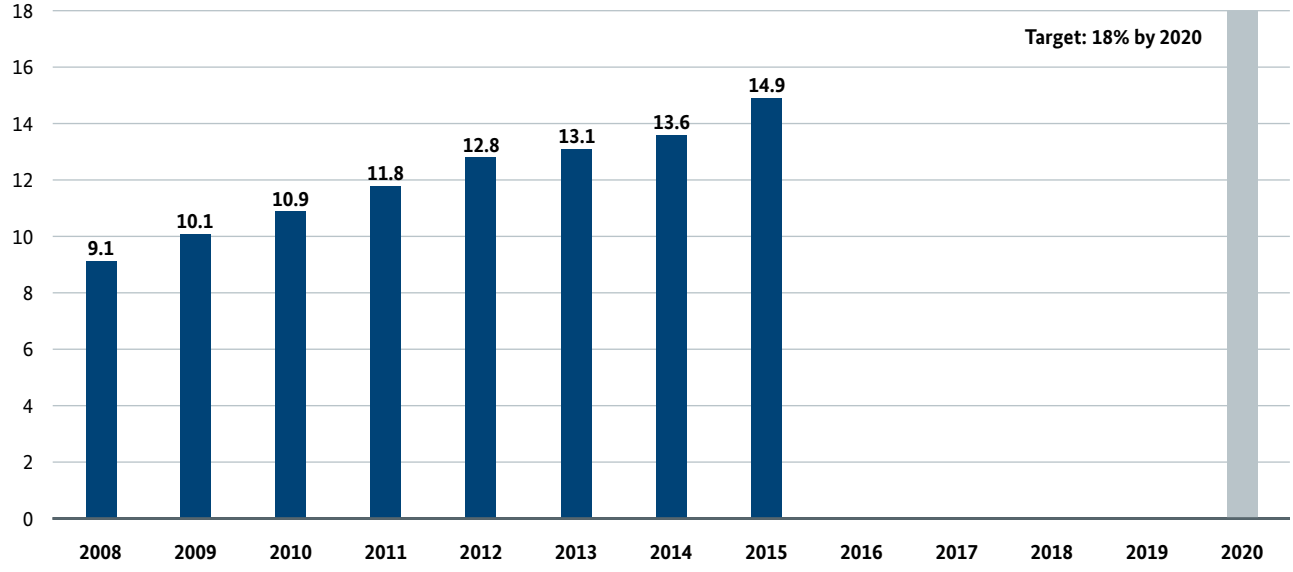
3.2 Renewable energy in the electricity sector

Almost every third kilowatt hour of electricity consumed in 2015 came from a renewable energy source. Total gross electricity consumption, i.e. domestic electricity production plus electricity imports minus electricity exports, stood at 593.8 TWh in 2015. Providing around 187.3 TWh, renewable energy was able to significantly consolidate its leading position in the electricity sector, achieving a 31.6% share in gross electricity consumption (see Diagram 3.2). The share

Diagram 3.1: Meeting the target for renewable energy in gross final energy consumption

2020 target	Renewable energy to cover 18% of gross final energy consumption
Status 2015	14.9%

Share of gross final energy consumption in %



Source: Working Group on Renewable Energy Statistics, August 2016

Trend	●●●●●
Measures	Renewable Energy Sources Act, Market Incentive Programme, Renewable Energies Heat Act, greenhouse gas quota, amongst other measures.

of renewables in the electricity supply has therefore increased by 4.3 percentage points from the previous year.

The 2020 target for the share of renewables in electricity consumption is likely to be reached ahead of schedule. The share of renewable energy in the electricity sector has more than doubled in total since 2008.

Record growth in wind energy is moving the strong expansion of renewables forward in 2015. 79 TWh of wind-derived energy was generated in 2015, with 71 TWh generated by onshore and 8 TWh by offshore wind installations. Generation the previous year stood at 57 TWh. This translates to an increase of roughly 38% in wind-derived electricity generation in 2015. Favourable wind conditions and the first full year of production for the new wind turbines added in 2014 were the primary reasons for this increase. Electricity production from biomass (solid, liquid, biogas and biogenic waste) stood at 50.3 TWh. Photovoltaic electricity generation reached a record high of 38.7 TWh. Hydroelectricity dropped to around 19 TWh, while geothermal electricity production continued to remain comparatively low at 0.1 TWh.

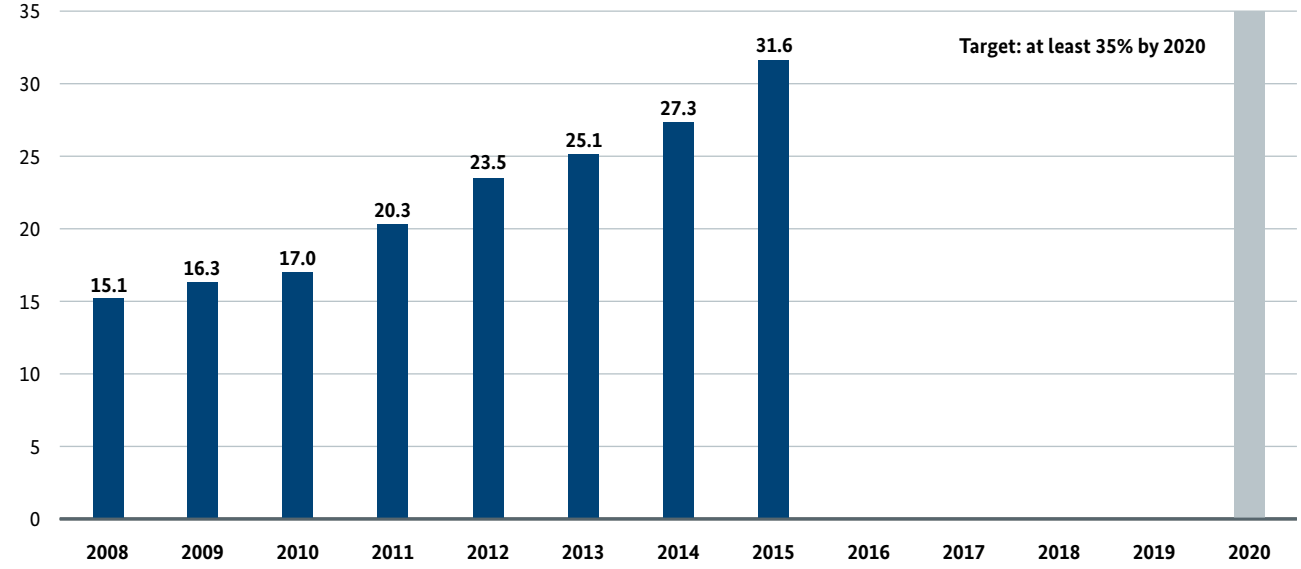
From a long-term perspective, the construction of additional wind and photovoltaic capacity, in particular, is driving the expansion of renewables. As Diagram 3.3 illustrates, electricity generation from renewables has doubled in total since 2008, rising from 93 to 187 TWh. Biomass experienced strong growth in the past but has stagnated of late. The shares of hydropower and deep geothermal energy, on the other hand, have remained virtually unchanged.

The expansion of renewables is making significant progress. The expansion of onshore wind is central to the success of the energy transition in the electricity sector, with 3,802 MW (gross) of new capacity installed in 2015. With decommissioned plant capacity factored in, total net onshore capacity added in 2015 amounted to 3,623 MW. The expansion is therefore roughly 1,000 MW above the deployment corridor of 2,500 MW defined in the Renewable Energy Sources Act 2014. At the same time, additional photovoltaic capacity in 2015 – standing at 1,444 MW of installed capacity – was more than 1,000 MW short of the deployment corridor of 2,500 MW defined in the Renewable Energy Sources Act 2014. New offshore wind installations with a capacity of roughly 2,290 MW were added. The slowdown in the expansion of biomass continued and, at around 14 MW (gross), was within the deployment corridor (see Table 3.1).

Diagram 3.2: Meeting the target for renewable energy in gross electricity consumption

2020 target	Renewable energy to provide at least 35% of gross electricity consumption
Status 2015	31.6%

Share of gross electricity consumption in %

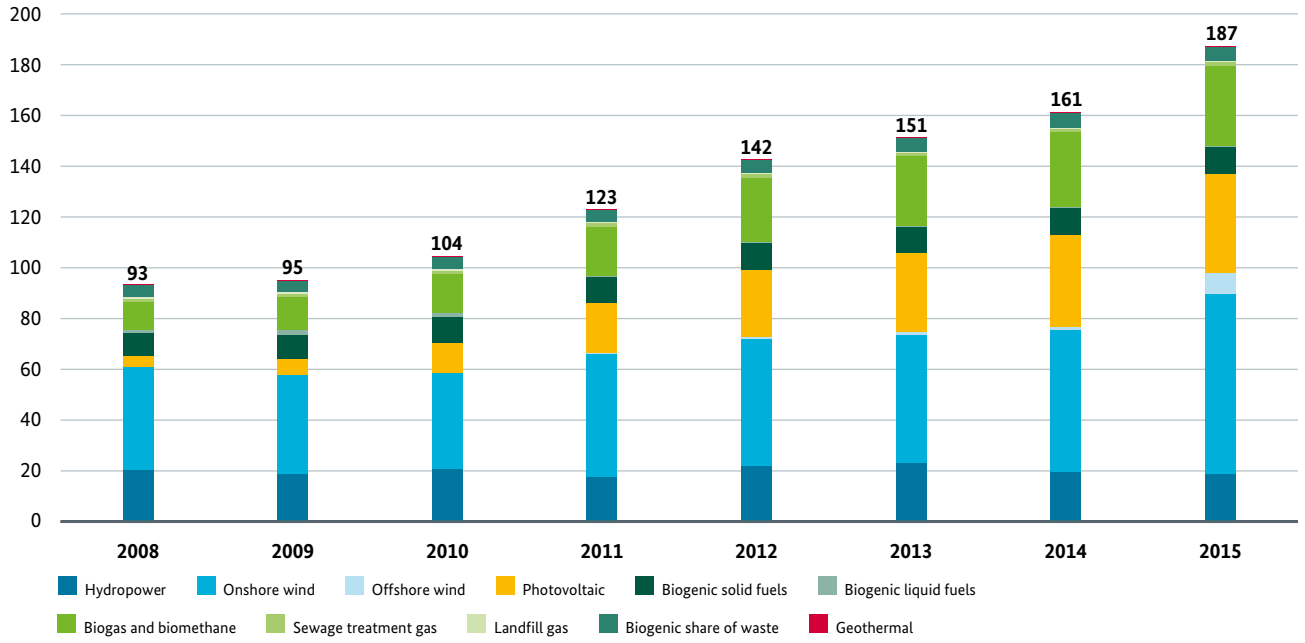


Source: Working Group on Renewable Energy Statistics, August 2016

Trend	● ● ● ● ●
Measures	Renewable Energy Sources Act

Diagram 3.3: Gross electricity generation from renewable energy sources

In TWh



Source: Working Group on Renewable Energy Statistics, August 2016

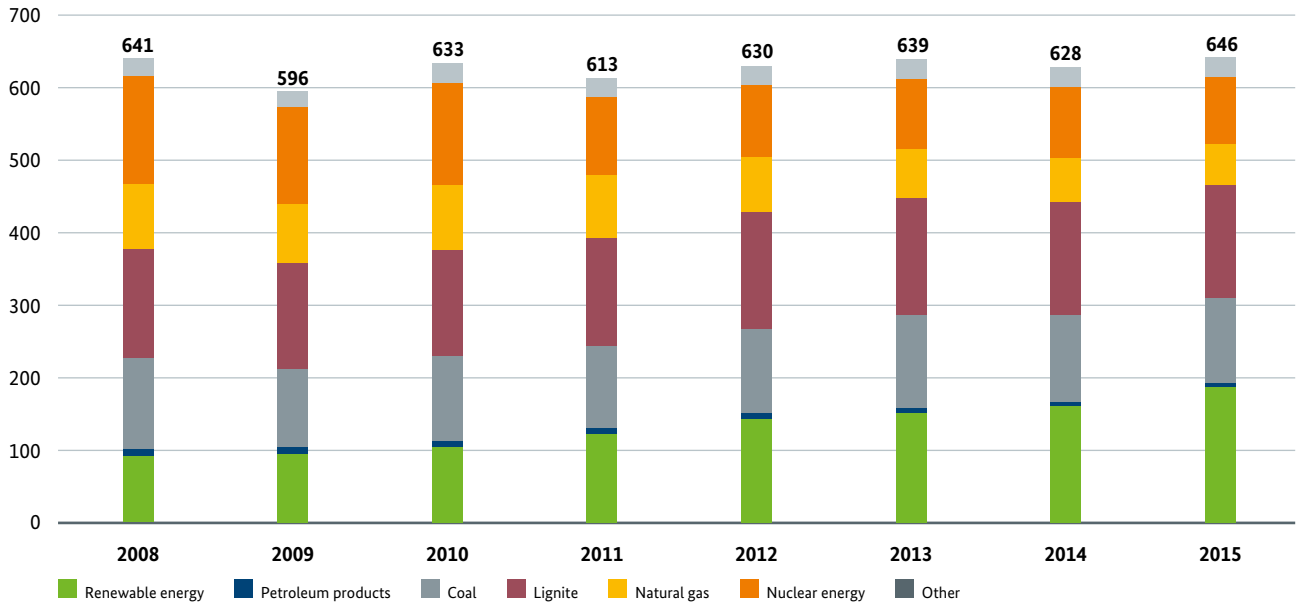
Table 3.1: Deployment corridor as defined in the Renewable Energy Sources Act 2014 and actual new installations in 2015

Technology	Target to increase the installed capacity under Section 3 of the Renewable Energy Sources Act 2014	Actual new installations in 2015:
Onshore wind	2,500 MW per year (net)	3,623 MW (net)
Offshore wind	6,500 MW by 2020; 15,000 MW by 2030	2,290 MW (net) (3,284 MW cumulative net)
Photovoltaic	2,500 MW per year (gross)	1,444 MW (gross)
Biomass	< 100 MW per year (gross)	14 MW (gross)*

Source: Working Group on Renewable Energy Statistics, August 2016
*The total increase in the installed capacity of biomass plants, primarily due to a non-generation-related change in capacity for flexibilisation purposes, amounted to 101 MW (net) in 2015.

Diagram 3.4: Gross electricity generation by energy source

In TWh



Source: Working Group on Energy Balances, August 2016

Renewables are consolidating their strong position in the German electricity mix. Total gross electricity generation in Germany increased in 2015 (see Diagram 3.4) and, at 645.5 TWh, exceeded gross electricity consumption (considers balance of electricity exchange with other countries) of 593.8 TWh. Compared with the previous year, the share of RES-based electricity generation in total electricity generation rose by around 3 percentage points in 2015, from 25.7% to 29.0%. This means that renewables produced roughly one third of German electricity in 2015 and were thereby able to further consolidate their strong position in the electricity mix. Renewables are now the number-one source of electricity in the electricity mix, ahead of lignite (155 TWh), coal (118 TWh) and nuclear energy (92 TWh). As in previous years, onshore wind proves to be the most important renewable source of electricity with a share of approximately 11% (71 TWh) in total electricity generation.

The energy transition in the electricity sector involves the continued development and enhancement of the entire system. In the first half of 2016, electricity generation from renewables rose by roughly 3% on the same period in the previous year. This can be attributed to a steadily increasing share in the electricity sector. The priority now is to adapt the entire energy supply system to a growing share of renewable energy whilst also safeguarding cost efficiency.

The laws adopted on 8 July 2016 have laid the cornerstones for this:

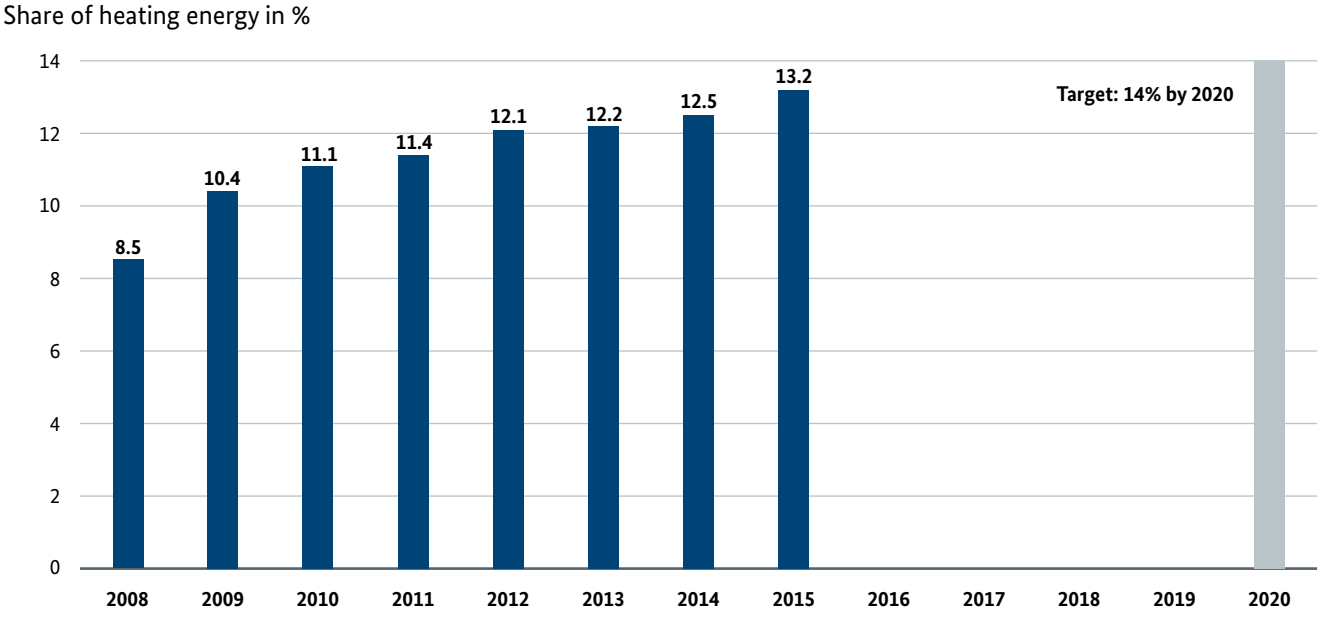
- By switching to a competitive auction system, the Renewable Energy Sources Act 2017 seeks to guarantee compliance with the deployment corridors for renewable energy, whilst ensuring the cost-efficient further expansion of renewables. In doing so, the Act makes renewables fit for the electricity market (see Chapter 3.5).
- The new Electricity Market Act creates an electricity market 2.0, which is ready for growing shares of renewables (see Chapter 8).
- The Act on the Digitisation of the Energy Transition signals the start of a modern infrastructure to successfully interlink all stakeholders involved in the supply of electricity in a smart grid (see Chapters 10 and 11.2).
- The reforms are embedded in the European internal market, thereby establishing the energy transition across national borders also (see Chapter 12).

3.3 Renewable energy in the heating sector

The trend in the development of renewable heat is positive. In 2015, renewables covered 13.2% (roughly 157.8 billion kWh) of heat consumed – up from 12.5% in 2014.

Diagram 3.5: Meeting the target for the share of renewables in heating and cooling energy consumption

2020 target	Renewables to provide 14% of heating and cooling energy consumed
Status 2015	13.2%



Source: Working Group on Renewable Energy Statistics, August 2016

Trend	●●●●●
Measures	Renewable Energies Heat Act, Market Incentive Programme

Renewable heat has increased disproportionally compared against total heat consumption. 2015 was a colder year overall compared with 2014. This was also reflected in an increase in total heat consumption, and increased generation from renewable sources which this also entailed.

Biomass remains the leading renewable source of heat. In particular, wood consumption of private households rose last year, also due to weather conditions. An increase in the number of pellet-fired plants also contributed to an increase in wood pellet consumption. With a share of roughly 88%, biomass (solid, liquid, biogas and biogenic waste) therefore remained the most important source of renewable energy in the heating sector overall. Heat pump heating systems and solar collectors provided around 7% and 5%, respectively, of total heat derived from renewables.

The 14% target for the share of renewables in total heating energy consumption will soon be reached. Current forecasts predict that, by 2020, final energy consumption for heating and cooling will drop by around 72 TWh compared with 2012. At the same time, the provision of heating and cooling from renewable sources can be expected to increase to 188 TWh. This means that renewables will likely have a 16.3% share in final energy consumption for heating and cooling in 2020, thereby not only reaching but also exceeding the 14% target set out in the Renewable Energies Heat Act.

The share of renewables in the heating and cooling sectors must continue to increase steadily to deliver on the goal of the Renewable Energies Heat Act in 2020. The entire building stock in Germany is to be virtually climate-neutral by 2050. As the Efficiency Strategy for Buildings has demonstrated, this will only be possible if serious progress is made by combining efficiency and the use of renewables for heating and cooling (see Chapter 5.4).

3.4 Renewable energy in the transport sector

2015 saw a decline in the consumption of energy derived from renewables in the transport sector. At 33.8 TWh, renewables accounted for around 5.2% of total final energy consumption, down slightly on the previous year. The share of biofuels in total final energy consumption stood at 4.6% in 2015, and the renewable share of the electricity consumed by electric vehicles at 0.6%. Biofuels therefore account for roughly 88% of renewable energy in the transport sector. One particular reason for the downward trend in the share of renewables in the transport sector was the decline in the share of biofuels compared with the previous year, which the increase in electric mobility was unable to offset. This is set against an increase in overall traffic-related energy consumption due to the increased volume of passenger and freight traffic compared with the previous year (see Chapter 6).

The system of promotion was changed in 2015 from a quota based on energy content for biofuels to a greenhouse gas quota. Under the new regulations, the petroleum industry is required to reduce the greenhouse gas emissions of its fuel products by 3.5% from 2015, by 4% starting in 2017 and by 6% from 2020 onwards. The greenhouse gas quota is currently being developed so that, alongside biofuels, other options can also count towards climate change mitigation in the transport sector (e.g. electricity used in electric vehicles). Biofuels with particularly low GHG emissions have entered the German market as a result of the GHG reduction quota (BLE 2016).

The importance of renewable electricity in the transport sector continued to grow in 2015 also. At 1.6% (42PJ/12 TWh), the total share of electricity in final energy consumption in the transport sector remained basically unchanged overall. However, renewable electricity consumption in the transport sector has increased, reflecting the strong increase in the share of renewables in gross electricity consumption, which stands at 31.6% (see Chapter 3.1), or 3.7 TWh in transport sector terms.

The Twelfth Act to Amend the Federal Pollution Control Act set the course to reach the 10% target for the transport sector set out in Directive 2009/28/EC. In line with applicable legal requirements, the greenhouse gas reduction commitment (greenhouse gas quota) will increase from the current rate of 3.5% to 4% starting in 2017 and to 6% from 2020 onwards. Further to this, the share of electricity in the transport sector will also increase as the better drive efficiency of electric motors in road and rail transport and the growing share of renewables in the power grid will also be taken into consideration in the future.

3.5 Renewable Energy Sources Act

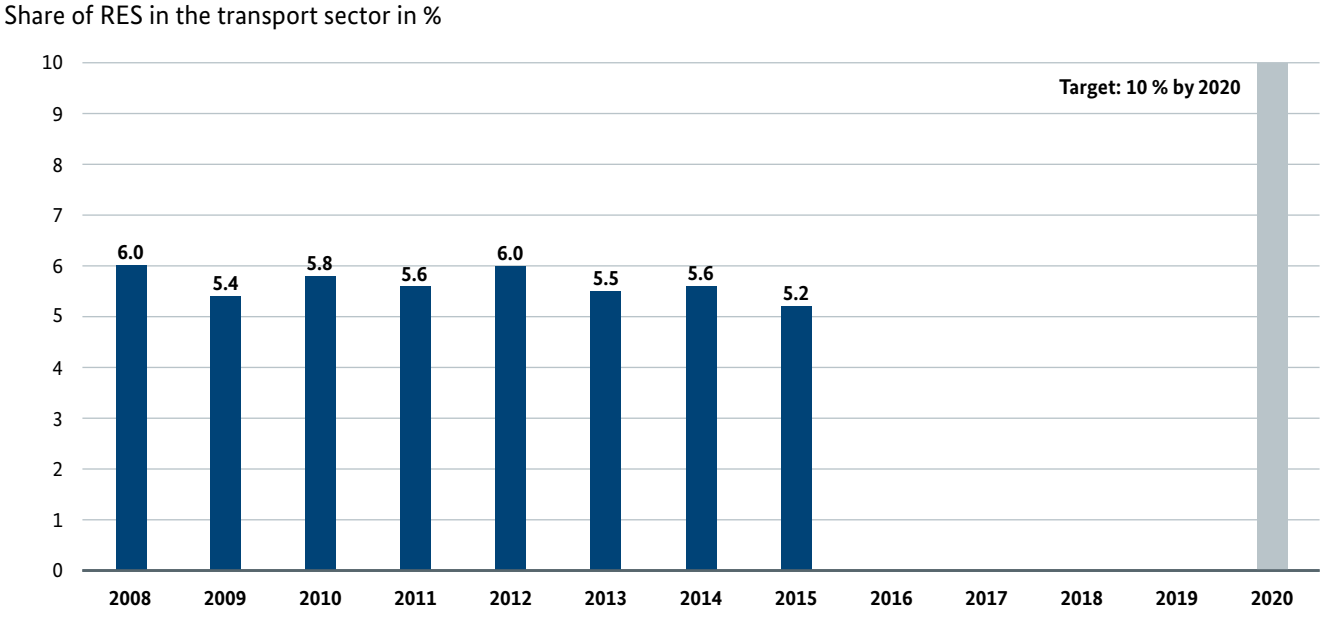
The Renewable Energy Sources Act is the central instrument for steering the expansion of renewable energy. The Act promotes the expansion of renewable energy sources in the electricity sector. Since the introduction of the Act in 2000, the share of renewables in gross electricity consumption in Germany has risen steadily from 6.2% to 31.6% in 2015 (see Diagram 3.2). The Act has undergone continuous development since its introduction – with amendments to the Act in 2004, 2009 and 2012, various PV revisions and the Renewable Energy Sources Act 2014 – as well as the most recent revision this summer, which comes into effect on 1 January 2017 ("Renewable Energy Sources Act 2017").

The Renewable Energy Sources Act 2014 paved the way to bring renewable energy more and more to the market and to determine the rate of financial support through a competitive process. The reform of the Renewable Energy Sources Act 2014 stipulated that the level of financial support for renewable energy was to be set by auction in a competitive framework by 2017 at the latest. To this end, the first pilot auctions for ground-mounted PV installations were held in 2015 and 2016. The aim was to build on the experience from these auctions to implement the system change, which is brought about in the new Renewable Energy Sources Act 2017. Under the provisions of this new Act, an auction system will also be introduced for onshore and offshore wind and for biomass in the future. In addition, the Renewable Energy Sources Act 2014 also introduced the compulsory direct sale of electricity. Since then, anyone producing electricity must also sell it.

The increasing level of direct sales with the market premium demonstrates that the switch from "feed-in" to "sales" is working. The direct sale of electricity is compulsory under the Renewable Energy Sources Act 2014. With this system, producers of RES electricity have the same responsibilities in the electricity system as conventional electricity producers: they forecast their electricity production, sell it on the electricity market and balance any deviations from the forecast on the intraday and balancing

Diagram 3.6: Meeting the renewables target in the transport sector

2020 target	10% share of renewables in the transport sector
Status 2015	5,2%



Source: Working Group on Renewable Energy Statistics, August 2016.

Trend	● ○ ○ ○ ○
Measures	Greenhouse gas quota, promotion of electric mobility amongst other measures

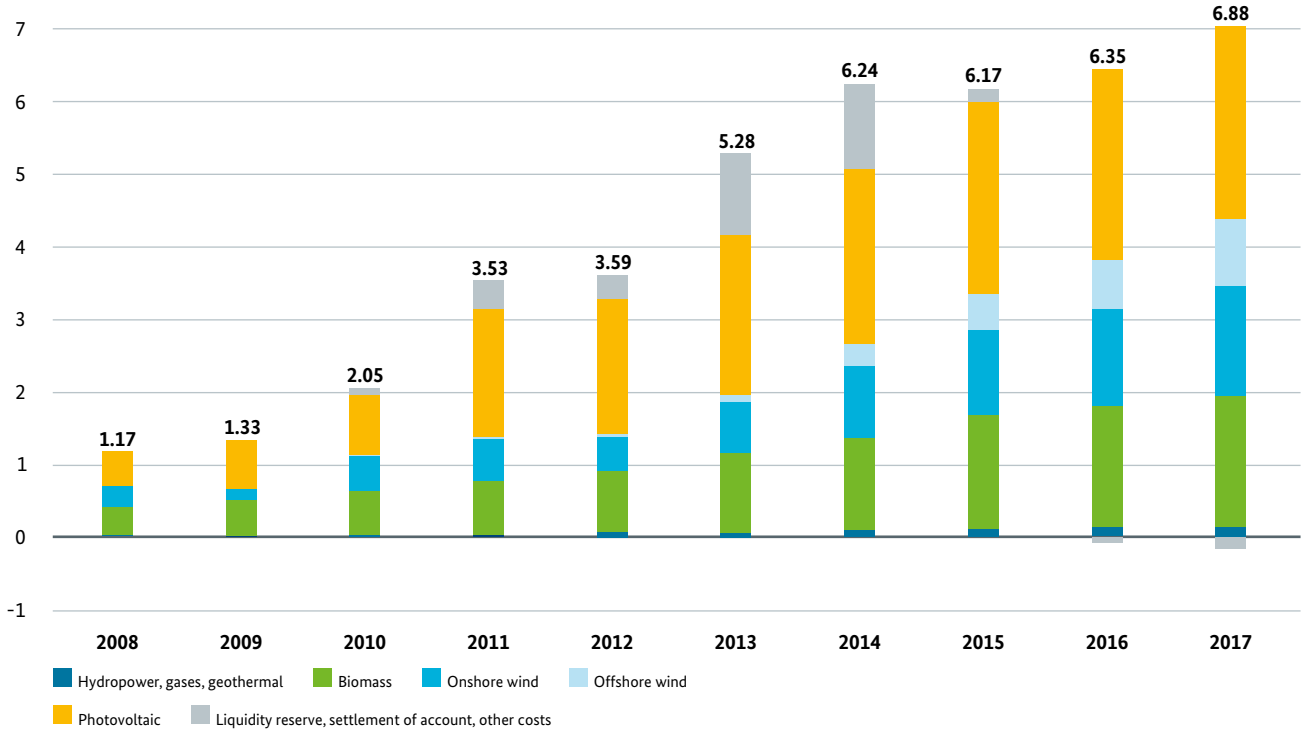
energy market. Compared against total generation capacities, the share of generation capacities registered with grid operators for the market premium increased from around 43% in 2013 to around 54% in 2015. At the end of 2015, generation capacities in the system of direct marketing totalled around 52.2 GW. With around 39.6 GW, wind energy continues to dominate the portfolio of RES electricity sold directly. The registered capacity for photovoltaics stood at around 7.0 GW at the end of 2015, while that for biomass was roughly 4.8 GW. Approximately 88% of the installed capacity of onshore and offshore wind installations sell their electricity through the market premium system. The corresponding share for biomass is around 72% and around 18% for PV.

Some 112 TWh of renewable electricity were supported through the market premium system in 2015. This is equivalent to roughly 60% of all electricity produced from renewable sources. The figure for 2014 was 84 TWh. Total funding through the market premium system amounted to roughly €11.6 billion in 2015 (2014: €8.6 billion).

The first pilot auctions are testament to the impact of competitive auctions on the expansion of renewables. With five invitations to tender so far, the pilot phase for ground-mounted PV installations has been characterised by a high level of participation and competition, and a heterogeneous bidder structure. Further questions with regard to the bidder structure and, in particular, the upholding of stakeholder diversity in this segment require further investigation. On the whole, the anticipated potential of competitive auctioning to reduce prices has been confirmed: within the space of one year, the price level has dropped from one round to the next, going from 9.2 to 7.41 ct/kWh on average. To fully assess the pilot stage, it is also necessary to wait for the final realisation rate of the projects awarded contracts through the pilot auctions. The realisation period is 24 months and will run until May 2017. So far 16.6% of the bid volumes have been implemented.

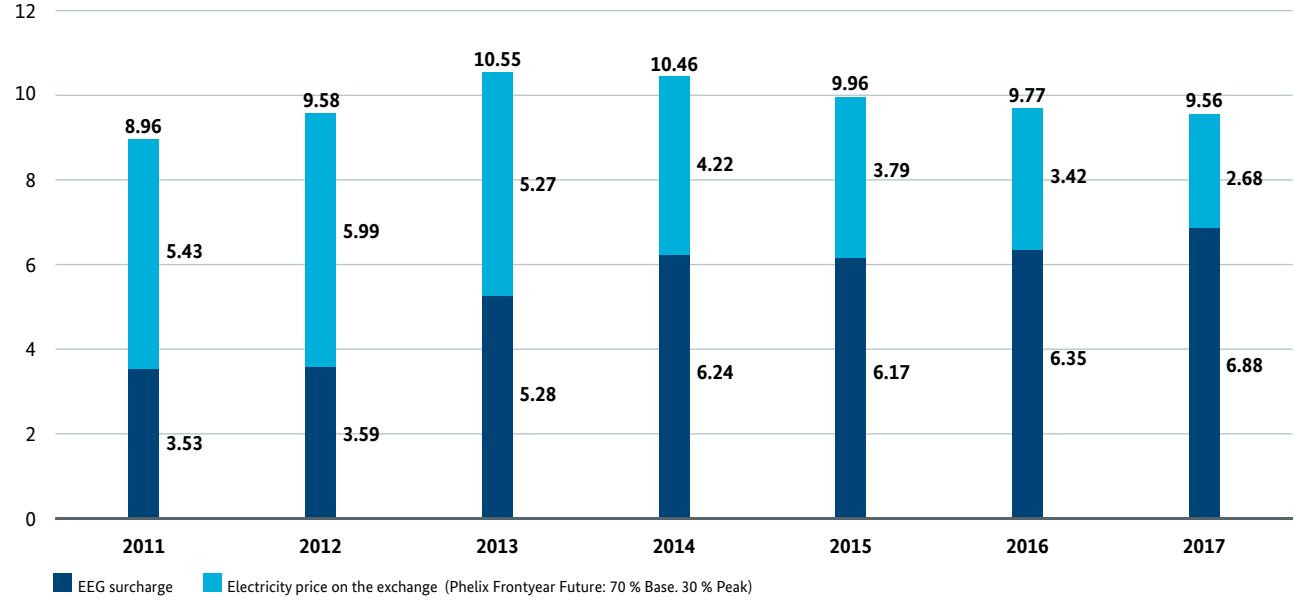
Financing for existing renewable energy plants continued to increase in 2015. The financing need is equivalent to the difference between remuneration or premium payments to the operators of existing RES plants under the Renewable Energy Sources Act and revenues from the sale of electricity from renewables on the electricity exchange. The prices and revenues on the electricity exchange fell in 2015, a development caused, inter alia, by the oversupply of power plant capacity and low demand for electricity in Europe. Renewables have themselves also contributed around 1 ct/kWh to the drop in prices on the electricity exchange on account of their low marginal costs (known as the merit-order effect). This is reflected in an increase in the cost of financial support, rising from €19.3 billion in 2014 to €21.8 billion in 2015. Remuneration for existing RES plants is based on guaranteed feed-in tariffs for periods of up to 20 years. Consequently, they cannot be modified, also against the backdrop of current and future reforms to the Renewable Energy Sources Act. It is still assumed that new installations will offer cost-saving potential as a result of advancements in technology and thereby drive down the rates of remuneration under the Renewable Energy Sources

Diagram 3.7: EEG surcharge by technology segment
ct/kWh



Source: Federal Ministry for Economic Affairs and Energy, October 2016 based on data from TSOs.
In 2016, the settlement of account marginally covers the liquidity reserve.

Diagram 3.8: Sum total of average electricity price on the exchange plus the EEG surcharge
ct/kWh



Source: Federal Ministry for Economic Affairs and Energy based on www.netztransparenz.de and the European Energy Exchange, October 2015
The electricity price on the exchange is represented by the average futures market price in the preceding year; situation in October 2015 for 2016.

Act. The need to finance RES is set against the positive impact of renewables, such as avoided emissions of greenhouse gases and atmospheric pollutants and the resulting reduction of harmful effects on health and the environment. In addition, the expansion of renewables produces macroeconomic benefits: for example, less use of fossil fuels causes energy imports to fall (see Chapter 7 and 12). In addition, the promotion of renewables in Germany through the Renewable Energy Sources Act and beyond has also contributed at an international level to a reduction in technology costs in the field of renewable energy.

The EEG surcharge in 2017 amounts to 6.88 ct/kWh. It is therefore 0.53 ct/kWh, or 8%, higher than the previous year. The EEG surcharge has inherited a large cost burden from the past, specifically payment for existing installations with high feed-in tariffs which cannot be altered due to the principle of the protection of legitimate expectations and the protection of vested interests. Falling prices for electricity on the exchange also reduce the sales revenues of these existing installations, increasing their need for support. In addition to the lower prices for electricity on the exchange, the expansion of offshore wind energy, which is currently still relatively expensive, is also a main factor contributing to the increase in the EEG surcharge (see Diagram 3.7).

The sum total of the electricity price on the exchange and the EEG surcharge has been falling since 2014. For electricity customers, the total amount they pay for their electricity bill is relevant. Even though the majority of consumers do not purchase electricity on the exchange to cover their needs, the total of the electricity price on the exchange and the EEG surcharge is relevant, as it gives an indication of the development of electricity procurement costs, which account for a third of a household customer's electricity bill. This total of the electricity price on the exchange and the EEG surcharge peaked in 2013 at 10.55 ct/kWh. Since then it has fallen for three consecutive years and is likely to drop again in 2017 despite an increase of roughly 40% in remunerated RES-based electricity generation between 2013 and 2017 (see Diagram 3.8). It has therefore been possible to slow down the cost dynamics of previous years appreciably.

The Renewable Energy Sources Act 2017 introduces a paradigm shift in renewables support towards more competition and greater cost efficiency. The Renewable Energy Sources Act 2017 marks the end of a period of technology support characterised by politically defined funding amounts. By largely changing the system of funding to one based on competitive auctions, the Act makes the further expansion of renewables cost-efficient. In addition, the expansion of onshore wind will temporarily be adapted locally in areas with high grid congestion.

Central measures for renewable energy in the electricity, heating and transport sectors

Renewable Energy Sources Act 2017

The Act **aims** to ensure the cost-effective continued expansion of renewables, establish a level playing field for all stakeholders in the auction system, maintain stakeholder diversity and comply with the deployment corridors for renewable energy.

Scope

- The necessary remuneration for the majority of renewable electricity is determined through auctions.
- With the switch to a competitive system, the framework will be created to maintain stakeholder diversity.
- Energy companies formed by members of the public (citizens' energy companies) are defined for the first time in the Act and can take part in the auctions under more relaxed conditions.
- Better dovetailing between the expansion of renewables and grid expansion by temporarily limiting local onshore wind expansion in areas with existing grid congestion.
- The remuneration for onshore and offshore wind, photovoltaics and biomass is determined through an auction system. Small installations are exempted from the obligation to take part in the auction process.

Facts and figures

Annual expansion targets/quantities up for auction:

- PV installations: 600 MW per year
- Onshore wind up to 2019: 2,800 MW gross per year; then 2,900 MW from 2020 onwards
- Offshore wind: 500 MW each year in 2021 and 2022; 700 MW per year from 2023–2025, and 840 MW per year starting in 2026
- Biomass: 150 MW from 2017–2019 and 200 MW from 2020–2022

Act to Revise the Renewable Energy Sources Act

Goals

- A funding system designed in a way that respects state aid law, and better systematisation of the rules governing self supply.

Scope

- The rules surrounding self supply are recast, but only certain areas of the current legal situation are modified (particularly with regard to modernised existing plants and reporting requirements).
- With vested rights adequately protected, existing self-supply installations will have to contribute partially to the EEG surcharge in the future if they undergo modernisation measures.
- Reporting obligations for self-supply which were previously regulated by both the Equalisation Mechanism Ordinance and the Renewable Energy Sources Act are now harmonised in the Renewable Energy Sources Act.

2015 Revision of the Market Incentive Programme

(see Chapters 4 and 5)

Goals

- More private, commercial and municipal investment in renewable heat plants

Scope

Promotion of the installation of solar thermal collectors, biomass heating systems or heat pumps for private citizens, freelance professionals and businesses based on a two-pronged approach:

- Firstly: grants from the Federal Office for Economic Affairs and Export Control (BAFA) for smaller installations in private households and business enterprises.
- Secondly: low-interest loans and repayment grants from Germany's state-owned development bank, *Kreditanstalt für Wiederaufbau (KfW)*, for large, commercial installations. The Revision came into force on 1 April 2015.

Facts and figures

- Funding budget of €300 million per year

Harmonised regulatory system for the heating market

(see Chapter 4)

Measures regarding electric mobility/biofuels/rail transport

(see Chapter 6)

4 Energy consumption and energy efficiency

Where do we stand?

Primary energy consumption rose slightly in 2015. Economic growth, population increase and the somewhat colder weather conditions contributed to this increase. Despite this, at 13,293 PJ primary energy consumption was at its second lowest level since 1990.

Primary energy consumption is to drop by 20% by 2020 compared with 2008 levels. To make the necessary progress in this regard, the Federal Government adopted the National Action Plan on Energy Efficiency (NAPE) in 2014 to boost energy efficiency further. The central measures of the NAPE are implemented by now, or have been introduced and are starting to work. Complementing this, a public awareness-raising and mobilisation campaign was launched in May 2016.

What is new?

With the publication of the Green Paper on Energy Efficiency, the Federal Ministry for Economic Affairs and Energy launched a discussion in summer 2016 on the strategic direction of, and additional approaches to, a long-term, target-oriented efficiency policy of the Federal Government.

The principle of “Efficiency First” is a central pillar for the Federal Government, as this is the only way to adequately limit demand and expand renewables in a resource-friendly, environmentally compatible manner.

	2015	2020	2030	2040	2050
Efficiency and consumption					
Primary energy consumption (compared with 2008)	-7.6%	-20% →			-50%
Final energy productivity (2008–2050)	1.3%/year (2008–2015)	2.1%/year (2008–2050)			
Gross electricity consumption (compared with 2008)	-4.0%	-10% →			-25%

4.1 Primary energy consumption and primary energy productivity

Primary energy consumption rose slightly in 2015 compared with the year before. Primary energy consumption comprises conventional and renewable energy. In 2015, primary energy consumption stood at 13,293 PJ, and was therefore up 0.9% on 2014 (see Diagram 4.1). The increase in consumption is primarily attributable to the somewhat colder weather conditions in 2015 compared with the previous year, as a considerable proportion of primary energy is used to heat spaces. Economic growth of 1.7% and a population increase of around 606,000 were also contributing factors. Following adjustments for weather conditions, the level of primary energy consumption in 2015 remained roughly the same as in the previous year. The effects of economic developments and population growth, which tended to drive up consumption, were offset by improvements in energy efficiency.

Compared with the reference year, 2008, primary energy consumption in Germany had dropped by 7.6% in total in 2015. To achieve the 20% reduction target by 2020, energy consumption must drop annually by 2.8% on average. If this value is compared with the annual average reduction of 1.1% achieved thus far, it is clear that considerable, redoubled efforts are needed to deliver on the goal.

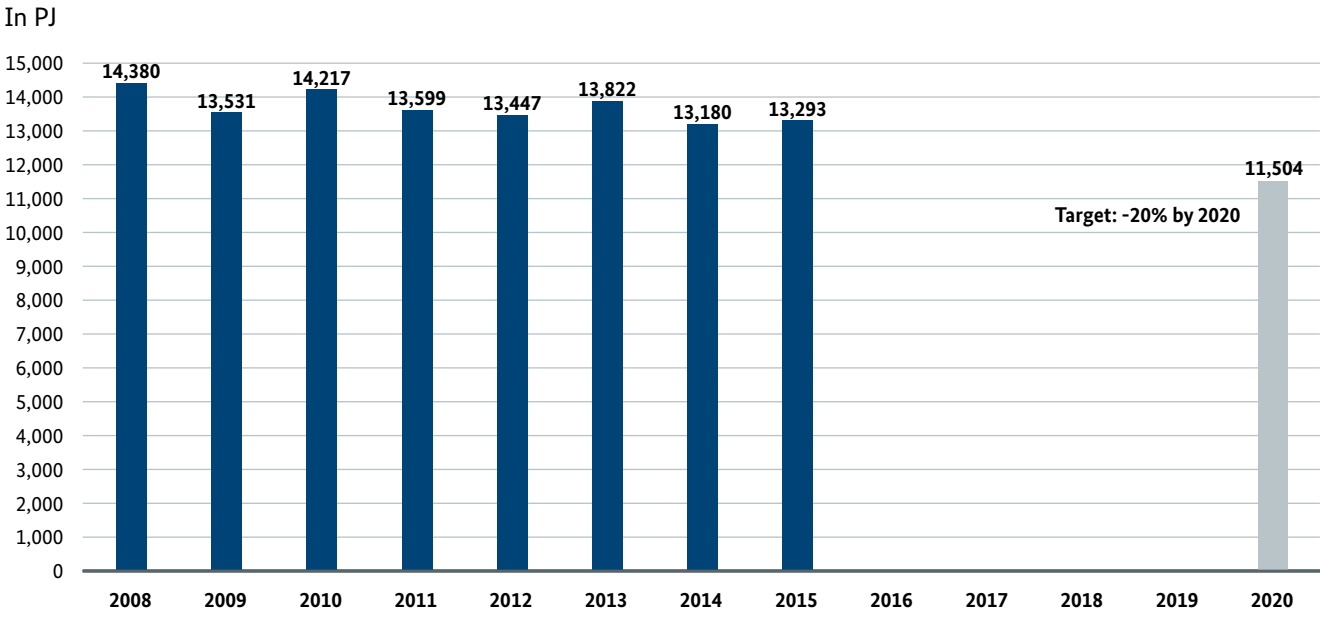
Demand for renewable energy and natural gas increased considerably. There was practically no change in demand for oil, while demand for other energy sources, such as petroleum, coal, lignite and nuclear, was on a downtrend to a greater or lesser extent. The comparatively cold winter in 2015 contributed to the higher demand for natural gas, particularly in the heating market.

In the first nine months of 2016, primary energy consumption increased slightly by 0.3% compared with the same period in the previous year. The favourable economic climate was the main reason for this development. The increase in natural gas consumption was particularly pronounced. This was due, inter alia, to the fact that more natural gas was used for electricity generation compared with the same period in the previous year. Petroleum consumption also increased, primarily due to the significantly higher consumption of diesel fuel. In contrast, the consumption of coal, lignite and nuclear declined. The milder weather conditions compared with the previous year had the effect of dampening demand for fuels for heating.

In addition to absolute energy consumption, how efficiently a national economy uses energy is also of central importance. Energy efficiency is one indicator of this. To determine energy efficiency, it is necessary to calculate the ratio of a country's economic output (e.g. gross domestic product or

Diagram 4.1: Meeting the primary energy consumption target

2020 target	20% reduction in primary energy consumption (compared with 2008)
Status 2015	-7.6%



Source: Working Group on Energy Balances, August 2016

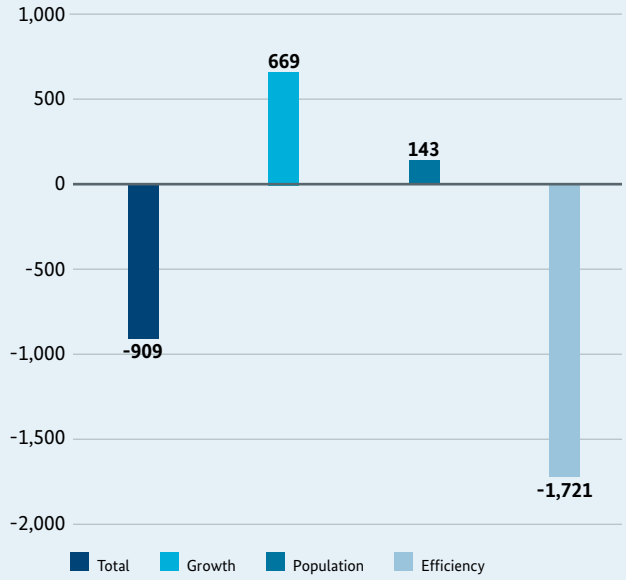
Trend	●●●○○
Measure	National Action Plan on Energy Efficiency

Factors influencing energy consumption

The changes in primary energy consumption are attributable to a number of factors. Apart from weather conditions, the most important determinants are the development of the population (demographic component), the gross domestic product per inhabitant (growth component) and macroeconomic energy intensity (energy intensity component). By analysing the components using the decomposition model proposed by Sun (1998), for example, it is possible to draw conclusions about the contribution of the individual factors influencing the development of primary energy consumption. The individual contributions quantify the change in total energy consumption that would occur, in theory, if just one of the components were to change while all the other factors remained constant.

The result, after adjusting for temperature differences, is that the overall decrease of 909 PJ in energy consumption between 2008 and 2015 is largely attributable to improvements in energy efficiency. In contrast, the positive economic developments during this period had the effect of increasing energy consumption. Taken in isolation, the total population increase of around 825,000 people also drove up energy consumption slightly. The component decomposition illustrates that efficiency efforts made during the 2008-2015 period with a view to reaching the primary energy consumption goals overcompensate for effects that drive up consumption, such as increasing per capita income and population growth.

Diagram 4.2: Components influencing the change in adjusted primary energy consumption in Germany in the period 2008–2015
In PJ



Source: Federal Ministry for Economic Affairs and Energy, based on data from the Working Group on Energy Balances, October 2016

gross value added) to energy consumption. Energy productivity therefore indicates the value of goods and services that can be produced with one unit of energy.

Primary energy productivity has increased slightly on the previous year. In 2015, it was possible to produce 0.8% more products and services with the same amount of energy compared with the previous year (see bottom curve in Diagram 4.3). Adjusted for the effects of the comparatively cold winter in 2015 and for changes in inventories, the increase, at 1.9%, on 2014 is more pronounced.

4.2 Final energy consumption and final energy productivity

Final energy consumption has increased compared with the preceding year. Final energy is the share of primary energy that is available to consumers after deductions for energy lost during transmission and conversion. In 2015, final energy consumption stood at 8,877 PJ, up 2% on 2014. In particular, the consumption of long-distance heating has risen significantly, up by 7.7%. Following adjustments for the effects of temperature and inventories, final energy consumption in 2015 rose 1% on the previous year.

Final energy productivity has remained more or less constant. The Federal Government's Energy Concept also refers the efficiency goal to final energy productivity, i.e. to the real gross domestic product per unit of final energy consumption. Final energy productivity stood at €313.50/PJ in 2015 compared with €314.60/PJ the previous year (see top curve in Diagram 4.3). Following adjustments for the effects of temperature and inventories, final energy productivity increased slightly by 0.7%.

Between 2008 and 2015, final energy productivity increased by 1.3% on average each year, which falls short of the target of an annual increase of 2.1%. To reach this target, final energy productivity must increase by an average of 3.3% per year through to 2020.

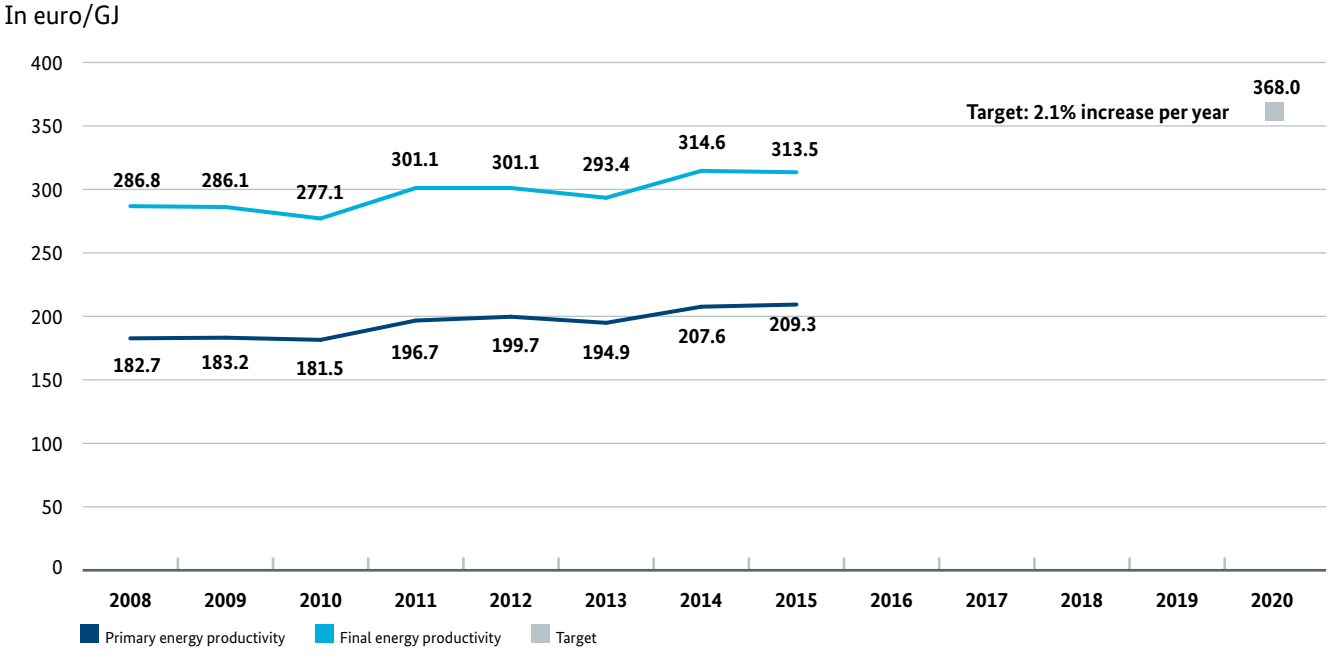
With the National Action Plan on Energy Efficiency (NAPE), the Federal Government launched a raft of measures in 2014, which – in addition to existing instruments – promote energy efficiency in central areas such as buildings and production (see Chapters 4.4 and box of measures). On 1 July 2015, the leaders of the CDU, CSU and SPD coalition parties adopted additional measures to bring about the necessary increase in energy efficiency. These measures aim to cut an additional 5.5 million tonnes of CO_2 (as a contribution to achieving a reduction of 22 million tonnes of CO_2 equivalent in the electricity sector) through energy efficiency measures in buildings, the municipalities, in industry and at German rail provider Deutsche Bahn AG. The Federal Government is providing a total of over €17 billion for measures to strengthen energy efficiency in the period from 2016 to 2020.

A broad-based campaign to boost energy efficiency was also launched in May 2016. The aim of the mobilisation and awareness-raising campaign "Germany Makes it Efficient" is to bring about a change in the mindset towards the more efficient use of energy and raise public awareness of possible ways to increase energy efficiency. The campaign is geared to private households, business enterprises and public institutions alike, and involves all the stakeholders.

The Federal Government is currently working on farther-reaching approaches to greater energy efficiency. To this end, the Federal Ministry for Economic Affairs and Energy published the Green Paper on Energy Efficiency in August 2016. The Green Paper contains hypotheses, analyses and key questions of the Federal Ministry for Economic Affairs and Energy concerning the central action areas and challenges associated with increasing energy efficiency and energy saving. The Green Paper launched a process of consultation which will form the basis for the development of

Diagram 4.3: Meeting the energy productivity target

2020 target	Increase final energy productivity by 2.1% per year
Status 2015	1.3% annually since 2008



Source: Working Group on Energy Balances, August 2016

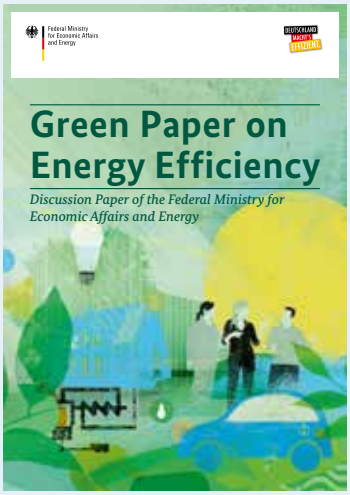
Trend	●●●○○
Measures	National Action Plan on Energy Efficiency

The Green Paper on Energy Efficiency published by the Federal Ministry for Economic Affairs and Energy places a priority on the principle of "Efficiency First"

The Green Paper on Energy Efficiency published by the Federal Ministry for Economic Affairs and Energy presents "Efficiency First" as a central element of a long-term strategy to reduce energy consumption. The central idea is that the cleanest and cheapest form of energy is energy that does not need to be generated in the first place. Firstly, the demand for energy must be reduced significantly and permanently in all sectors; secondly, renewable energy is used directly in all sectors wherever possible and economically viable; and thirdly, electricity from renewable sources is used efficiently for heating, transport and industry (sector coupling). "Efficiency First" aims to strengthen energy efficiency as a cornerstone of the energy transition.

From a **planning perspective**, the implementation of Efficiency First involves system-wide optimisation. This means that the demand side is primarily optimised by leveraging efficiency potential, and the size and design of the system is demand-led. Energy efficiency saves energy, helps reduce greenhouse gas emissions and facilitates the overall transition of our energy system to one based on renewables, provided that rebound effects are avoided. In future, the direction of energy efficiency policy is to be more closely aligned with the basic aim to make savings anywhere this is cheaper from a macro-economic point of view than building new generation, storage and grid capacities. After all, the sensible prioritisation of energy efficiency over the expansion of generation capacity can result in the cost optimisation of the energy system. In other words, Efficiency First means also taking economic efficiency and greenhouse gas neutrality into consideration.

More in-depth studies are required for further details of, and approaches to, potential operationalisation. **International comparisons**, in particular, are also very useful to this end. Different regulatory approaches must be considered in this context.



a medium- to long-term Federal Government strategy to reduce energy consumption. This process of consultation comprises online consultation, the Energy Transition Platform on Energy Efficiency and regional events.

4.3 Electricity consumption and electrical energy efficiency

Gross electricity consumption rose slightly in 2015. Gross electricity consumption refers to the volume of electricity consumed in Germany. It stood at 594 TWh in 2015, and had therefore increased by 0.3% on the previous year (see Diagram 4.4). A decomposition of the components using the same model as applied above for primary energy consumption reveals the following: the increase in gross electricity consumption is primarily attributable to the growth of the economy and the population increase. These factors, which tend to drive up consumption, could be offset in part – but not fully – by improvements in efficiency. In the first nine months of 2016, gross electricity consumption rose slightly by 0.4% compared with the same period the previous year.

Between 2008 and 2015, gross electricity consumption declined by around 4%. This is equivalent to an average annual reduction of roughly 0.6%. To achieve the 10% reduction target by 2020, electricity consumption must fall by a further 37 TWh, translating to an annual reduction of around 1.3%. This comparison makes it clear that considerable additional effort is also needed here if Germany is to reach the goals set out in the Energy Concept by 2020. If we are to make further progress with decarbonisation in the heating and transport sectors, increasing amounts of green electricity should be used efficiently in these sectors within the context of sector coupling. To keep the additional need for renewable electricity to a minimum, sector coupling should always use the technologies that efficiently convert electricity to heat, cold or propulsion energy, or that use a small amount of electricity to harness a maximum amount of renewable energy, and thereby replace the largest possible amount of fuel with a small amount of renewable electricity (see Chapter 11.1).

Macroeconomic electricity productivity increased in 2015. Macroeconomic electricity productivity expresses the ratio of real GDP to total gross electricity consumption and is

therefore an indicator of how efficiently an economy uses electricity. In 2015, it registered an increase of 1.4% on the previous year. There has been a trend towards greater decoupling of economic growth from the development of electricity consumption ever since the 1990s. Macroeconomic electricity productivity in 2015 was around one third higher than the 1990 level, and increased by around 1.2% on average each year during this period.

The measures set out in the National Action Plan on Energy Efficiency (NAPE) and updates to the NAPE will provide fresh stimulus for reducing electricity consumption and increasing electrical energy efficiency. Many of the measures also address the electricity sector, such as the National Top-Runner Initiative to increase the market penetration of energy-efficient products, and the STEP up! programme for the promotion of electrical energy efficiency measures in a competitive tendering framework. In addition, the implementation of the EU Directive on the eco-design of products and the transposition and amendment of the EU Directive on energy consumption labelling will make a major contribution to increasing efficiency in the electricity sector.

4.4 National Action Plan on Energy Efficiency

With the National Action Plan on Energy Efficiency (NAPE), the Federal Government has launched a comprehensive strategy to deliver on the energy consumption goal. NAPE defines immediate actions and farther-reaching work processes in order to meet the national efficiency and climate goals. It also makes a significant contribution to the 2020 Climate Action Programme, which focuses on reaching the 2020 climate change goal.

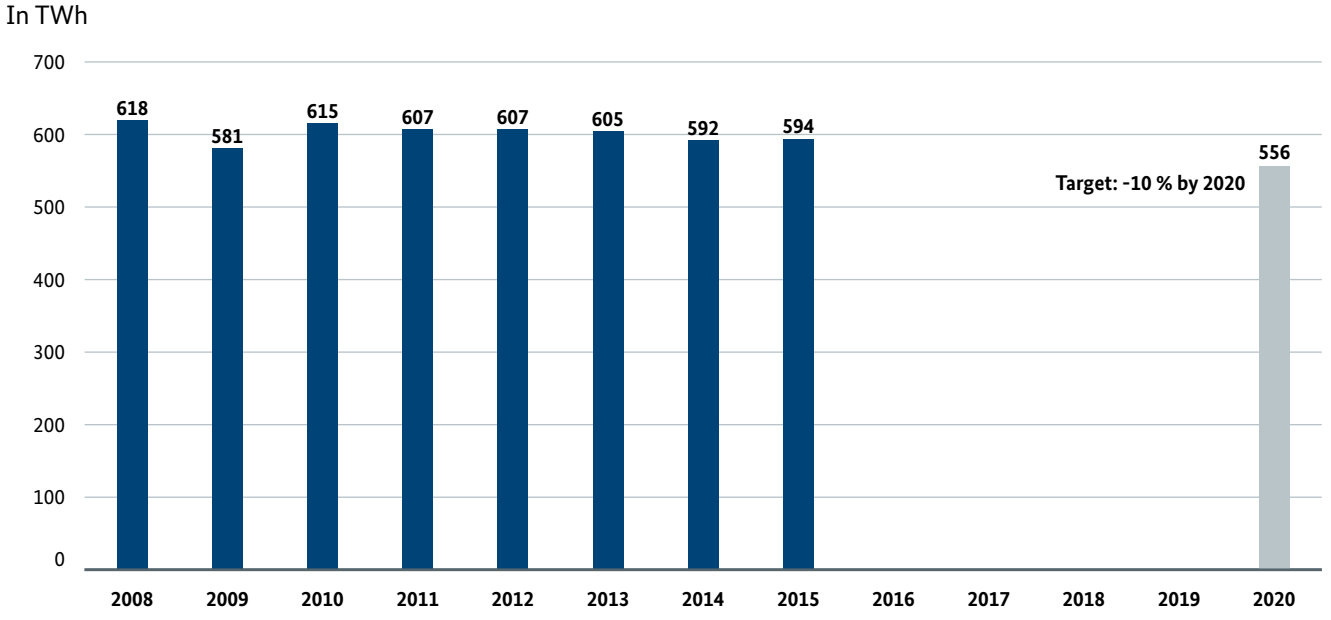
The most important action areas of energy efficiency policy are to:

- Step up energy efficiency in the buildings sector
- Establish energy efficiency as a business model and a model for generating returns on investment
- Increase personal responsibility for energy efficiency

For these action areas, the NAPE defines cross-cutting measures designed to reduce energy consumption on the demand side.

Diagram 4.4: Meeting the gross electricity consumption target

2020 target	Reduce gross electricity consumption by 10% by 2020 (compared with 2008)
Status 2015	-4.0%



Source: Working Group on Energy Balances, August 2016

Trend	●●○○○
Measures	National Action Plan on Energy Efficiency

Energy efficiency will be increased with a broad array of measures. NAPE measures to boost energy efficiency aim to save 390–460 PJ of energy in total by 2020.

NAPE monitoring will be more in-depth in the further course of the monitoring process. The general state of implementation of the NAPE and the central measures of the NAPE in terms of their goal and content will firstly be examined in the following section. These measures were implemented or introduced in 2015 and 2016 and are starting to work. In this context, it is worth noting that measures typically do not deliver maximum effects at the start, as implementation structures must first be established and awareness of the measures raised among the target groups. As a result, a higher level of support is only possible over time. Therefore, for most measures it is still too early to quantify the effects on the basis of a detailed evaluation. The measures will be monitored in more detail in the further course of the monitoring process. The Federal Government's Climate Change Report provides an analysis of the current state of implementation of the NAPE measures and their impact on emissions reduction according to the current state of planning and – where available – the current state of implementation with a view to reaching the GHG reduction target.

The implementation of the NAPE and other measures to boost energy efficiency is making headway. For example, the Market Incentive Programme for renewable energy in the heating market and the CO_2 Building Modernisation Programme – with the KfW schemes it finances for residential and non-residential buildings – have been expanded or scaled up. Overall, all the key measures of the NAPE Immediate Action Programme have already been implemented or introduced. Additional NAPE programmes commenced recently, such as the promotion of electrical energy efficiency measures in a competitive tendering framework (STEP up!) and the Energy Savings Meter pilot programme for the promotion of digital solutions for the energy transition. STEP up! and the Energy Savings Meter pilot programme, in particular, signal the move to a results-based system of support for efficiency measures that is open to all technologies. In addition, programmes are also in place that complement the NAPE on the basis of the decisions made by the leaders of the coalition parties CDU, CSU and SPD on 1 July 2015. Examples include the funding programme to prevent and utilise waste heat in commercial businesses and the revised Programme to Promote High-efficiency Cross-cutting Technologies.

Central measures in the area of energy efficiency

National Action Plan on Energy Efficiency

as well as further refinements and complementary programmes on the basis of the decisions made by the leaders of the coalition parties CDU, CSU and SPD on 1 July 2015

Updated CO_2 Building Modernisation Programme (KfW funding programmes for energy-efficient construction and retrofitting)

Goals

- Step up energy retrofitting of residential buildings through new and improved incentives and greater involvement of the commercial and municipal/social sector (energy-efficient new builds and modernisation of non-residential buildings).

Scope

- Support particularly encompasses new building construction and building energy-retrofits to meet the KfW energy efficiency standards, as well as individual energy efficiency measures. Support is provided in the form of grants or low-interest loans combined with repayment subsidies based on the following principle: the higher the level of energy efficiency, the higher the financial support.

Facts and figures

- Funding of €2 billion per year in 2015 and 2016

Energy Efficiency Incentive Programme

Goals

- Smart combination of individual measures, market rollout of fuel cell heating, and increased consumer awareness for energy efficiency

Scope

- Promote the introduction of innovative fuel cell heating on the market, the installation of ventilation systems in connection with renovation measures on the building shell, the replacement of inefficient heating systems with efficient ones, and an information campaign to promote investment measures. The programme commenced in January 2016 and has been incorporated into the established structure of the CO_2 Building Modernisation Programme and the Market Incentive Programme.

Facts and figures

- Annual programme funding of €165 million through to 2018 inclusive

Continued development of the Market Incentive Programme for renewables in the heating market

(see Chapter 3)

National Efficiency Label for old heating systems

Goals

- Increase the rate of replacement of old, inefficient boilers

Scope

- Starting in 2016, the new efficiency label applies for boilers that are more than 15 years old, and provides consumers with an individual assessment of the efficiency of their boiler systems. In addition, consumers receive information about farther-reaching energy consulting services and funding programmes.

Facts and figures

- Approximately 13 million boilers will be labelled over the next 8 years. The measure has the potential to increase the annual replacement rate by approx. 20% to 3.7%.

Promotion of heating optimisation using high-efficiency pumps and hydraulic balancing

Goals

- Promotion of the replacement of old pumps with high-efficiency heating and warm water circulation pumps in buildings and optimised heating through the use of hydraulic balancing and low-cost measures

Scope

- The funding programme seeks to support the replacement of up to 2 million pumps in buildings and the additional optimisation of up to 200,000 heating systems per year by 2020, with the aim of cutting around 1.8 million tonnes of CO_2 by 2020. The programme commenced in August 2016.

Facts and figures

- Funding of roughly €100 million is available in 2016.

Updated “Production Facilities and Processes” KfW efficiency programme

Goals

- Promotion of energy-efficient production facilities and production processes

Scope

- The KfW offers interest-rate subsidies for the promotion of energy-efficient production facilities and production processes. The programme has been refined to align the level of funding with the amount of energy savings achieved. In addition, collaboration with institutions that provide financial support at *Land* level is being expanded and the measure is being openly advertised.

Facts and figures

- 257 loan approvals with a total value of roughly €970 million were granted in 2015. In the first quarter of 2016, 136 loan approvals had been granted with a total value of around €400 million.

Energy Efficiency Networks Initiative

Goals

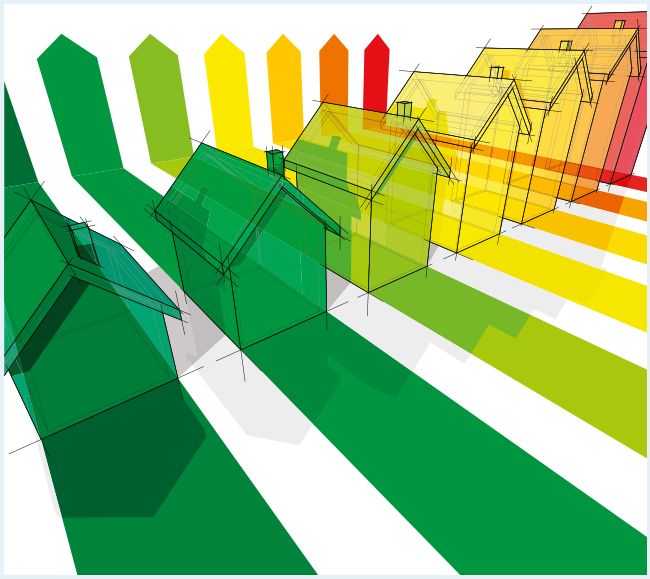
- 500 energy efficiency networks set up and established on a voluntary basis by 2020

Scope

- Businesses define efficiency goals for themselves and for the network as a whole and implement suitable measures. The Federal Government and 21 business associations and organisations are members of the alliance for action. Participating businesses benefit from the structured sharing of experience and ideas to increase energy efficiency.

Status

- Over 90 new networks with around 1,000 businesses have been set up so far.



Mandatory energy audits for non-SMEs

Goals

- Identify potential for energy savings in company energy supply systems, provide incentive for the introduction of an energy management system to ISO 50 001

Scope

- Entering into force in April 2015, the amended Energy Services Act requires large businesses to perform energy audits according to EN 16247-1 by 5 December 2015, and every four years thereinafter, or alternatively introduce an energy management system to ISO 50001 or an environmental management system to EMAS by 31 December 2016.

Facts and figures

- According to the explanatory memorandum to the law, up to 50,000 businesses in Germany fall under the rules for mandatory energy audits. The Federal Office for Economic Affairs and Export Control is responsible for the enforcement of the law. In 2016, it conducted a representative number of spot checks to check compliance with the requirement for mandatory energy audits.

Programme to Promote High-efficiency Cross-cutting Technologies

Goals

- Unlock the savings potential of cross-cutting technologies

Scope

- The funding programme has been continued in a new format since May 2016. While it continues to promote certain technologies as before, a number of new elements have also been added. In particular, new groups qualify for support, and now big companies with over 500 workers can also apply for funding.

Facts and figures

- In the past three years, roughly 35,000 small and medium-sized enterprises received support of around €189 million to invest in energy-efficient cross-cutting technologies. These measures delivered energy savings of around 1,000 GWh per year and cut CO_2 emissions by around 0.6 million tonnes of CO_2.

"Put Waste Heat to Work" – Waste Heat Prevention Campaign

Goals

- Prevent and utilise waste heat

Scope

- Promotion of investment in waste heat prevention and utilisation in business enterprises. The programme commenced in May 2016.

Facts and figures

- The Federal Ministry for Economic Affairs and Energy expects that around 1,300 complex, systemic measures can be implemented with the programme. The aim is to achieve additional annual CO_2 savings of 1 million tonnes through the programme by 2020.

Programme to Promote Energy-efficient and Climate-smart Production Processes

Goals

- Promotion of investment designed to boost energy efficiency in industrial production processes, reduction in energy consumption, energy costs and greenhouse gas emissions

Scope

- Support is given to measures to improve energy efficiency in commercial and industrial production processes, particularly measures to move production methods and processes to energy-efficient technologies, and measures for the efficient use of energy from production processes and systems within the company

Facts and figures

- With support granted to around 60 projects and an anticipated investment budget of €7 million, around 180,000 tonnes of CO_2 have been avoided annually so far, which translates to primary energy savings of 2.54 PJ per year.

Competitive tendering scheme for electrical energy efficiency measures (STEP up!)

Goals

- Reduce electricity consumption through the promotion of electrical energy investment measures across all technologies, stakeholders and sectors

Scope

- Funding is awarded to electrical energy efficiency measures that promise the best electricity savings per "euro of funding" within a competitive tendering procedure. The first round of tendering began on 1 June 2016.

Facts and figures

- A budget of €300 million is available for the pilot phase through to the end of 2018.

Promoting energy savings contracting

Goals

- Encourage municipalities and small and medium-sized enterprises (SMEs) to tap existing potential for energy savings, remove barriers in the allocation of loans (long contract periods, high costs of investment) by expanding the existing guarantee offer

Scope

- Since the start of 2015, the Federal Government has supported advisory services for municipalities and SMEs with a focus on the development of energy savings contracting projects and associated bid invitation processes. In addition, the guarantee offer seeks to reduce the risk of default with the goal that SMEs, inter alia, also act as contractors.

Facts and figures

- 24 of the 26 applications made received approval, with 18 applications for orientation advice, 5 for implementation advice and 1 for advice regarding bid invitations.

Refinement of the SME Energy Transition and Climate Action Initiative

Goals

- Close involvement of the craft trades and commerce in the energy transition restructuring process

Scope

- Strengthen local dialog, optimisation of advisory services and greater exchange of experience and knowledge-sharing. Notice of the first allocation decisions was served at the end of 2015, and the kick-off event was held in April 2016.

Facts and figures

- Funding for this measure amounts to €2 million in total through to 2018 (inclusive). 20% of the costs are covered by the German Confederation of Skilled Crafts (ZDH), the seven participating environment centres or chambers of crafts and the Heinz-Piest Institute. So far, over 16,000 contacts with businesses have been established, 60 model businesses identified and some 300 energy scouts trained.

Energy Management Systems funding programme

Goals

- Promote the establishment of measures and systems that enable the systematic recording and analysis of energy consumption levels and create the framework to implement effective energy efficiency measures building on this information.

Scope

- Funding for the initial certification of an energy management system to DIN EN ISO 50001 or an alternative system according to Annex 2 of the Efficiency System Ordinance (regulation on the energy tax cap and energy efficiency), the purchase of sensing, metering and instrumentation technology, and software.

Facts and figures

- A total of 610 applications for funding were submitted between July 2013 and May 2016.

Energy Savings Meter pilot programme

Goals

- Support businesses wishing to trial and demonstrate digital solutions and new business models among third-parties (end customers) to save energy and to manage loads to serve the needs of the power grid. End customers in this context can be households, trade, commerce and the services industry. This is done by using digital metering systems to identify and implement energy savings.

Scope

- Technology-neutral promotion of innovative and IT-based pilot projects (per kWh of energy saved). In the pilot phase from 2016-2018, the focus is on the development and utilisation of IT innovations to save energy. In addition, the aim is to also test and incentivise value-added services, such as demand side management for sector coupling or private-sector financial services for energy efficiency.

Status

- The measure was launched in May 2016 and will be in force until the end of 2018. Total funding of €29 million is made available in the period from 2016 to 2020.

National Top Runner Initiative

Goals

- Improve the energy and power efficiency of products across all sectors

Scope

- Concentration of measures to accelerate the market penetration of top-quality services and products that help reduce energy consumption

Status

- Measure commenced on 1 January 2016; initiative support network founded with central associations (Friends of the Earth Germany (BUND), Federation of German Consumer Organisations (VzBV), German Industry Initiative for Energy Efficiency (deneff), German Retail Association (HDE), Association of German Chambers of Commerce and Industry (DIHK), German Electrical and Electronic Manufacturers' Association (ZVEI), BITKOM, Germany's digital association).

Energy advice for municipalities and non-profit organisations

Goals

- Energy advice for the energy retrofitting or construction of non-residential buildings by municipalities and non-profit organisations

Scope

- Energy advice as a key contribution to increasing willingness to invest in, and acceptance of, modernisation measures in the buildings of municipal and non-profit institutions.

Status

- Around 300 applications have been made to the Federal Office for Economic Affairs and Export Control since the measure was rolled out on 1 January 2016.

A fact-based evaluation of these measures will be performed in the further course of the monitoring process.

Additional measures

Green Paper on Energy Efficiency

Goals

- Develop a medium- to long-term strategy to reduce energy consumption

Scope

- Consultation on key questions and hypotheses regarding the most important challenges in the area of energy efficiency with all the stakeholders concerned through to 31 October 2016, followed by assessment and appraisal by the Federal Ministry for Economic Affairs and Energy.

"Germany Makes it Efficient" awareness-raising and mobilisation campaign

Goals

- Motivate all consumer groups to use heating and electricity as efficiently as possible

Scope

- Educate consumers on the efficient use of energy, identify paths to funding programmes and advisory services

Status

- Launched successfully in May 2016, by July 2016 the programme website www.machts-effizient.de had received over 800,000 clicks

Energy and Climate Action Campaign of the German Hotel and Catering Association (DEHOGA)

Goals

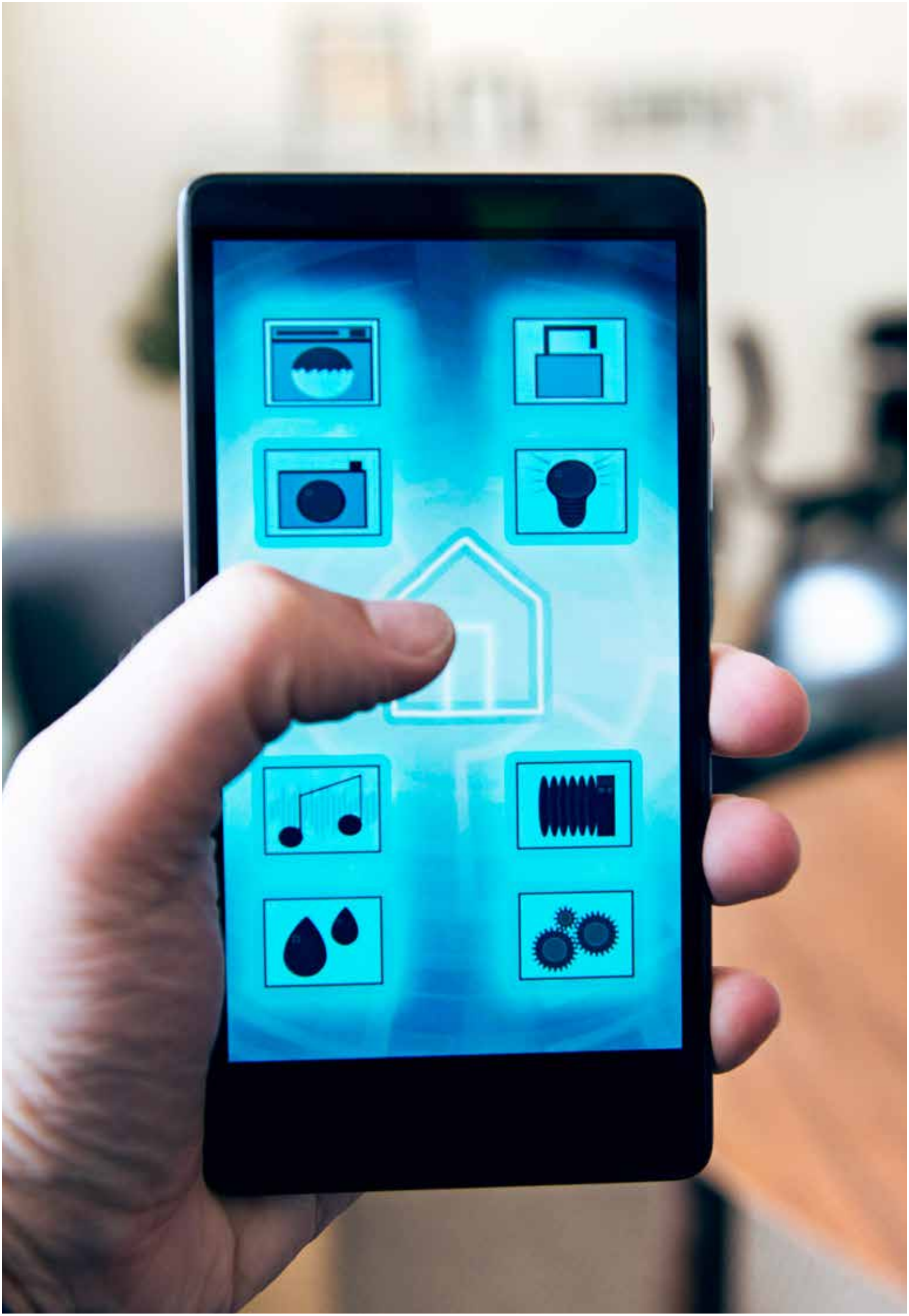
- The DEHOGA Energy Campaign supported by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety is one of the first and biggest sector campaigns for energy efficiency and climate change mitigation in Germany. It specifically aims to provide sector-specific information and advice on efficiency and cost-saving potential and how such potential can be tapped in the hospitality industry

Scope

- A number of tools have been developed, including energy-saving fact sheets, an economic viability calculator and a "virtual" hotel in the form of a 3D animation that provides interactive information about modern building services engineering and relevant user behaviour. In addition, energy consultant alliances, energy discussion groups and energy efficiency networks provide opportunities for knowledge-sharing within the industry.

Status

- As a result of onsite energy advice, so far it has been possible to cut over 30,000 tonnes of carbon dioxide emissions each year and save €10 million in costs. The campaign is therefore making a key contribution to climate change mitigation and to the development of sustainable quality tourism in Germany. The DEHOGA Energy Campaign serves as a model for the development of other sector-specific approaches. Plans are in place for DEHOGA to share its best practices and experience with other industries/associations.



5 Buildings

Where do we stand?

Due to the colder winter in 2015 compared with 2014, final energy consumption in the buildings sector in 2015 increased by 4.3% on the previous year. Benchmarked against the baseline year, 2008, final energy consumption was down by 11.1%.

Primary energy consumption also increased in 2015, up 4.2% on 2014 levels. Benchmarked against the baseline year, 2008, primary energy consumption was down 15.9%.

The share of renewables in heat consumption stood at 13.2% in 2015. The 2020 target will therefore soon be met.

What is new?

In addition to the launch of several new funding programmes, advisory services and the efficiency campaign, the first measures from the Efficiency Strategy for Buildings were also implemented. Important steps have therefore been taken to reduce energy consumption in buildings on a sustainable basis and increase the share of renewable energy in buildings.

	2015	2020	2030	2040	2050
Efficiency and consumption					
Primary energy consumption in buildings (compared with 2008)	-15.9%	→			-80%
Heat consumption in buildings (compared with 2008)	-11.1%	-20%			
Renewable energy					
Share of heat consumption	13.2%	14%			

5.1 Energy consumption in buildings

The buildings sector plays a central role in the energy transition. The share of final energy consumption in buildings in total energy consumption stood at 35.3% in total in 2015. Private households accounted for the majority of this energy consumption, followed by the trade, commerce and services (TCS) sector, and industry (see Diagram 5.1).

Final energy consumption in buildings, hereinafter also referred to as heating energy demand, rose in 2015. Building-specific final energy consumption for heat (heating energy demand) comprises the consumption values for space heating, space cooling and warm water supply. In addition, the power consumption of (permanent) lighting systems in non-residential buildings is also included. Heating energy demand stood at roughly 3,069 PJ in 2015, up by 4.3% on the previous year. This increase was largely due to the relatively cold weather at the start of 2015, which increased the demand for heating.

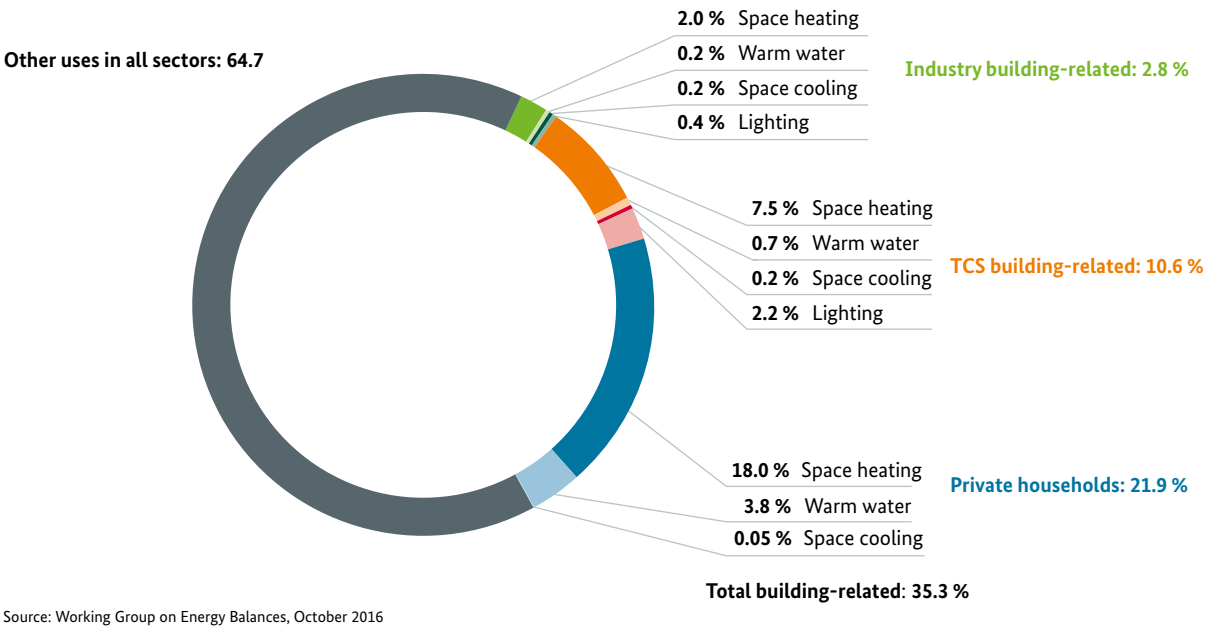
The demand for heating energy has dropped by 11.1% since 2008. This means that heating energy demand fell annually by around 1.7% on average during this period. To reach the target of cutting heating energy demand by 20% by 2020 compared to the 2008 baseline, heating energy demand would need to decrease annually by an average of 2.1% in the next few years. Therefore current reduction rates need to be stepped up. Key measures for the further reduction of energy consumption have been introduced with the adoption of the National Action Plan on Energy Efficiency (NAPE) and the development of the Efficiency Strategy for Buildings (see Chapter 5.4).

Energy efficiency in buildings declined in 2015 compared with 2014. Final energy consumption of private households increased more than the amount of residential space. The ratio of these two values to one another reflects the level of energy efficiency in the buildings sector: specific final energy consumption for space heating among private households increased by 14.4% on the previous year. After adjusting for temperature, this increase is far lower, at 5.2%. The value has dropped by 11.9% overall since 2008 (see Diagram 5.3). This means that, on average, energy in the residential buildings sector has been used more and more efficiently, resulting in an overall decline in heating energy demand despite increasing residential space. After adjusting for temperature, final energy consumption for space heating among private households in 2015 was 10.1% lower than in 2008.

5.2 Primary energy consumption

Primary energy consumption of buildings was 4.2% higher in 2015 than in the previous year. In addition to the provision of heating, cooling, warm water, and also lighting in the case of non-residential buildings, the primary energy consumption indicator also factors in the non-renewable effort for the production, conversion and transportation/distribution of the individual energy sources. Primary energy consumption does not encompass renewable energy sources, however. It can therefore be reduced both by energy efficiency improvements and by increasing the share of renewables to cover heating energy demand. In 2015, primary energy consumption stood at 3,685 PJ compared with 3,538 PJ in the previous year.

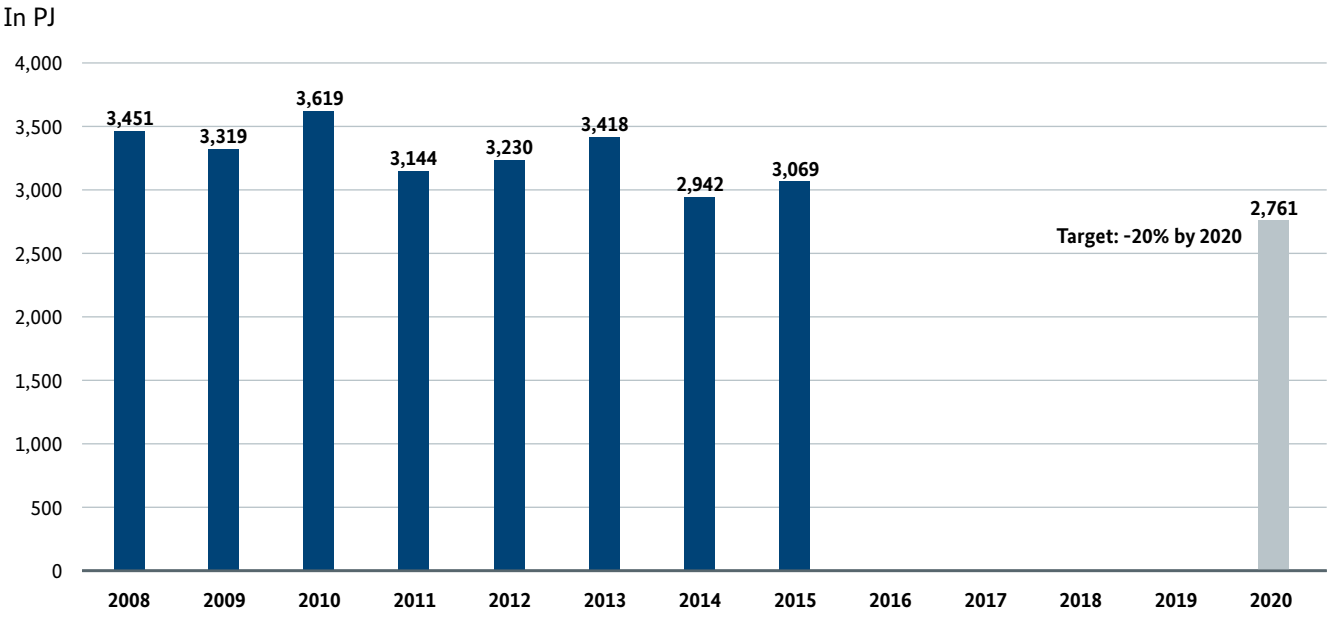
Diagram 5.1: Share of final energy consumption in buildings in total final energy consumption in 2015



Source: Working Group on Energy Balances, October 2016

Diagram 5.2: Meeting the target for heating energy demand

2020 target	20% reduction in heating energy demand (compared with 2008)
Status 2015	-11.1%

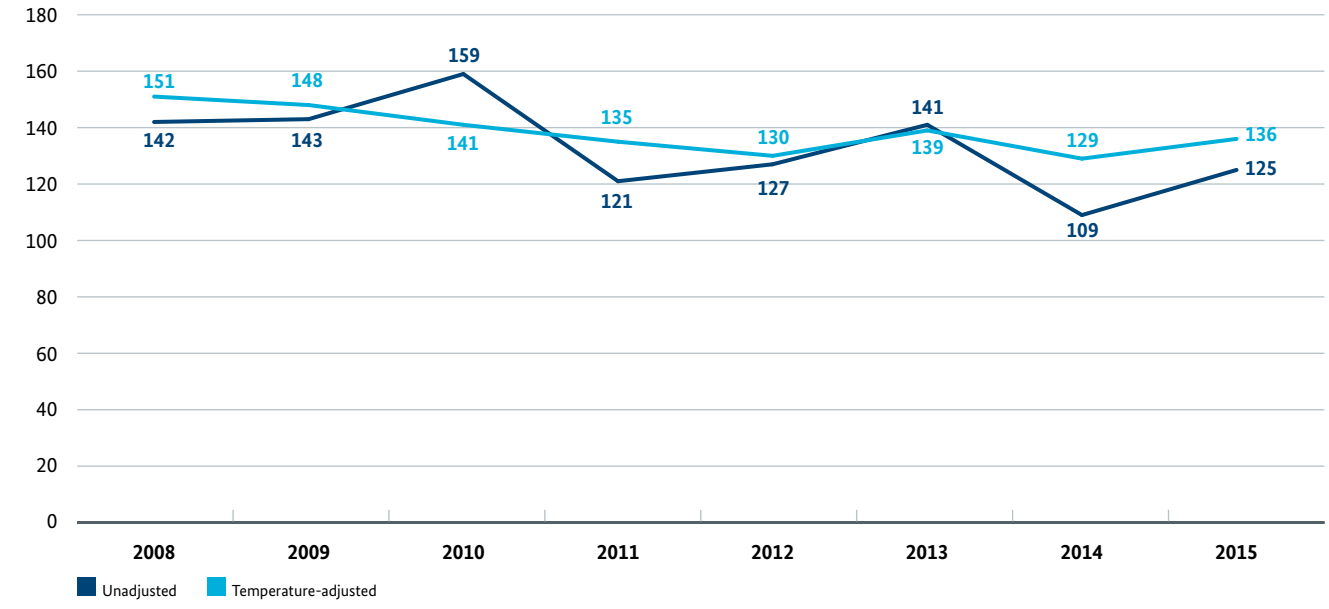


Source: Working Group on Energy Balances, October 2016

Trend	● ● ● ● ●
Measure	National Action Plan on Energy Efficiency, Efficiency Strategy for Buildings, Climate Action Programme

Diagram 5.3: Development of specific final energy consumption for the generation of space heating in private households

In kWh/m²



Source: Working Group on Energy Balances and Federal Statistical Office, October 2016.

Primary energy consumption has already decreased by roughly 16% since 2008. This is equivalent to an average annual reduction of 2.4%. This is a clear indication that Germany is on the right track to reducing primary energy consumption (see Diagram 5.4). As the primary energy consumption goal is set far into the future (80% reduction by 2050 compared with 2008 levels), it does not make sense to extrapolate the value on a linear basis to estimate the level of progress towards the goal. However, the forecast in the reference scenario used in the Efficiency Strategy for Buildings suggests that – based on existing instruments (as at 2013) – primary energy consumption would drop by around 60% by 2050 compared with 2008 levels.

To reach the long-term goals, a comprehensive strategy for the buildings sector was presented with the Efficiency Strategy for Buildings. This strategy integrates the electricity and heating sector and establishes a clear framework for action for the energy transition in buildings (for a detailed description see Chapter 5.4).

5.3 Modernisation and investment in the buildings sector

In the residential construction sector, roughly 300,000 planning permissions were granted and around 250,000 building completions were registered in 2015. Of these new builds, some 140,000 residential units were supported by the "Energy-efficient Construction" module of the CO_2 Building Modernisation Programme. This means that around 50% of newly built residential buildings were supported by the KfW, and were thereby constructed to a higher energy efficiency standard than the Energy Saving Ordinance requires. With the help of the "Energy-efficient Modernisation Programme", the energy efficiency of around 240,000 residential units in total was increased in 2015.

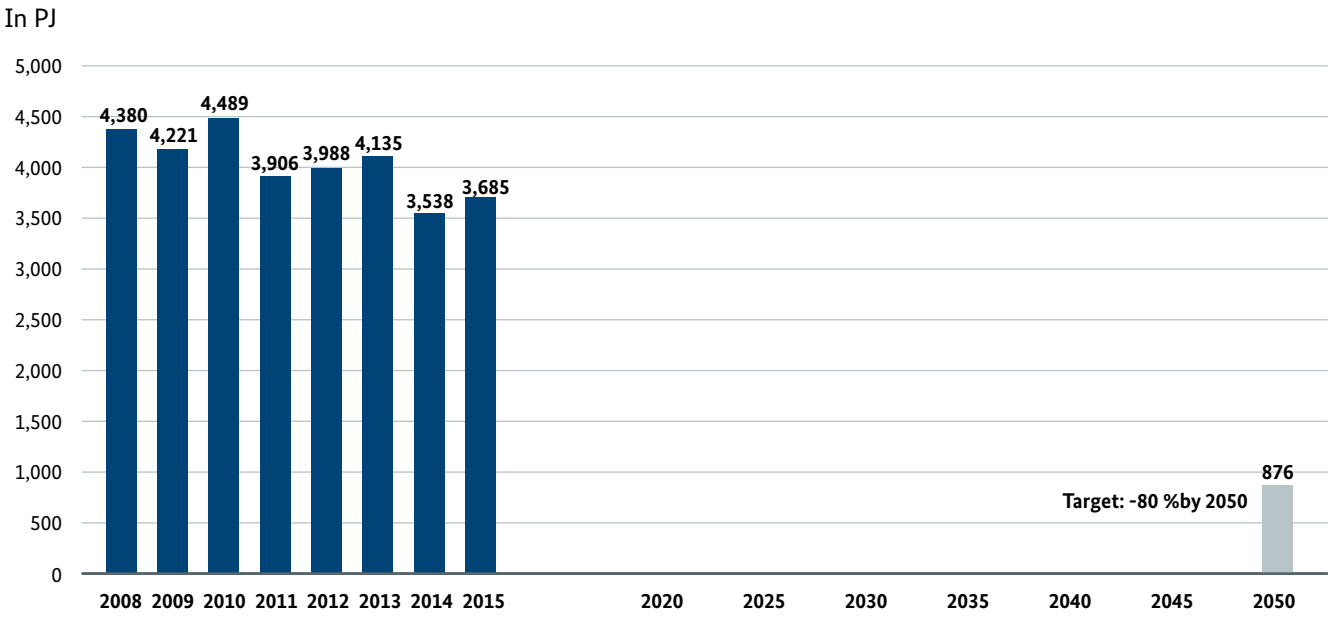
With regard to renewables (RES) for heat generation, the installation of roughly 38,000 renewable energy heating systems – primarily in residential buildings – was promoted in 2015 under the Market Incentive Programme. The technologies deployed comprised solar thermal, biomass and heat pumps. The grants amounted to €92.3 million in total. The investment volume of these measures amounts to around €492.2 million.

5.4 Efficiency Strategy for Buildings

Final energy consumption needs to be reduced and the share of renewables in the heating sector increased if Germany is to meet the Federal Government's goals in the buildings sector by 2050. The current set of instruments already reaches many building owners and encourages them to invest in energy conservation in their buildings.

Diagram 5.4: Meeting the target for primary energy consumption

2020 target	80% reduction in primary energy consumption (compared with 2008)
Status 2015	-15.9%



Source: Federal Ministry for Economic Affairs and Energy based on data from the Working Group on Energy Balances, October 2016

Trend	No trend information available given the long goal horizon to 2050.
Measures	National Action Plan on Energy Efficiency, Efficiency Strategy for Buildings and Climate Action Programme

Despite this, more investment in energy retrofitting and renewable heat is needed. The National Action Plan on Energy Efficiency (NAPE) has initiated additional immediate measures and farther-reaching work processes for improved energy efficiency in the buildings sector, as well as in other sectors. Overall, these measures allow Germany to make a major step towards reaching the energy policy goal of a virtually climate-neutral building stock (see Chapter 4.4).

In November 2015, the Federal Cabinet adopted a strategy for the energy transition in the buildings sector with the Efficiency Strategy for Buildings. Containing both new measures and proposals for the development of existing measures, this strategy shows how the goal of a virtually climate-neutral building stock by 2050 can be achieved by combining greater energy efficiency with the increased use of renewable energy.

The progress of the Efficiency Strategy for Building towards the goal and the state of implementation are evaluated in the "Energy of the Future" monitoring process. At the measure level, there are evaluation processes that are either already established or are planned, depending on what extent the measure is implemented. However, many measures of the strategy have only just been implemented, or will be implemented shortly. Therefore, no evaluation results are yet available for this Monitoring Report. The first solid results can be expected by the next Progress Report.

Implementation of the Efficiency Strategy for Buildings commenced in 2016. The "Energy-efficient Buildings 2050 – Innovative Projects for a Virtually Climate-neutral Building Stock in 2050" funding initiative kicked off in April 2016, and the Programme for the Promotion of Heating Optimisation using High-efficiency Pumps and Hydraulic Balancing commenced in August 2016. Preparations are currently underway for the launch of the new "customised renovation roadmaps for buildings" instrument that advises on energy retrofits.

Central measures in the buildings sector

Customised renovation roadmaps for buildings

Goals

- Standardised recommendations for tailor-made, gradual energy retrofits

Scope

- The renovation roadmap gives building owners a clear, more reliable strategy for the gradual energy retrofitting of their buildings over a multi-year period. Besides strictly energy-related solutions, the roadmap also focuses on the specific options for the building owner and the specific condition of the building when identifying the renovation approach.

Energy-efficient Buildings 2050 – Innovative Projects for a Virtually Climate-neutral Building Stock in 2050 funding initiative

Goals

- Transfer the results of research into the building shell, building services engineering and the use of renewables with a view to broad implementation

Scope

- Support is given to pilot projects for energy-optimised buildings and neighbourhoods with a broad impact.

"Solar Construction/Energy-efficient Cities"

Goals

- Joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research concerning new technologies and strategies for better energy efficiency and the integration of renewables in order to move the energy transition forward in buildings and urban areas.

Scope

- The first projects are set to start in the summer of 2017.

Facts and figures

- €150 million will be available from 2017 onwards

Promotion of heat optimisation using high-efficiency pumps and hydraulic balancing

Goals

- Achieve quick CO_2 reductions by leveraging the energy-efficiency potential in buildings with measures that do not require major structural changes, and set in motion farther-reaching renovation measures in boiler rooms

Scope

- Support is provided for 1) the replacement of inefficient heating and warm water pumps with high-efficiency models, and 2) heating optimisation with hydraulic balancing and additional low-cost measures (e.g. installation of pre-configurable thermostat valves) either individually or as a combination of measures.

Updated CO_2 Building Modernisation Programme – KfW-funded (see Chapter 4)

Energy advice for municipalities and non-profit organisations (see Chapter 4)


240V~
110V~

6 Transport

Where do we stand?

With an increase of 1.3% on 2005 in 2015, the development of final energy consumption in the transport sector runs counter to the goals of the Energy Concept. Additional efforts are needed if Germany is still to reach the 10% reduction goal.

The goals of the Energy Concept in the transport sector can only be reached with the greatest possible electrification of vehicle drives. With the exception of rail transport, electrification has only just begun in Germany. In the rail sector, around 90% of rail services are already electric and around 60% of the federal rail network routes are electrified.

Nonetheless, the number of vehicles with alternative drives is steadily increasing. The number of electric cars on the road is still well below the target of one million by 2020. In this context, the focus is on the faster expansion of the necessary infrastructure.

One way of reducing final energy consumption is to switch to rail. If this is to materialise, it will require continued high-level investment in the rail infrastructure, the introduction of innovative technologies in rail freight transport and new logistics solutions. Ultimately, an automated and digitised rail freight transport system should be the outcome.

What is new?

With the eco-bonus and other measures to support the creation of a nationwide charging infrastructure, the Federal Government is continuing its work to bring electric mobility to the mass market.

The promotion of hydrogen fuel cell mobility is entering the next period of funding. The Round Table on Gas-based Mobility paves the way for the next concrete steps in the industry.

The 2030 Federal Transport Infrastructure Plan gives priority to the maintenance of the existing infrastructure over new infrastructure construction, contains key measures to move transport to rail, and also addresses bicycle-based transport for the first time.

	2015	2020	2030	2040	2050
Renewable energy					
Share in the transport sector	5.2%	10%*			
Efficiency and consumption					
Final energy consumption: transport (compared with 2005)	1.3%	-10% →			-40%

*Target under EU Directive 2009/28/EU

6.1 Energy consumption in the transport sector

Final energy consumption in the transport sector increased slightly in 2015. Taking all modes of transport together, final energy consumption in the transport sector stood at 2619 PJ in 2015, up 0.1% on the previous year (see Diagram 6.1). The transport sector therefore accounts for roughly 30% of total final energy consumption in Germany.

Energy consumption is stagnant or increasing across all modes of transport apart from rail transport. As Table 6.1 shows, energy consumption for road and inland waterway transport has increased, both on the previous year and on the baseline year, 2005. In the field of air transport (international and domestic), consumption has increased since 2005, and has changed little on the previous year. In the rail sector, energy consumption has decreased compared with 2014. On account of a revision of rail sector data, it is not possible to compare energy consumption directly with 2005 values. However, it can be assumed that energy consumption has decreased.

Final energy consumption in the transport sector has increased by 1.3 percentage points overall compared against the baseline year, 2005. Final energy consumption in the transport sector has therefore increased annually by around 0.1% on average since 2005, and even by 2.3% annually since 2010.

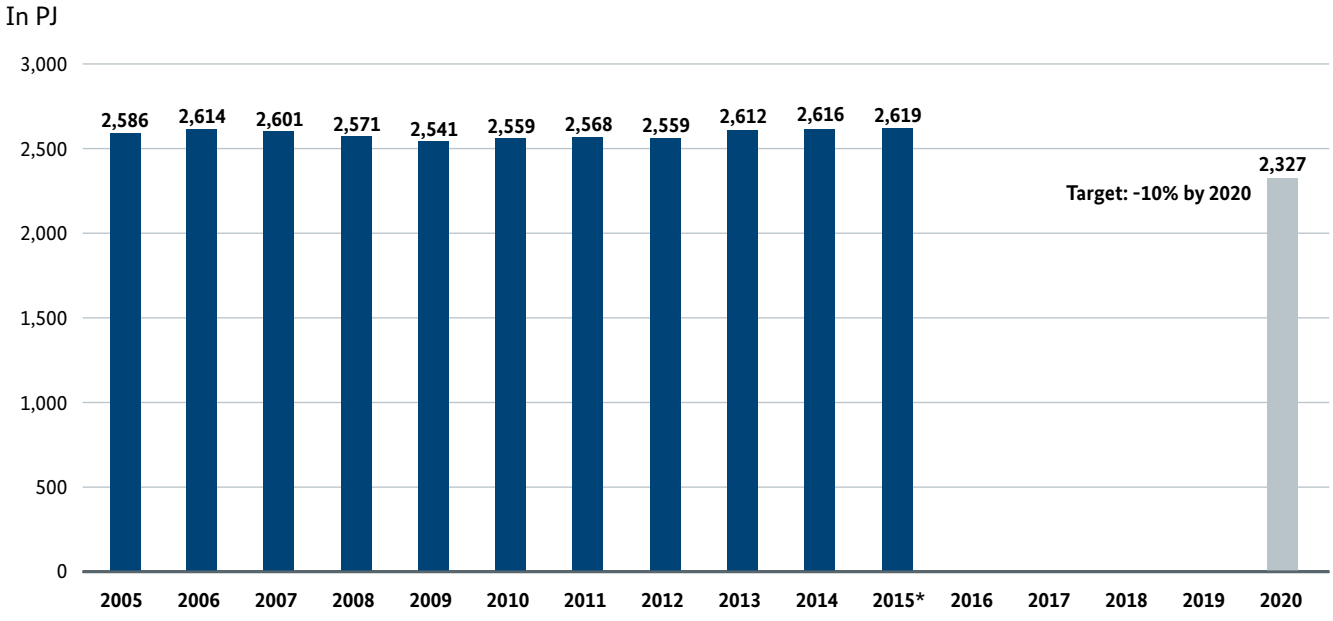
In light of this development additional efforts are urgently needed, including on the short-term, to reach the target: to cut final energy consumption by 10% by 2020, it would need to be reduced by a total of 12.5% compared with 2005 levels over the next five years, and by an average of 2.5% per year.

There was a significant increase once again in the passenger kilometres travelled and the volume of freight moved in 2015. The number of passengers or goods transported is multiplied by the total transport distance in a given period to calculate the passenger kilometres travelled or the freight moved, respectively. The passenger kilometres travelled and the volume of freight moved have increased by 8.4% and 12.1% respectively since 2005, and by 1.3% and 1.2% respectively compared with 2014.

Specific energy consumption has decreased among passenger cars, but is stagnant among heavy goods vehicles (HGV). In the case of the current fleet of passenger cars and estate cars, average consumption per 100 km fell by 7% between 2005 and 2015, and by 0.1% compared with the previous year. This demonstrates that the transport sector is also becoming more efficient, particularly through the use of enhanced drive technologies. Efficiency gains here are mainly the domain of the petrol engine, however, while the efficiency of diesel engines has hardly increased. A study

Diagram 6.1: Meeting the target for final energy consumption in the transport sector

2020 target	10% reduction in final energy consumption (compared with 2005)
Status 2015	1.3%



Source: Working Group on Energy Balances, October 2016
*2015 figures provisional

Trend	● ○ ○ ○ ○
Measures	2020 Climate Action Programme, Mobility and Fuel Strategy, Electric Mobility Act, Car Efficiency Labels, EU CO_2 fleet emission targets

Table 6.1: Energy consumption by mode of transport and increase compared with the baseline year and the preceding year

	2015 in PJ	2015 % share	% change on 2014	% change on 2015
Road	2,188.4	83.6	0.1	1.8
Air	362.2	13.8	0.0	5.1
Rail	54.2	2.1	-0.4	Data revision
Inland waterways	14.0	0.5	15.5	3.1
Total	**2,618.8**	**100**	**0.1**	**1.3**

Source: Working Group on Energy Balances, August 2016

conducted by the ICCT found that, given the vehicle efficiency of the current vehicle fleet, no appreciable increase in efficiency has been achieved among HGVs in Europe since 1997, based on average consumption per 100 kilometres, and irrespective of the duty cycle (Lastauto-Omnibus 2015, a German trucking magazine, in ICCT 2015). Growing demand for higher engine power, in particular, has prevented this from happening.

Efficiency gains are unevenly distributed across the various modes of transport. A comparison of the specific consumption rates across all transport modes based on the Federal Environment Agency's TREMOD model reveals that the greatest efficiency gains can be found in rail transport, which clearly exceed on-road efficiency improvements: in the area of freight transport, specific on-rail consumption dropped by more than 30% between 2005 and 2014, and even by more than 40% in the area of passenger transport. This method is based on the average consumption per passenger-kilometre in passenger transport and per tonne-kilometre in freight transport, and therefore also includes improvements in efficiency as a result of load management and fewer empty runs in freight transport.

The average fuel consumption of newly registered passenger cars and estate cars has dropped in recent years. Between 2008 and 2015, average consumption fell by 20% in total, as official figures from the Federal Motor Transport Authority reveal. These figures on the fuel consumption of newly registered vehicles are derived from model-based manufacturer data and are currently the only official figures available. Therefore the Federal Government is working hard – particularly at the EU and international level – to ensure that the new WLTP type approval for passenger cars and light-duty vehicles, which encompasses an enhanced test procedure and better test parameters, is implemented quickly in order to increase the representativeness of the CO_2 type approval values and ensure better reproducibility. Ultimately, when purchasing a vehicle consumers should be able to rely more readily on the test data once more.

A reversal of the trend in the transport sector, resulting from significantly lower energy consumption, is and will remain a long-term project. Overall, final energy consumption in transport runs contrary to the goals of the Energy Concept. So far, efficiency improvements have been unable to offset the growing energy consumption in the transport sector resulting from the significant increase in the volume of traffic. With the Mobility and Fuels Strategy and the 2020 Climate Action Programme, the Federal Government therefore established a mix of support, advice, funding and an enhanced regulatory framework as early as 2014, which

is designed to further reduce final energy consumption in the transport sector (see Chapter 6.4). In addition, the focus is already on the use of technical innovations resulting from R&D funding and associated programmes to take the innovations to market (see Chapter 13), as well as the potential of digital solutions (see Chapter 11.2).

Automated and connected driving will redefine mobility in motorised private transport, freight transport and public passenger transport. With the "Strategy for Automated and Connected Driving – Remain a lead provider, become a lead market, introduce regular operations", the Federal Government has adopted guidelines to exploit the opportunities presented by the mobility system of the future. Mobility of the future should be safe, clean and efficient. Technology should help prevent critical situations and accidents. Automated and connected driving will significantly improve traffic flows. As a result, traffic congestion and unnecessary braking and acceleration manoeuvres can be reduced, which can help cut emissions from mobility.

Due to the increasing need for transportation, it will be more important than ever to break the link between traffic volume and energy consumption. Assuming continued economic growth, the 2015 Projection Report of the Federal Government specifically forecasts a strong increase in energy consumption in road freight transport up to 2035. Even if all the measures adopted by 2015 were implemented, energy consumption would still only decrease marginally. Therefore Germany looks set to fall short of targets post-2020 also, as there is no sign of major progress, at least in the short- to medium-term, with regard to the use of alternative drives in road freight transport and with regard to moving freight from road to rail (see Chapter 6.2 and 6.3).

European legislation to limit the CO_2 emissions of road vehicles must be developed further with ambitious targets for the post-2020 period in order to meet energy consumption and climate goals at national and European level. The EU legislation to increase the efficiency of road vehicles is currently the most effective instrument to cut energy consumption, and thereby significantly reduce greenhouse gases in the transport sector. It is crucial that this legislation be updated and refined specifically and for all vehicles for the post-2020 period. After all, the early announcement of specific efficiency goals for new vehicles is central to bringing carbon-efficient vehicles faster to market (and also electric mobility, see Chapter 6.2) and gives industry and consumers planning security.

More use must also be made of potential to prevent demand for transportation and reduce traffic volumes. This can be achieved by increasing system efficiency in the transport sector, such as through integrated land-use and traffic management planning or through compact interlinked journeys. The continued development of the Mobility and Fuels Strategy will place more attention on these areas in the future.

6.2 Alternative fuels and innovative drive technologies

The energy transition in the transport sector can only succeed with a significant increase in the share of alternative and innovative drives. The goal of the Energy Concept is to have one million electric vehicles on German roads by 2020 and six million by 2030. Another focus of the Energy Concept is the strengthening and expansion of other alternative fuels in connection with innovative drive technologies. Electric mobility and other alternative drives already enable no-carbon or low-carbon mobility today. Overall, however, their share in the volume of traffic has been relatively small so far.

The number of electric drive vehicles is increasing rapidly, but the market share is still small. As Diagram 6.2 shows, around 42,000 battery-powered 3-wheel-plus vehicles were registered in 2015, around 11,000 of which were externally chargeable hybrid electric vehicles. Overall, the number of 3-wheel-plus vehicles increased by almost 50% on the previous year. However their market share remained at less than 1% of new passenger car registrations. In addition to 3-wheel-plus electric drive vehicles, increasing numbers of two-wheel electric vehicles, such as pedelecs und e-bikes, can be seen on German roads. Their market share rose to around 13% in 2015 (ITD/ifeu 2015, German Bike Association (ZIW)).

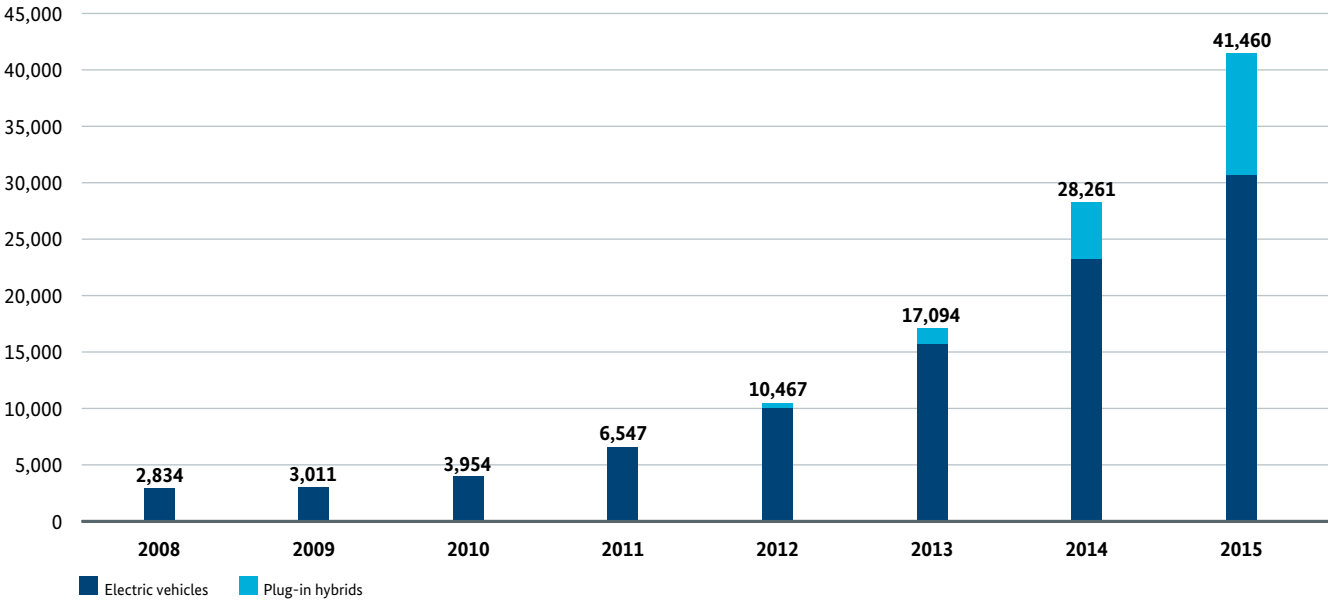
The future of mobility is electric – not only in rail transport but also in the passenger car sector. The priority now is to speed up the development of a market for such technologies. The number of electric cars has increased more than ten-fold overall since 2010. A mobility scenario with one million electricity-based cars on the road by 2020 can only become a reality with considerable effort, also on the part of the business community. Furthermore, for the German automotive industry to retain its position as a leading automotive provider, also with regard to electric mobility, Germany will need to develop a market for electric vehicles. Therefore, with the eco-bonus for the purchase of electric vehicles and the funding programme to build charging infrastructures, as decided in May 2016, the Federal Government is continuing its efforts to bring electric mobility with battery or hydrogen/fuel cells to the mass market across all transport modes.

More renewable energy will make mobility climate-friendly. The share of renewables in the transport sector stands at 5.2% in 2015 and is to increase further (see Chapter 3.4). It is also all the more important that there is a steady increase in the share of renewables in electricity production (see Chapter 3.2), as this reduces the specific carbon dioxide emissions of the electricity used to power electric vehicles.

Besides the electric drive, other alternative types of drive train and alternative fuels also play an important role. One comparatively energy-efficient option is to give priority to the direct use of renewables to decarbonise the transport sector (see Chapter 11.1). As a study commissioned by the Federal Ministry of Transport and Digital Infrastructure illustrates, electrification through sector coupling and energy efficiency in the transport sector go hand in hand (DLR et al. 2016a). However, system requirements, such as adequate generation capacity from renewables and an efficient power grid infrastructure, must be met to handle the potentially sharp increase in the demand for electricity. At the same time, growth in electric mobility still lags behind expectations. Therefore, in the interim it is necessary to consider all existing vehicle technologies and fuels that are cleaner and produce less CO_2 than conventional drives. In this context, however, the sometimes long investment cycles in the transport sector must be considered, and it is essential to avoid getting locked into ineffective and high-emission technologies.

Renewable fuels will be used increasingly for transport. In the long term, the use of renewable fuels is the only way to wean shipping and air travel off their dependency on fossil fuels. As the potential of biomass is limited, the vast majority of these fuels will be produced on the basis of electrical energy from renewable sources. Both fuel options still offer sufficient potential for efficiency gains in production. This applies, in particular, to the electrolysers needed by both fuel types for the production of hydrogen. The Federal Government will step up its research efforts (particularly in the area of electrolyser material and surface research) so that this potential for boosting efficiency can be leveraged as soon as possible.

Diagram 6.2.: Numbers of 3-wheel-plus electric vehicles
Numbers



Source: Federal Motor Transport Authority, January 2016
From 2012, also includes plug-in hybrid vehicles and range extender vehicles.

Electric buses play an important role in the electrification of the transport sector. In recent years, the Federal Government has promoted a wide range of projects to support the electrification of the road-bound public transport network, aiming to establish zero-emission and low-emission vehicles faster in the market. An increasing supply of battery-powered buses, in particular, has been observed on the market, attracting growing interest from transport service companies, with concrete plans for procurement in some cases. The findings of a study commissioned by the Federal Ministry of Transport and Digital Infrastructure revealed that hybrid trolley buses also offer particular potential on busy routes (DLR et al. 2016b). The Federal Government is promoting the use of hybrid trolley buses in three cities. In addition, heavy-duty vehicles (HDV) also offer potential to reduce GHG emissions per vehicle kilometre or tonne kilometre by approx. 30% by 2030. This can be achieved through measures such as additional efficiency improvements in combustion engines and transmissions, hybridisation, enhanced aerodynamics, the use of tyres with optimised rolling, changes to vehicle length and the use of hydrogen and liquid natural gas (LNG) or renewable methane in optimised gas engines. The additional emissions reductions that are needed can also be achieved here through the use of electric drives, inter alia, which are already being trialled in HDVs for regional deliveries. The Federal Government is currently making preparations to field-trial a hybrid trolley truck under real conditions.

The number of fuel cell vehicles already available on the market is growing, but successful market breakthrough still needs some time. The mobile application of fuel cells in conjunction with hydrogen technology in a vehicle involves supplying electricity to the electric drive via a fuel cell that is powered by hydrogen as the secondary fuel. There are currently some 500 hydrogen and fuel cell vehicles in Germany. Research and development projects in hydrogen and fuel cell technology will give rise to additional, marketable products in the future (see Chapter 13).

Natural gas is a fuel of the future, particularly in the shipping sector. The main advantage of natural gas is the significantly lower level of pollutants it emits. Therefore natural gas-based mobility in the form of liquid natural gas (LNG) is a possible alternative to marine diesel and heavy fuel oil, particularly in the maritime and inland waterways transport sector, i.e. precisely in an area which has been associated with high emissions of pollutants up to now. In road freight transport, on the other hand, LNG can primarily be considered an interim technology en route towards the gradual, greatest possible electrification of overland transport. Apart from LNG, compressed natural gas (CNG) in passenger cars, local goods distribution and local public transport also has potential to help significantly reduce pollutants and partially reduce CO_2 emissions in a cost-effective manner. By using a blend of natural gas and biomethane or synthetic methane, natural gas vehicles can be almost as climate-friendly to run as electric vehicles (depending on the electricity mix). The use of these alternative fuels does not alter the issue of energy consumption, which remains on a par with that of present-day fossil fuels.

The number of natural gas vehicles stands at around 100,000. The number of annual new vehicle registrations varies greatly. The Bundestag requested the Federal Government to put forward a draft bill to extend the energy tax concession on natural gas and liquid gas. This has been done with the ministry draft bill of the Second Act to Amend the Energy Tax and Electricity Tax Act, which is currently being coordinated internally. Furthermore, in talks with representatives from the automotive industry in December 2015 it was agreed for natural gas to have a 4% share in the fuel market in the road transport sector by 2020. To this end, the Federal Ministry of Transport and Digital Infrastructure established a task force on LNG in heavy-duty vehicles and the Federal Ministry for Economic Affairs and Energy set up the Round Table on Gas-based Mobility.

The infrastructure for alternative drive systems calls for faster infrastructure expansion and uniform standards.

- So far, electric vehicles are primarily charged at home, complemented by a charging option at the vehicle owner's place of work in an ideal scenario. At the end of 2015, there were 5,836 publicly accessible charging stations in Germany. By July 2016, this figure had risen to 6,517 – with 230 fast charging stations – according to data from the energy sector (survey by the Federal Association of the German Energy and Water Industry). Most of these charging stations are located in regions that hosted demonstration projects. Currently the fast charging stations are primarily located on routes connecting large cities.

Table 6.2: Reduction in final energy consumption by exploiting potential to shift traffic to rail

Forms of transport	Reduction in final energy consumption in 2030 in PJ compared with 2010 according to studies by the German Aerospace Centre (DLR)	Reduction in CO_2 emissions in 2030 in million tonnes compared with 2010 according to studies by the German Aerospace Centre (DLR)
Freight transport	98	8.5
Long-distance passenger transport	15	1.2
Local passenger transport	102	8.6
Transport total	**215**	**18.3**

Source: DLR et al. 2016c, d.

- According to data from the National Organisation for Hydrogen and Fuel Cell Technology (NOW), 21 hydrogen filling stations for fuel cell vehicles were in operation or had been completed by June 2016. In Germany, industry is responsible for the expansion of the hydrogen infrastructure. To this end, participating companies joined forces to set up H2 Mobility Deutschland, creating the organisational basis to put in place a nationwide network of hydrogen refilling stations and thereby ensure the supply of hydrogen throughout the country. The development of a hydrogen supply infrastructure for fuel cell vehicles can be supported through the National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP), which has been extended for the period 2016–2025 (see Chapter 13).
- According to surveys conducted by the Initiative for Natural Gas-based Mobility, the filling station network for compressed natural gas (CNG) comprised over 900 stations at the start of 2016, the majority of which were integrated into existing filling stations. The first LNG filling station for HDVs was opened in Ulm in 2016. Bunkering facilities for LNG are already available in a number of ports.

In addition to current measures for the development of the charging infrastructure, the main basis for progress in this area is the Charging Station Ordinance which the Federal Government introduced to transpose the minimum technical requirements of the 2014 EU Directive on the Deployment of Alternative Fuels Infrastructure. The continued development of this Directive and other measures are planned for 2016 and are actively supported and organised by the Federal Government.

6.3 Shift to environmentally friendly modes of transport

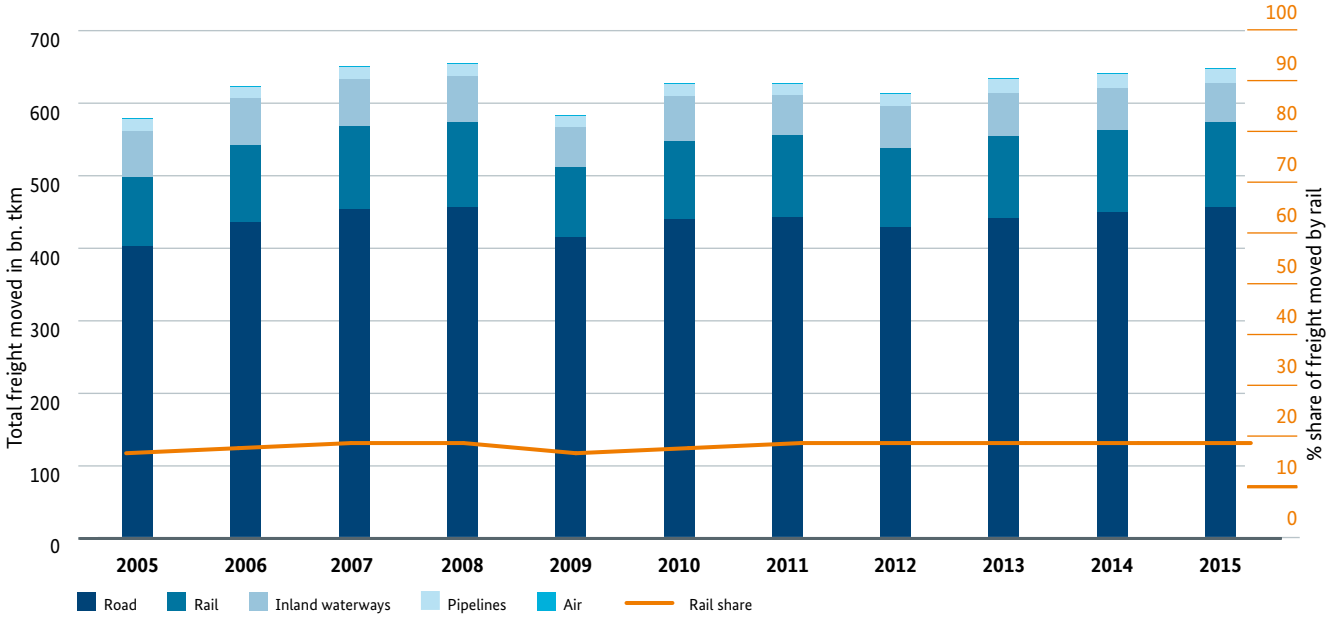
For the energy transition in the transport sector to succeed, some traffic must shift to rail and public transport services. According to the Energy Concept, the aim is to put the necessary framework in place to move traffic to more environmentally friendly forms of mobility as an alternative to motorised private transport. Studies commissioned by the Federal Ministry of Transport and Digital Infrastructure found that considerable reductions in final energy consumption and CO_2 emissions by 2030 are possible and feasible, particularly in rail freight transport and local passenger transport, but also in long-distance passenger services (DLR et al. 2016c, d). According to the studies, these reductions can be achieved without having to rely on regulatory and fiscal measures or on the part-financing of operations. An in-depth discussion within the Federal Government on the results of the study has yet to be held.

This indicates that shifting traffic to rail could make a significant contribution to meeting the goal of a 40-42% reduction in transport-related greenhouse gas emissions in the 1990–2030 period, as agreed in the Federal Government's 2050 Climate Action Plan. With regard to final energy consumption, shifting to rail could also contribute to a 20% reduction in final energy consumption in the 2005–2030 period. This, in turn, would be the linear interpolation of the 40% reduction in final energy consumption in the period 2005 to 2050, as required by the Energy Concept of the Federal Government.

While the volume of freight moved by rail has increased overall in recent years, its share in total freight moved has stagnated, however. Owing to the sharp increase in the volume of freight traffic in recent years and the dominant role of road freight transport, the CO_2 emissions and final energy consumption of freight traffic in Germany have risen slightly in recent years. This trend is projected to continue in the coming years according to the 2030 Traffic Forecast. In addition, the 2015 Projection Report anticipates that the measures adopted up to 2014 inclusive and the efficiency gains in road traffic (see Chapter 6.1) will not be enough to deliver on the energy consumption and CO_2 emission reduction goals in the freight transport sector. Increased use of rail could help achieve the goal if the appropriate infrastructure, rolling stock and logistics concepts are in place, as many trains are already electric, and therefore offer considerable energy efficiency. The share of renewables in the rail electricity mix is also growing steadily. At 116.6 billion tonne-kilometres, the volume of freight moved by rail is around 20% higher than in 2005 in absolute terms and 4% higher than in 2014. In recent years, however, the share of freight moved by rail in total freight moved has scarcely changed, remaining below the 20% mark in 2015 also.

An automated and digitised rail freight transport system is needed to improve the competitive position of rail freight transport compared with road freight transport. Studies commissioned by the Federal Ministry of Transport and Digital Infrastructure find that – with the appropriate framework – a rail freight transport system that is automated and digitised by 2030 could almost treble the volume of freight moved by rail. This would require considerable investment in the rail infrastructure, in innovation programmes, in rolling stock and in new logistics strategies for intermodal transport, including appropriate intermodal terminals also for continental intermodal transport, and for amounts less than a full container load (DLR et al. 2016c). Even with favourable assumptions for rail transport and the introduction of price-control measures, studies on behalf of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety/Federal Environment Agency only anticipate a maximum increase of around 50–80% in the volume of freight moved by rail (UBA 2016d, e; Oeko-Institute et al. 2016). Considerable additional investment in the rail infrastructure is needed annually to realise the potential for shifting traffic to rail, as indicated in Table 6.2 (DLR et al. 2016c, d). Further to this, the Federal Government is supporting the construction and expansion of intermodal terminals for intermodal transport and private sidings by providing financial contributions towards the construction of the infrastructure (see Overview of measures).

Diagram 6.3.: Share of freight moved by rail in total freight moved



Source: Federal Ministry of Transport and Digital Infrastructure, October 2016

Even though the number of passenger kilometres travelled by local public passenger transport is increasing overall, the share of local public passenger transport in total passenger transport remains largely unchanged. In Germany, cars are used to travel short distances, which account for the majority of consumption and emissions in passenger transport. Each day around 30 million passengers use local public transport services and, in purely mathematical terms, avoid around 20 million car journeys as a result. The number of passengers in local public passenger transport grew by around 7% between 2006 and 2014. With 110.3 passenger kilometres in 2015, local public passenger transport is around 12% higher than in 2005 and roughly 0.6% lower than in 2014. Despite this upward trend, the share of local public passenger transport in total passenger transport has been consistently below 10% for a number of years.

To make more of the opportunities offered by public transport, the public transport system needs to be consistently strengthened nationwide. According to studies commissioned by the Federal Ministry of Transport and Digital Infrastructure and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety there are many ways to capitalise more on the potential of the local public passenger transport system (DLR et al. 2016e; Oeko-Institute et al. 2016). Findings of the Oeko-Institute study reveal that a smarter parking policy, in particular, can improve the competitiveness of the public transport system. In this context, the authors recall the moderation and coordination role of the Federal Government and call, inter alia, for the "Development of a National Local Public Passenger Transport Strategy". Responsibility for planning, designing, organising and financing local public passenger transport, including local passenger rail services, lies with the *Länder* and municipalities, however. The Federal Government will provide the *Länder* with funds amounting to €8.2 billion in 2016 to support this work. Starting in 2017, this amount will increase annually by 1.8% through to 2031 inclusive. In addition, under the provisions of legislation on unbundling (*Entflechtungsgesetz*), the *Länder* receive annual compensation payments of around €1.336 billion to improve transport conditions in the municipalities, as well as federal financial assistance totalling €332.6 million on the basis of the federal programme under the Local Authority Transport Infrastructure Financing Act. According to the First Reform of the Federal System, these payments will only run through to 2019 inclusive. In October 2015, the Federal Government and the *Länder* agreed to continue the funding under this federal programme beyond 2019 on a permanent basis. Further implementation steps are currently being coordinated at the federal level. During the negotiations on the restructuring of Federal/*Länder* financing in October 2016 it was also decided that the *Länder* would receive compensation for the loss of unbundling funds within the framework of general payments from VAT tax revenue.

In future, the expansion of the public transport system should increase its contribution to reaching the goals of the energy transition. For this reason, the Federal Government set out to make public transport more climate-friendly in the 2020 Climate Action Programme. Among other measures, the Federal Government continues to lend significant support to the *Länder* and municipalities to finance the local public passenger transport system. Not least, the Federal Government promotes mobility management for companies and innovations in the local public transport system, such as better passenger information systems and electronic tickets. The Initiative for Digital Connectivity in Public Passenger Transport supports such activities. To

make the aforementioned traffic-shifting potential a reality in local and long-distance passenger transport, the Federal Government will implement the "*Deutschland-Takt*" – a Germany-wide integrated cyclic schedule – in the coming years. In addition, the aim is to also move forward with the expansion of the tram, light rail and metro networks and the electrification of urban bus transport.

As the central infrastructure instrument, the Federal Transport Infrastructure Plan has the potential to drive forward the transfer of traffic to efficient, low-emission modes of transport. The 2030 Federal Transport Infrastructure Plan adopted in August 2016 maps out the expansion of the transport infrastructure each year for the next 15 years. It focuses in particular on the specific goals of transport policy that the development of the transport infrastructure can specifically influence. A strong infrastructure is essential for seamless mobility in passenger transport and an efficient freight transport system. The 2030 Federal Transport Infrastructure Plan, and the infrastructure expansion legislation derived from this plan, also influence energy consumption in the transport sector and therefore progress towards the energy transition goals in this sector through to 2030 and beyond. The projects of the 2030 Federal Transport Infrastructure Plan to shift freight traffic from road to rail, the electrification of railways, and the introduction of the Germany-wide integrated cyclic schedule (*Deutschland-Takt*) offer potential in this respect. For the first time ever, the Federal Transport Infrastructure Plan also mentions the cycling infrastructure, particularly the greater participation of the Federal Government in the future construction of fast bike lanes. The rail and waterway network projects included in the Federal Transport Infrastructure Plan cause traffic flows to shift, resulting in a reduction in the energy input and therefore the CO_2 emissions of the transport sector. Altogether, the 2030 Federal Transport Infrastructure Plan will result in reductions of up to 0.4 million tonnes of CO_2 per year. This is equivalent to around 0.24% of current emissions in the transport sector. This reduction in CO_2 emissions is the result of measures to strengthen climate-friendly transport modes.

6.4 Instrument mix in the transport sector

In the Fourth Monitoring Report, the Federal Ministry of Transport and Digital Infrastructure was asked to present information concerning the effectiveness of new measures towards meeting the targets in the transport sector both in this Fifth Monitoring Report and in subsequent Monitoring Reports, and to take further measures where needed.

According to estimates of the scientific advisory consortium for the Mobility and Fuels Strategy appointed by the Federal Ministry of Transport and Digital Infrastructure, the transport measures adopted thus far will deliver a 148 PJ reduction in final energy consumption in the transport sector in the period from 2005 to 2020. This equates to a reduction of 5.7%. One of the reasons for the gap between this figure and the envisaged 10% reduction target is that it is now thought that a HGV toll that depends on vehicle CO_2 emissions or energy efficiency categories to replace the current HGV toll, which depends on the class of pollutant, will have a weaker impact.

Central measures in the transport sector

Consumption/efficiency/climate action

Continued development of the 2013 Mobility and Fuels Strategy

Goals

- The Mobility and Fuels Strategy adopted by the Federal Cabinet in 2013 is continued as an important vehicle for implementing the energy transition in the transport sector as defined in the National Sustainability Strategy. It currently provides an overview of technologies as well as energy and fuel options for the various modes of transport.

Scope

- As a "learning strategy", the Mobility and Fuels Strategy shows how the energy transition in the transport sector can be implemented in the long term. A central issue in this context is to identify where it is possible to gradually replace the combustion engine with an electric motor, given that (i) the energy efficiency of an electric motor is at least twice that of a combustion engine and (ii) renewable energy can be integrated far more easily into electric motors than into combustion engines. To reach the goals of the Federal Government's Energy Concept, overland transport should be electrified to the greatest extent possible on a step-by-step basis. The keys to achieving this are the promotion of electric mobility with battery and fuel cells and the redoubling of efforts to move traffic to rail.

New World Harmonised Light Vehicle Test Procedure (WLTP)

Goals

- Make available more representative and reproducible values for CO_2 emissions and fuel consumption so that the vehicle fuel consumption rates in the test scenario once again correlate more with the on-road values that the vehicle driver experiences.

Scope

- The emission standards and consumption standards for passenger cars and light vehicles are defined for the post-2020 period on the basis of this new procedure, wherein the stricter requirements of this procedure must be taken into account. Once the relevant EU Directive is amended, the new test cycle will also be incorporated into the passenger car energy consumption labelling system (car label) and increase the credibility and thereby the effectiveness of the label.

Strategy for Automated and Connected Driving

Goals

- Create the framework and necessary conditions for the introduction of automated and connected driving systems in conjunction with smart transport systems

Scope

- The emission standards and consumption standards for passenger cars and light vehicles are defined for the post-2020 period on the basis of this new procedure, wherein the stricter requirements of this procedure must be taken into account. Once the relevant EU Directive is amended, the new test cycle will also be incorporated into the passenger car energy consumption labelling system (car label) and increase the credibility and thereby the effectiveness of the label.

Reform of EU Regulations to reduce CO_2 emissions in new passenger cars and light vehicles

Goals

- New CO_2 fleet targets for the post-2020 period

Status

- The amendment to the EU Regulation on CO_2 emissions of passenger cars and light vehicles is expected in the first quarter of 2017.

EU Regulation to reduce CO_2 emissions of heavy-duty vehicles (HDV)

Goals

- New CO_2 fleet targets for the post-2020 period

Status

- The HDV regulation is not expected before 2020.

EU Regulation on national GHG reduction contributions for sectors outside the scope of the ETS (non-ETS) in the 2021–2030 period (see Chapter 12.1)

Electric mobility – alternative fuels – refilling and charging infrastructure

Electric Mobility Market Incentive Package

Goals

- Force the pace on the expansion of electric mobility and the charging infrastructure.

Scope

- To speed up the development of a market for electric vehicles, corresponding funding is increased by a total of €1.6 billion (together with the €600 million in funds provided by the business community). A premium of €4000 is paid for purchases of new all-electric vehicles and of €3000 for plug-in hybrids. Total funding is set at €1.2 billion, the costs of which are shared equally between the Federal Government and the automotive industry. The Federal Government is making €300 million available to improve the vehicle charging infrastructure.

Status

- Adopted in May 2016. Car buyers have been able to submit their applications to the Federal Office for Economic Affairs and Export Control since July 2016. Number of applications in September 2016: roughly 3000. To ensure that electric vehicles can also be used for longer distances, work has commenced on installing fast charging stations at the roughly 430 service stations on the federal motorways since autumn 2016.

"Local Electric Mobility" funding programme

Goals

- Support the market uptake of electric vehicles by supporting EV procurement in a municipal context and associated measures to develop charging infrastructures. Promotion of strategic research and demonstration projects in the local public passenger transport system and with electric delivery vehicles or light-duty vehicles.

Status

- As the result of the first call for applications for funding, the Federal Ministry of Transport and Digital Infrastructure has issued notification of grants awarded for around 100 projects since June 2015.

"Renewable and Mobile" funding programme

Goals

- Move the electric car forward as a marketable environmental innovation.

Status

- Under the request for proposals in October 2015, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety called for the submission of outline proposals.

Round Table on Gas-based Mobility

Goals

- Organise dialog between the various market players and work with the Federal Ministry for Economic Affairs and Energy to develop a package of measures by the end of January 2017 to reach the 4% target for natural gas mobility.

Status

- The Round Table met for the first time in September 2016. The first step is to identify a range of focus regions in Germany where the use of natural gas vehicles and infrastructure expansion are to move forward particularly quickly.

Taskforce on LNG in heavy-duty vehicles

Goal

- Accelerate the market entry of LNG in heavy-duty freight transport.

Status

- Having being founded at the initiative of the Federal Ministry of Transport and Digital Infrastructure in November 2015, the work of the taskforce is essentially centred on three areas: 1. Development of measures for the development of the LNG market in Germany; 2. Assessment of the environmental and climate effects and evaluation of economic viability based on real-life values from the demonstration projects implemented by the Federal Ministry of Transport and Digital Infrastructure; 3. Creation of an information basis for feasibility and implementation aspects for users of LNG HDVs.

H2 Mobility project

Goals

- Develop 400 hydrogen filling stations in Germany by 2025. The first 100 filling stations will be built irrespective of vehicle uptake (chicken and egg dilemma).

Status

- The first 50 hydrogen filling stations are part-funded by the Federal Government under the National Innovation Programme for Hydrogen and Fuel Cell Technology.

2014 EU Directive on the Deployment of Alternative Fuels Infrastructure

Goals

- Appropriate minimum number of refuelling and charging points for alternative fuels and establish necessary minimum technical standards and minimum standards for consumer information.

Scope

- The implementation of the EU Directive is an integral part of the Mobility and Fuels Strategy, as the swift development of an effective refilling and charging infrastructure for alternative fuels is at the core of the energy transition in the transport sector. The National Policy Framework adopted by the Federal Cabinet was submitted to the EU Commission in November 2016. The measures of the Policy Framework will be implemented by the various ministries responsible.

Switch to environmentally friendly modes of transport

Promotion of investment in the rail infrastructure

Goals

- Maintain a high level of investment through to 2030.

Scope

- In accordance with the Federal Transport Infrastructure Plan and corresponding infrastructure expansion legislation.

2020 National Cycling Plan

Goals

- The promotion of bicycle transport is a common objective of the Federal Government, the *Länder* and municipalities.

Facts and figures

- Federal funding for non-investment innovative projects amounted to €3.2 million in 2016. Further to this, cycle paths also received €98 million in funding by way of federal trunk roads. An additional €1.2 million were also provided for the improvement of paths along federal waterways. Equal amounts are set out in the 2017 budget. In addition, around €1.3 billion are provided each year from the federal budget, inter alia for the improvement of municipal transport conditions, (known as “unbundling funds”). This level of funding will continue through to 2019 and the funds can also go towards the development of the cycling infrastructure.

2030 Federal Transport Infrastructure Plan

Goals

- Maintenance and replacement ahead of expansion and construction, elimination of congestion on main routes, strengthening of the more climate-friendly modes of transport.

Status

- The 2030 Federal Transport Infrastructure Plan was adopted in the Cabinet in August 2016. The infrastructure expansion legislation adopted by the Bundestag forms the basis for the financing and realisation of infrastructure expansion and construction projects.

Facts and figures

- Over €270 billion in total are earmarked for maintenance and replacement measures and for road, rail and waterway infrastructure expansion and construction projects.

7 Greenhouse gas emissions and environmental impacts

Where do we stand?

Following a significant drop between 2013 and 2014, greenhouse gas emissions rose slightly in 2015 compared with the previous year. Overall, greenhouse gas emissions have decreased by an estimated 27.2% compared with 1990 levels.

The 2016 Climate Action Report demonstrates that the measures of the 2020 Climate Action Programme are already taking effect, a considerable contribution to closing the climate change mitigation gap can be expected and that the goal still remains within reach.

The Federal Government reaffirms the need for consistent implementation of the agreed measures in order to actually meet the reduction targets it adopted for the measures in the 2020 Climate Action Programme.

What is new?

In light of the outcome of the Paris Convention on Climate Change, the Federal Government adopted a national 2050 Climate Action Plan in November 2016.

	2015	2020	2030	2040	2050
Greenhouse gas emissions					
Greenhouse gas emissions (compared with 1990)	-27.2%*	at least -40%	at least -55%	at least -70%	-80% to -95%

*Provisional figure for 2015

2015 UN Climate Change Conference in Paris

The 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21) signed on to a new agreement on climate change in Paris on 12 December, 2015. The **Paris Agreement** and the accompanying decisions establish an ambitious climate policy regime with the following climate change mitigation milestones:

- All 197 Parties – developed countries, emerging markets and developing countries alike – have made a firm commitment to action, and not just developed countries as in the past.
- The Parties commit, inter alia, to progressively more ambitious measures to keep global temperature increase to well below 2°C compared with pre-industrial levels. Efforts should be pursued to limit the temperature increase to 1.5°C.
- To monitor progress towards this long-term goal, a global review process ("ambition mechanism") will take place every five years, starting in 2018. The nationally determined contributions must be updated every five years from 2025 onwards.
- Developed countries will support developing countries annually with emissions reduction and adaptation efforts through technology development and transfer, capacity building measures and financial aid. The pledge made in 2009 to mobilise US$100 billion a year for climate finance by 2020 will be extended through to 2025.

The Paris Agreement entered into force in November 2016: with ratification by the European Union and other member states, including Germany, more than 55 countries responsible for more than 55% of global greenhouse emissions had ratified the treaty by 5 October 2016. Please refer to Chapter 12 for information on the implementation of climate change mitigation goals at European level.

7.1 Total greenhouse gas emissions

According to initial estimates of the Federal Environment Agency for 2015, total greenhouse gas emissions in Germany have fallen by more than 27%, or a total of 340 million tonnes of CO_2 equivalent, since 1990. On the basis of these estimates, greenhouse gases amounting to around 908 million tonnes of CO_2 equivalent were emitted in 2015. This is 0.7% more than the previous year (see Diagram 7.1). Following the significant drop in emissions in 2014, greenhouse gas emissions are still well below 2013 levels despite the increase. Accounting for slightly more than 39% of total emissions, the energy sector is the biggest source of greenhouse gases in 2015. Industry is the second-biggest emitter with 20% of total emissions, followed by transportation (18%) and private households (10%). The agriculture and trade, commerce and services (TCS) sectors are responsible for 8% and roughly 4% of total emissions, respectively. Remaining emissions (around 1%) are essentially caused by the waste management industry.

Emissions in the energy sector fell slightly compared with the previous year. In contrast, households and transport had significantly higher emissions than the year before. At roughly 4%, private households accounted for the biggest increase on the previous year, as more energy was needed for heating due to the colder weather conditions. The emissions of the trade, commerce and services sector are also 5% higher than the previous year for this reason. GHG emissions in the energy sector fell by roughly 0.9%, but increased in the industry sector by 0.5%. Another increase was also registered in the transport sector where greenhouse gas emissions rose by over 2% on the previous year, thereby pushing emissions above 1990 levels for the transport sector, albeit only marginally.

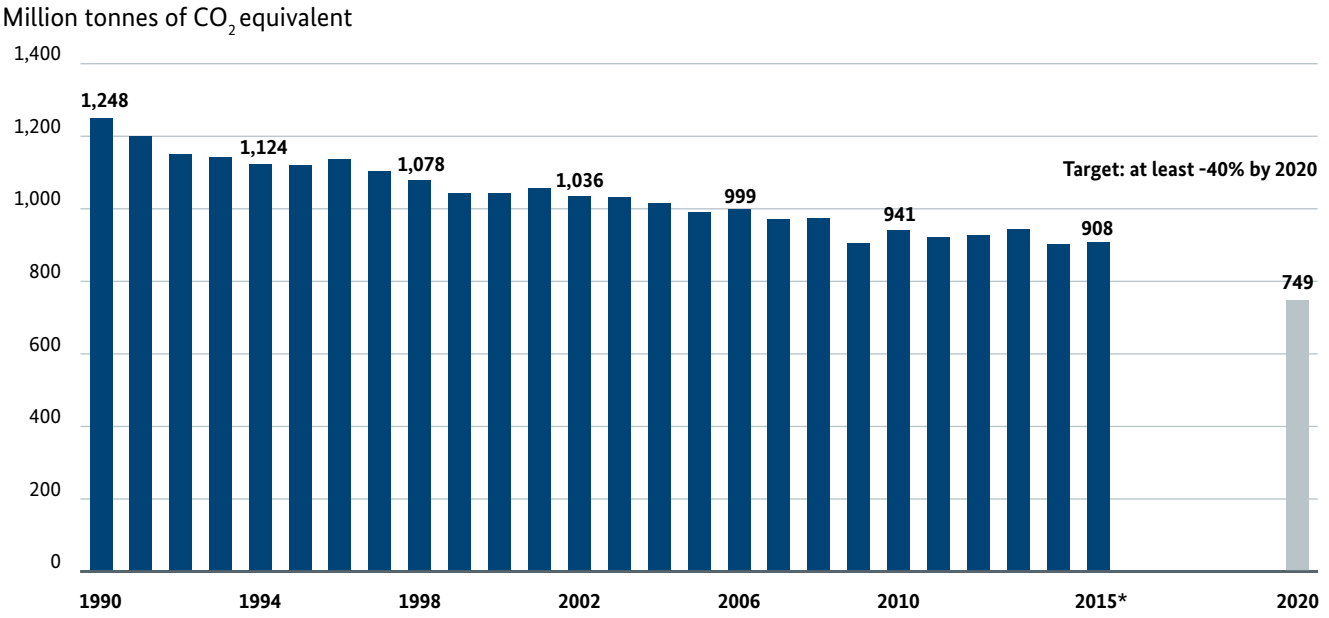
The emissions of the energy sector have also declined appreciably over the long term. In 2015, emissions were around 24% below 1990 levels and therefore just slightly below the overall reduction achieved. This was due, inter alia, to the increasing importance of the use of renewables (see Chapter 3) and their substitution of fossil-based energy, and to better plant efficiency.

Weather conditions, low commodity prices and a high electricity export surplus have a major bearing on the climate footprint for 2015. Colder weather conditions compared with the previous year, and a resulting increase in the need for heating energy, coupled with lower fuel prices caused greenhouse gas emissions to creep up slightly in 2015. A high electricity export surplus with a still high proportion of coal-derived electricity, and therefore emissions with a high carbon intensity, also prevented a more significant decline in GHG emissions in the electricity sector despite the continued expansion of renewable energy.

Of the individual greenhouse gases, CO_2 is the most dominant gas emitted, primarily as a result of combustion. Owing to the above-average decrease in other greenhouse gases, the share of CO_2 emissions has increased by almost

Diagram 7.1: Meeting the target for greenhouse gas emissions in Germany

2020 target	Reduction in greenhouse gas emissions of at least 40% (compared with 1990)
Status 2015	-27.2%*



Source: Federal Environment Agency
*Provisional figures for 2015

Trend	●●●○○
Measure	2020 Climate Action Programme

four percentage points to roughly 90% since 1990 (see Chapter 7.2). Methane emissions (CH_4) had a 6.2% share in 2014, and nitrous oxide (N_2O) 4.3%. Fluorinated greenhouse gases accounted for around 1.6%. This greenhouse gas make-up is typical of a highly industrialised country.

To reach the 40% target, the Federal Government adopted the 2020 Climate Action Programme in December 2014 containing a range of over 100 measures. A climate change mitigation gap of 5–8 percentage points, which was identified beforehand, formed the basis for the 2020 Climate Action Programme. Without factoring in the measures of the Climate Action Programme, the German 2015 Projection Report published in March 2015 indicates a reduction range of 32–35% compared with 1990. It thereby confirms the gap that needs to be closed and therefore the need for the ambitious and focussed implementation of the measures of the Action Programme.

The Federal Government oversees the implementation of the measures in the Climate Action Programme in a continuous process and presents a Climate Change Report each year. This Climate Change Report presents current trends in the development of emissions in the various action areas, describes progress in the implementation of the measures contained in the Climate Action Programme and provides an outlook of the expected effect the individual measures will have on reducing emissions by 2020. The Federal Government presented the first Climate Change Report in November 2015, which did not yet contain an assessment of the emissions reduction impact of the individual measures of the Climate Action Programme with a view to 2020. This will be provided for the first time in the 2016 Climate Change Report (see Chapter 7.4).

In September 2016, the scope of the 2015 Projection Report included the results of a scenario that suggests that the emissions reduction effect of all the measures adopted in the 2020 Climate Action Programme can amount to 60 million tonnes of CO_2 equivalent under ambitious, textbook implementation conditions. The current projection therefore shows a reduction range of 37–40% in 2020. This range is the result of uncertainties surrounding the development of key influencing factors, such as economic growth, fuel prices, the electricity external trade balance and demographic trends. Taking into account the current development of these factors and the current quantification of the effect of the Climate Action Programme on emissions reduction based on the current state of implementation and planning, a reduction in the lower half of the range can be expected. These projections and estimates, however, are still fraught with uncertainty. While the Federal Government will take the results of the projection report into account in climate policy considerations, it is not aligned with the results.

The Federal Government therefore reaffirms the need for consistent implementation of the measures agreed in the 2020 Climate Action Programme. Further to this, the Federal Government will continue to oversee the implementation of the measures on an ongoing basis, and continue to assess the impact on emissions reduction. On the basis of the projections and estimates due to be updated next year (including the 2017 Projection Report, 2017 Climate Action Report with updated quantification) and the reduction targets set out for the individual action areas in the Action Programme, the Federal Government will be able to make specific adjustments from 2018 onwards if necessary – also as part of the implementation of the 2050 Climate Action Plan.

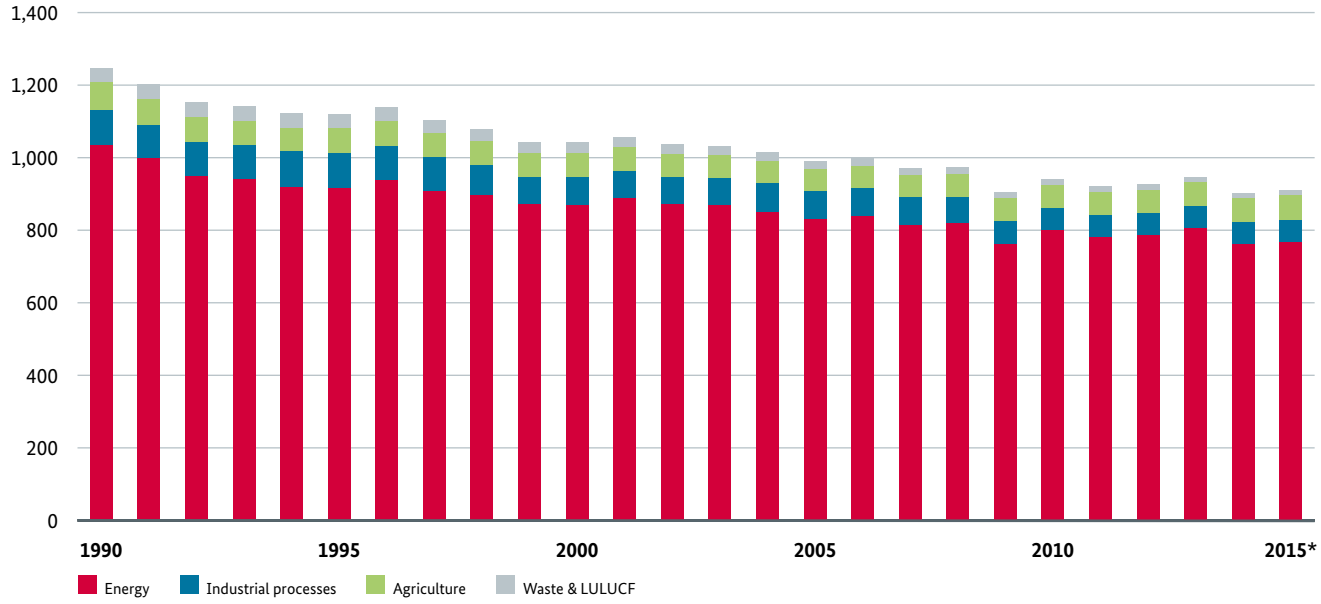
The 2050 Climate Action Plan provides important orientation for the post-2020 period. The Federal Government adopted this Climate Action Plan on 14 November 2016. The 2050 Climate Action Plan aims to spell out in concrete terms Germany's current 2050 climate change goal and the agreed intermediate goals in light of the Paris Agreement, and back these goals with measures based on comprehensive impact assessments (see Chapter 7.4).

7.2 Energy-related greenhouse gas emissions

According to initial estimates of the Federal Environment Agency, energy-related greenhouse gas emissions in Germany rose slightly in 2015 compared with the previous year. Energy-related GHG emissions comprise the energy sector, i.e. emissions from the burning of fossil fuels in power plants for the public supply of electricity and heating, as well as fugitive emissions in upstream and downstream processes (e.g. extraction, transportation, storage and conversion of fuels), and also the emissions occurring in the manufacturing sector, heating systems and vehicles. These account for around 85% of total emissions (see Diagram 7.2). Roughly 0.7% more emissions were produced in 2015 than in the previous year, which corresponds to the percentage increase in total emissions.

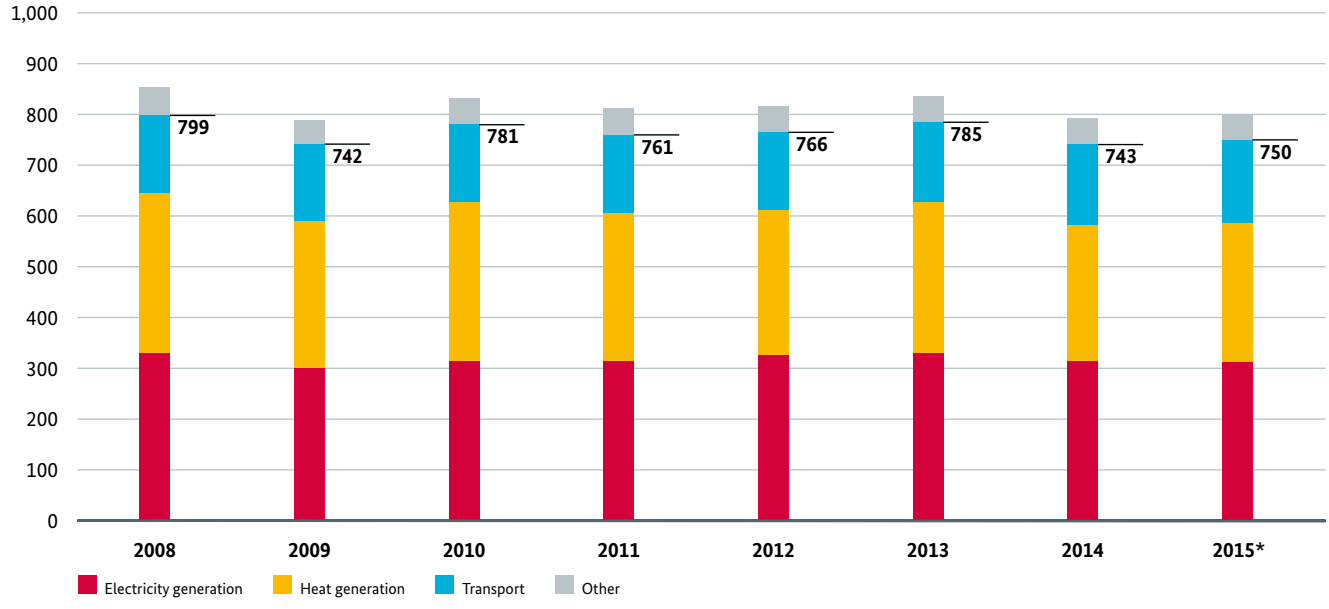
Energy-related CO_2 emissions have dropped significantly since 1990, but showed a slight overall increase in 2015 compared with the previous year. While energy-related CO_2 emissions continue to follow a downwards trend when viewed over the long term, they registered a 0.7% increase to 750 million tonnes in 2015 compared with 2014 (see Diagram 7.3), thereby accounting for the bulk of the total 799 million tonnes of CO_2 emissions. Most of the energy-related CO_2 emissions were produced from the burning of fossil fuels to generate electricity and heat, and in the transport sector. By contrast with Diagram 7.2, Diagram 7.3 only looks at CO_2 emissions, and diffuse emissions are not taken into account. Overall, the increase in 2015 is primarily attributable to increased emissions in the heating and transport sector. In contrast, CO_2 emissions in electricity generation declined.

Diagram 7.2: Greenhouse gas emissions by source group
Million tonnes of CO_2 equivalent



Source: Federal Environment Agency, March 2016
* Provisional values for 2015

Diagram 7.3: Energy-related CO_2 emissions disaggregated by sector
Million tonnes of CO_2 equivalent



Source: Federal Environment Agency, June 2016
*Provisional values for 2015. Other emissions (indicated in the bar in the graphic, but not included in the total) are primarily process emissions from industry and emissions from diffuse sources. A different sectoral breakdown is applied in international climate reporting.

Greenhouse gas emissions avoided through the use of renewable energy

The replacement of fossil fuels with renewables (see Chapter 3) makes a key contribution to reaching the climate goals. Total emissions of around 160 million tonnes of CO_2 equivalent were avoided in 2015 benchmarked against a reference system without renewable energy and with the same demand for energy in 2015. The electricity sector accounted for emissions savings of approx. 120 million tonnes. Through the use of renewables, the heating sector avoided 34 million tonnes of CO_2 equivalent and the transport sector reduced its emissions by around 4.4 million tonnes.

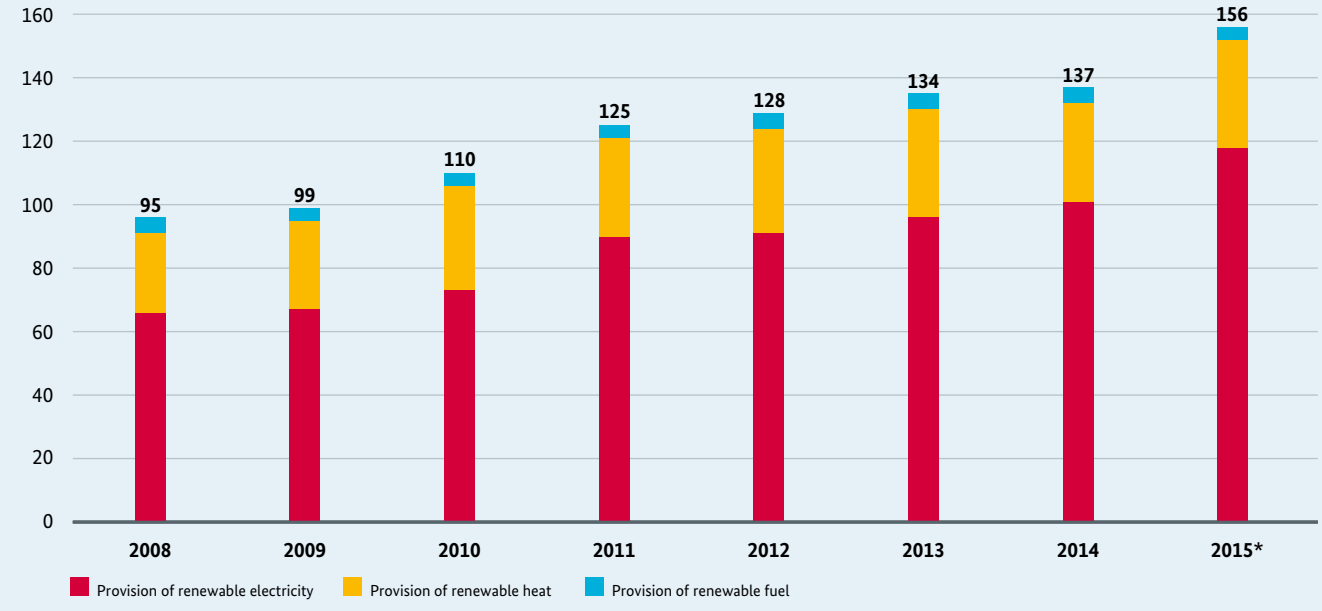
Calculations of the volume of emissions avoided through the use of renewable alternatives are based on a net analysis. Here, the emissions produced by the provision of final energy from renewable sources are offset against the gross emissions avoided by substituting fossil fuels and/or nuclear fuels, where applicable, with renewables (Fh ISI 2016). In contrast to the GHG emissions of GHG inventories that are calculated according to internationally binding rules, this calculation also factors in all the upstream process chains involved in the production and provision of the fuels and for the construction and operation of the plants (excluding plant dismantling).

Biomass helps reduce emissions in all sectors of consumption. Roughly 61 million tonnes of CO_2 equivalent were avoided through the use of biomass in solid, liquid or gas form in all three sectors of consumption. Around 53.6 million tonnes of CO_2 equivalent are avoided through the use of wind energy, roughly 23.6 million tonnes of CO_2 equivalent through the use of photovoltaic installations and approximately 14 million tonnes of CO_2 equivalent through the use of hydroelectric plants.

In the electricity and heating sector, the result hinges significantly on the type of fossil or nuclear fuels that are replaced (UBA 2015/Fh ISI 2016). With regard to the use of biomass for energy purposes, the type and origin of the raw materials used also play an important role in the emissions footprint.

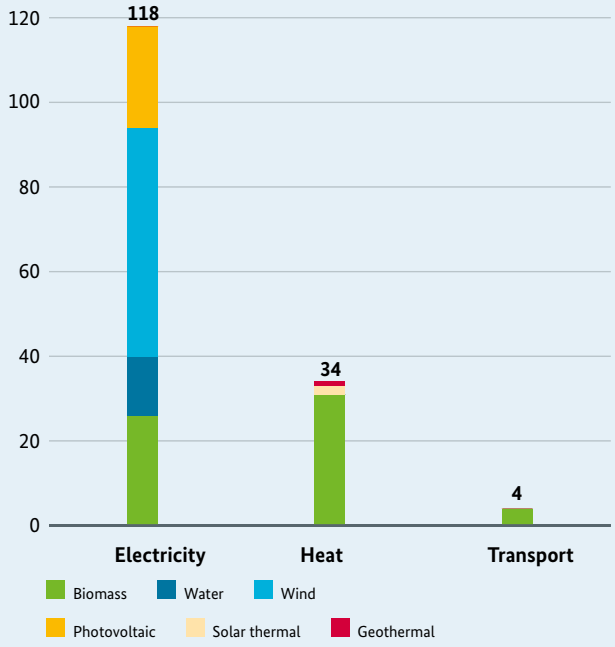
The methodology (Diagrams 7.4 and 7.5) applied to calculate the emissions avoided by renewables is based on the specifications of the EU Renewable Energy Directive (2009/28/EC).

Diagram 7.4: Greenhouse gas emissions avoided through the use of renewable energy
Million tonnes of CO_2 equivalent



Source: Working Group on Renewable Energy Statistics based on data from the Federal Environment Agency, August 2016
*Provisional figures for 2015

Diagram 7.5: Effect of renewables on avoidance of emissions in 2015*, disaggregated by energy source and sector
Million tonnes of CO_2 equivalent



Source: Working Group on Renewable Energy Statistics based on data from the Federal Environment Agency, August 2016
*Provisional figures for 2015

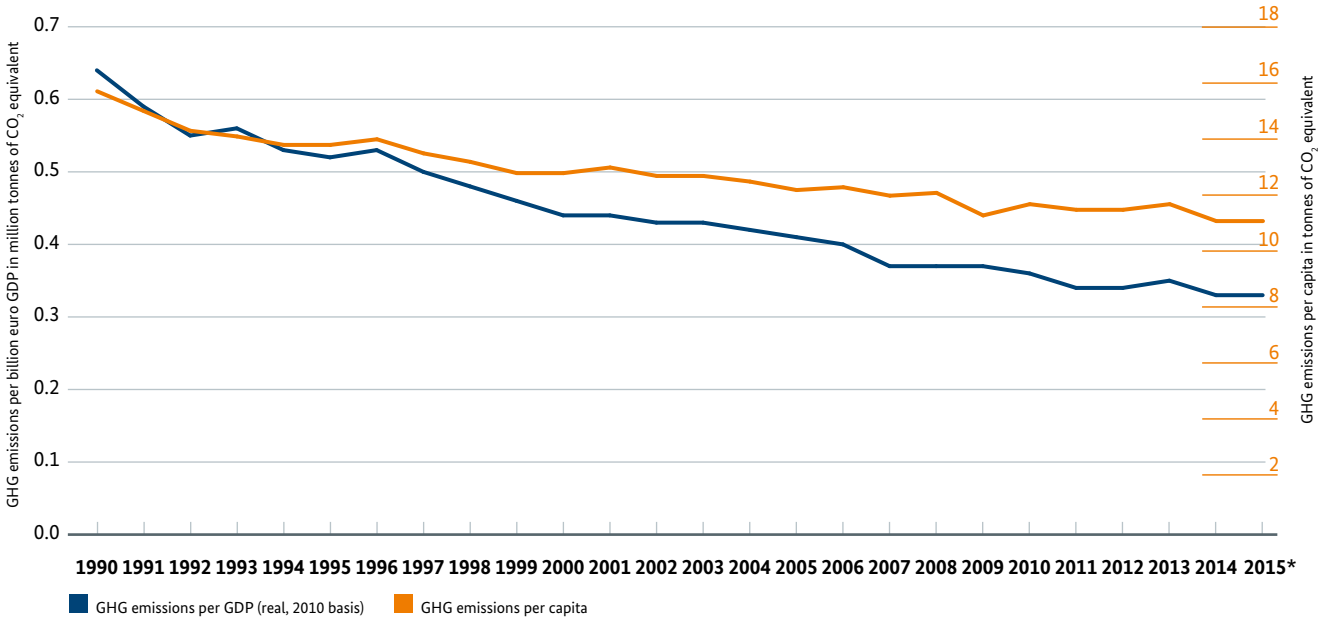
7.3 Greenhouse gas emissions and economic output

Overall, greenhouse gas emissions in relation to economic output have continued to decrease. While greenhouse gases amounting to around 0.59 million tonnes of CO_2 equivalent were emitted per billion euro of GDP in 1991, this figure had dropped to just 0.33 million tonnes of CO_2 equivalent in 2015. This translates to a 45% decrease. Specific greenhouse gas emissions per capita also dropped by 25% between 1991 and 2015, going from 15.0 tonnes to 11.1 tonnes of CO_2 equivalent (see Diagram 7.6). In the EU-28, specific greenhouse gas emissions per capita fell by 27% between 1991 and 2014, from 11.6 to 8.45 tonnes of CO_2 equivalent. For information on competitiveness, please refer to Chapter 9.3.

7.4 2020 Climate Action Programme and 2050 Climate Action Plan

The 2020 Climate Action Programme is the central instrument to close, by 2020, the climate change mitigation gap identified in the 2013 Projection Report. The Action Programme is designed to contribute between 62 and 78 million tonnes of CO_2 equivalent towards closing the climate mitigation gap. This aggregate contribution is based on individual contributions from more than 100 individual measures. At this stage, roughly 70% of the measures adopted in the Action Programme have already been fully implemented, and work has already commenced on the implementation of the remaining measures.

Diagram 7.6: Greenhouse gas emissions per capita and GDP



Source: Federal Environment Agency, Federal Statistical Office, May 2015
*Provisional figures for 2015

The quantification to assess the impact of measures to reduce emissions, as illustrated in the 2016 Climate Action Report, was performed by a group of experts on behalf of the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. This quantification shows that the measures of the Action Programme are already working and can be expected to make a considerable contribution to closing the gap. Factoring in the current state of implementation and planning of the individual measures, the current estimate of the total anticipated contribution to emissions reduction amounts to between 47 and 58 million tonnes of CO_2 equivalent for 2020 (see Table 7.1).

The expert assessment of the effect of measures in the Action Programme to reduce emissions carries a degree of uncertainty, particularly in the early or initial phase of implementation. However, according to this assessment the contribution is lower than the "snapshot" contribution of roughly 60 million tonnes of CO_2 equivalent estimated in the current projection report under ambitious, textbook implementation conditions. Despite these uncertainties, the goal can still be achieved. The Federal Government therefore reaffirms the need for consistent implementation of the agreed measures in order to actually meet the reduction targets it adopted for the measures in the 2020 Climate Action Programme. Further to this, the Federal Government will continue to oversee the implementation of the measures on an ongoing basis. On the basis of the projections and estimates due to be updated next year (including the 2017 Projection Report, 2017 Climate Action Report with updated quantification) and the reduction targets set out for the individual action areas in the Action Programme, the Federal Government will be able to make specific adjustments from 2018 if necessary – also as part of the implementation of the 2050 Climate Action Plan.

With the adoption of the 2020 Climate Action Programme, the Federal Government set up a Climate Action Alliance, overseen by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety. The task of the Climate Action Alliance is to support implementation of the measures adopted under the Climate Action Programme, make it easier to realise potential that is currently rated as "not yet quantifiable" and identify additional possibilities for action. The Climate Action Alliance met for the first time in March 2015 and has since then convened twice a year, once in spring and once in autumn. A range of issues have been discussed at the sessions so far, including climate action in the transport sector, in municipalities, agriculture, small and medium-sized enterprises, the craft sector and industry.

The 2050 Climate Action Plan adopted by the Federal Government in November 2016 is based on the outcome of the 21st Framework Convention on Climate Change and is being implemented as a modernisation strategy on three levels: It develops concrete guiding principles for the individual action areas for 2050, allows room for innovation and strives for maximum sustainability. For all action areas it maps out robust, transformative paths, highlights critical path dependencies and pinpoints interdependencies. In particular, it defines concrete milestones and strategic measures for the GHG intermediate goal for 2030, also taking impact and cost analyses into account.

Table 7.1: Contribution of central policy measures to reaching the 40% target

	Contribution to GHG emissions reduction in 2020 in million tonnes of CO_2 equivalent	
Central policy measures	**Contribution according to original estimate, as at December 2014**	**Contribution according to current expert assessment (rounded figures)**
National Action Plan on Energy Efficiency (NAPE) excluding measures in the transport sector	Approx. 25–30 (including building energy efficiency)	25–30 (including building energy efficiency)
"Climate-friendly building and housing" strategy	Approx. 5.7–10 in total (1.5 - 4.7 of which in addition to NAPE)	4.2 to 5.0 in total (0.8 of which in addition to NAPE)
Measures in the **transport sector**	Approx. 7–10	1.15–1.6
Reduction in non-energy-related emissions in the sectors:		
Industry, trade, commerce and services	2.5–5.2	1.2–2.5
Waste management	0.5–2.5	0.05
Agriculture*	3.6	0.6–2.1
Reform of the emissions trading system	Depends on how the ETS is organised at the EU level	
Additional measures, particularly in the electricity sector	22	18.3–19.5
Advice, information and independent initiatives for more climate action		0.23–1.8
Total	**62–78**	**47–58**

Source: 2016 Climate Action Report

*The contributions to GHG emissions reduction estimated in December 2014 are based on the emission factors for nitrous oxide valid at that time for international reporting. These have since been adjusted and form the basis for estimates in the 2016 Climate Action Report.

2050 Climate Action Plan

Goal

- The overriding goal of the 2050 Climate Action Plan is for Germany to be largely GHG-neutral by 2050. Within the context of the goals set out, the Climate Action Plan is characterised by being technology-neutral and open to innovation. It provides orientation for investment, particularly for the period up to 2030.

Sectoral targets

- The 2050 Climate Action Plan addresses the following action areas: energy sector, buildings, transport, industry, agriculture as well as land use and forestry. Overriding objectives and measures are also presented.
- Sectoral targets (reduction targets) are defined for the various action areas, working on the basis of the intermediate goal adopted by the Federal Government for 2030 – to reduce greenhouse gas emissions in Germany by at least 55%.

Impact assessment

- As the sectoral targets can, to some extent, have far-reaching consequences for economic and social development in Germany, they will undergo a comprehensive impact assessment. The result of the impact assessment will be discussed with the social partners and adjustments can be made to the sectoral targets in 2018 if necessary.

Commission for "Growth, Structural Change and Regional Development"

- Another important element of the Climate Action Plan is the decision to set up the Commission for "Growth, Structural Change and Regional Development." To support structural change, this Commission has been tasked to develop an instrument mix that brings together economic development, structural change, social compatibility and climate change mitigation. Preliminary work is to begin before the end of this legislative period so that the Commission can start work at the beginning of 2018 and present results by the end of 2018 if possible.

Programme of measures

- In 2018, the 2050 Climate Action Plan will be underpinned by a programme of measures, quantified on the basis of their contribution to emissions reduction, to ensure that the 2030 goals will be achieved.

Implementation

- To regularly monitor implementation and progress towards goals, the Federal Government will continue to issue Climate Action Reports beyond 2020 so that adjustments can be made if necessary. The aim is for continued broad involvement in the implementation and the development/revision of the programme of measures.

Update

- The 2050 Climate Action Plan is updated regularly, also with a view to implementing the ratchet mechanism, as set out in the Paris Agreement, to regularly crank up the ambition of national climate action policies. The applicable programme of measures will be revised with each update to the Climate Action Plan. The Climate Action Plan is due to be updated for the first time by late 2019/early 2020 – the time when the parties to the Paris Agreement are required to submit new contributions.

7.5 Environmental compatibility of the energy supply system

Effective climate change mitigation is not possible without a sustainable energy policy. The transition to the age of renewables, coupled with greater efficiency in the conversion and use of energy, protects our natural resources and creates the framework for economic and social development both in Germany and worldwide. The burning of conventional fuels, such as coal, oil and natural gas, negatively impacts both the climate and the environment.

Renewable energy and energy efficiency help prevent the acceleration of climate change with serious consequences for the environment, society and the economy. The share of conventional energy sources will be scaled back with the increase in energy efficiency and the continued expansion of renewables as the mainstay of the German energy supply system. In this context, the decision to phase-out nuclear energy, which has already been adopted, is one of the major changes taking shape in the energy sector. The energy transition goes hand in hand with the reduction of electricity generation based on fossil fuels. Ensuring that this transition is socially acceptable and viable is a challenging undertaking. Given that around 85% of greenhouse gas emissions are energy-related, climate and environmental problems will abate as the energy system is restructured. The energy, heating and transport sectors are the primary source of these emissions.

The expansion of renewable energy itself should not negatively impact our countryside and natural environment. Therefore an energy supply system that is environmentally compatible and nature-friendly must minimise the amount of land required to produce, process and transport energy and non-energy resources and prevent permanent soil degradation and the loss of agricultural space. The expansion of renewables also places new demands in terms of nature preservation and rural conservation. On the one hand, being climate-friendly, renewable energy has a positive effect on nature and the environment. On the other hand, the uncontrolled expansion of renewable energy itself can negatively impact our countryside and natural environment. Therefore, the priority is to provide incentives so that businesses and other economic players find suitable sites for the various facilities in order to keep any adverse effects to a minimum. Less demand for energy as a result of the energy efficiency measures initiated by the Federal Government has particularly positive implications for nature and the environment.

As it develops a secure, economic and environmentally compatible energy supply system, the Federal Government is also mindful of other potential environmental and health risks. This is because a wide range of other pollutants – such as nitrogen oxides, particulate matter or mercury – are released to the atmosphere in addition to greenhouse gases (such as carbon dioxide or methane) when fossil fuels and biogenic fuels are used for energy. These pollutants are not only harmful to the natural environment but also have an adverse effect on human health.

When solid biogenic fuels are used in decentralised facilities it is important to ensure compliance with strict emission standards so as not to jeopardise the positive trend in pollutant reduction resulting from the use of renewable energy. In addition, the emission of pollutants from the biogas sector (e.g. ammonia emissions when spreading plant-based digestate fertilizer) must be reduced to a minimum. Accidents at biogas facilities in the past have caused considerable local water pollution in some cases. In terms of plant safety and operator responsibilities, potential hazards to health and the environment must be ruled out to the greatest extent possible. With regard to the cultivation of maize, which increased considerably in the past, more attention must be paid to ensuring strict compliance with good farming practice. Changes to the Renewable Energy Sources Act managed to curb the expansion of the cultivation of maize for bioelectricity production: Germany's maize acreage has been constant since 2012 (FNR 2015).

The phase-out of nuclear energy for the production of electricity and the safe permanent disposal of radioactive waste should considerably reduce the risks posed by radioactive substances. Under the Atomic Energy Act, the last nuclear power plants will lose their licence to operate at the end of 2022. The search for a suitable repository for high-level radioactive waste is also moving forward on the basis of the Repository Site Selection Act and the recommendations of the Final Repository Commission (see Chapter 8).

In the future it should be easier to measure the environmental impact of the energy transition. Comparable times series – like those for the development of greenhouse gases – are not yet available for the development of the environmental compatibility of the energy system. For this reason, the Federal Environment Agency commissioned a study in order to close this data gap. The aim, therefore, is to be able to present quantitative information on the implications of the energy transition for the environmental compatibility of the energy system, in addition to the development of greenhouse gas emissions. Further to this, other research projects on the impact of the energy transition on the environment and on nature conservation are ongoing at the Federal Environment Agency and the Federal Agency for Nature Conservation, respectively.

Central measures for the promotion of environmental compatibility

"Nature Conservation and the Energy Transition" centre for expertise (KNE)

Goals

- Work towards an energy transition that is compatible with the natural environment both to reach the climate change goals and maintain biological diversity. As a professional and neutral point of contact for all stakeholders in the context of nature conservation and the energy transition, the KNE centre of expertise helps to bring greater objectivity to debates and to prevent local conflict.

Scope

Since it commenced operation on 1 July 2016, the work of the KNE focusses on three areas:

- The centre provides specialised information by answering written questions on the complex topic of nature conservation and the energy transition.
- For conflict resolution, the centre will offer a training programme for professional mediators specifically for areas of conflict between nature conservation and the energy transition. The centre can then draw from this pool of mediators to help mediate in local disputes.
- The centre will initiate and coordinate dialog between nature conservation and energy transition stakeholders with the aim arriving at a common solution.

Repository Site Selection Act (see Chapter 8)

Goals

- Site selection process to find a site for a final repository facility for particularly high-activity waste.

Scope

- The Repository Site Selection Act will be evaluated based on the recommendations of the Final Repository Commission.

Part II: Targets and policies of the energy transition

This part of the Monitoring Report looks at other targets and the energy policy framework for the implementation of the energy transition. Specifically, this part addresses the following topics:

Power plants and security of supply

Affordable energy and a level playing field

Grid infrastructure

Integrated development of the energy system

Energy transition in the European and international context

Energy research and innovation

Investment, growth and jobs

8 Power plants and security of supply

Where do we stand?

The supply of electricity in Germany is secure. Demand for electricity in Germany is covered at all times, guaranteeing a high degree of supply security.

The decommissioning of the nuclear power plant in Grafenrheinfeld in June 2015 was another step towards the phase-out of nuclear energy.

What is new?

The electricity market is getting fit for renewables: The Electricity Market Act adopted in July 2016 will develop the electricity market into an electricity market 2.0.

Starting in July 2017, a user-friendly information platform open to the public will provide information about the electricity market and in doing so will increase transparency.

All power generation facilities and certain consumption plants will be recorded in a transparent manner in a single market master data register from early 2017 onwards. Reporting obligations will be simplified and reduced.

With the proposals presented by the Final Repository Commission in July 2016, viable strategies are now available for the search for a final repository. In October 2016, the Federal Government adopted the recommendations of the Commission for the funding of the nuclear phase-out. Both these measures are of central importance for planning security.

Security of supply	Covering the demand for energy in Germany at all times.
Nuclear phase-out	Shutting down the last nuclear power plants at the end of 2022.

8.1 Power station fleet

There has been another strong increase in installed renewable capacity. Overall, the net nominal capacity of the electricity generation plants connected to the German power grid grew by about 60 GW between 2008 and 2015 (see Diagram 8.1). In 2015, the nominal capacity of electricity generation plants based on renewable energy amounted to 98 GW, up 8.4% on the previous year. Therefore, the share of nominal capacity from renewables rose to roughly 48% of total power plant capacity (see also Chapter 3). As the supply of energy depends on natural conditions – particularly in the case of wind and solar – and the full installed capacity is therefore not always available, significantly more capacity is needed to produce a certain amount of electricity when using wind energy and photovoltaic installations than with the conventional power station fleet. Installed capacity alone is therefore not an indicator of security of supply. The latter is discussed in greater detail in Chapter 8.4.

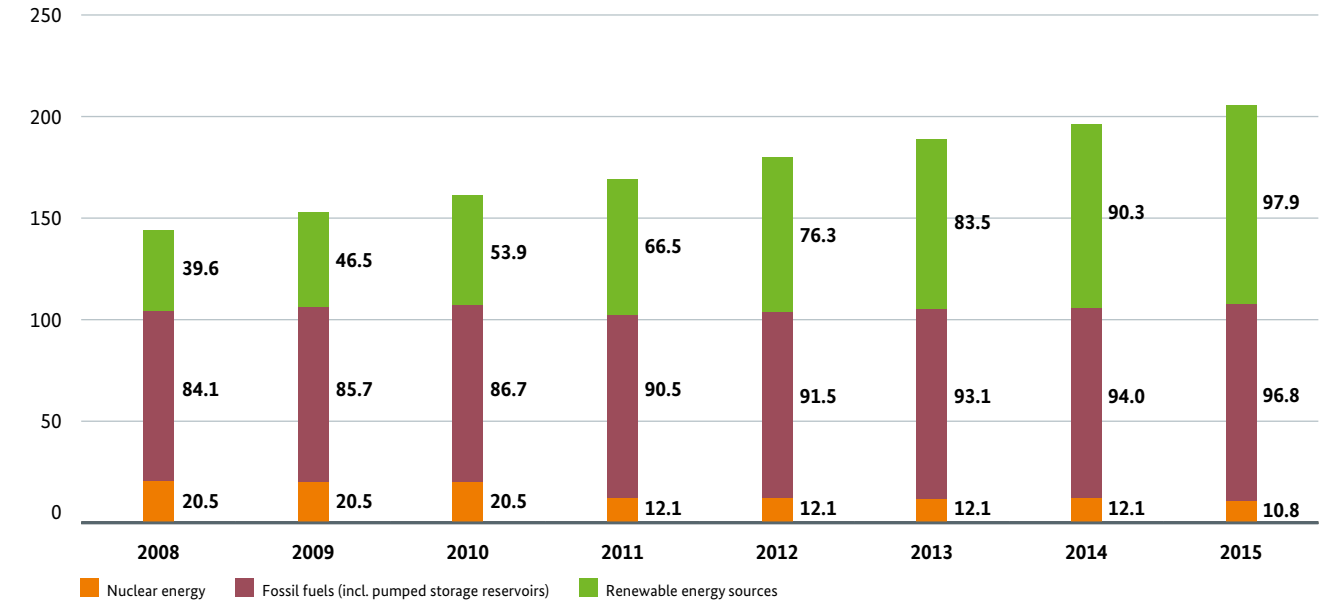
The total capacity of conventional power plants increased in 2015 compared with the previous year. There were changes in the relevant capacity provided by nuclear energy, coal and natural gas in 2015. Overall, the decommissioning of the nuclear power plant in Grafenrheinfeld is overcompensated by additional capacity from coal.

Electricity generation capacities are heterogeneously distributed throughout Germany. While conventional power plants primarily feed into the grid in some *Länder*, renewable energy dominates in nine *Länder* (see Diagram 8.2). Nuclear power plants currently still contribute to electricity generation in four *Länder*. In addition, foreign electricity generation facilities with a net nominal capacity of around 4.6 GW are also connected to the German grid. Bavaria and Lower Saxony are the main hubs of installed capacity based on renewables, while North Rhine Westphalia leads the way for conventional power plants. The highest share of renewable energy, measured against total installed capacity, can be found in the states of Mecklenburg-Western Pomerania (85%), Saxony-Anhalt (75%), Rhineland-Palatinate and Schleswig-Holstein (both 72%). The share of conventional power stations in the installed capacity is highest in the city states of Berlin (94%), Hamburg (93%) and Bremen (83%).

Combined heat and power (CHP) plays a special role in conventional electricity generation and local heating supply. CHP involves the simultaneous generation of electrical energy and heat (e.g. for district heating). CHP plants therefore use the fuel more efficiently than production in separate plants. This conserves resources and is good for the climate and the environment. In 2015 CHP electricity generation amounted to 105.5 TWh (Working Group on Energy Balances 2016).

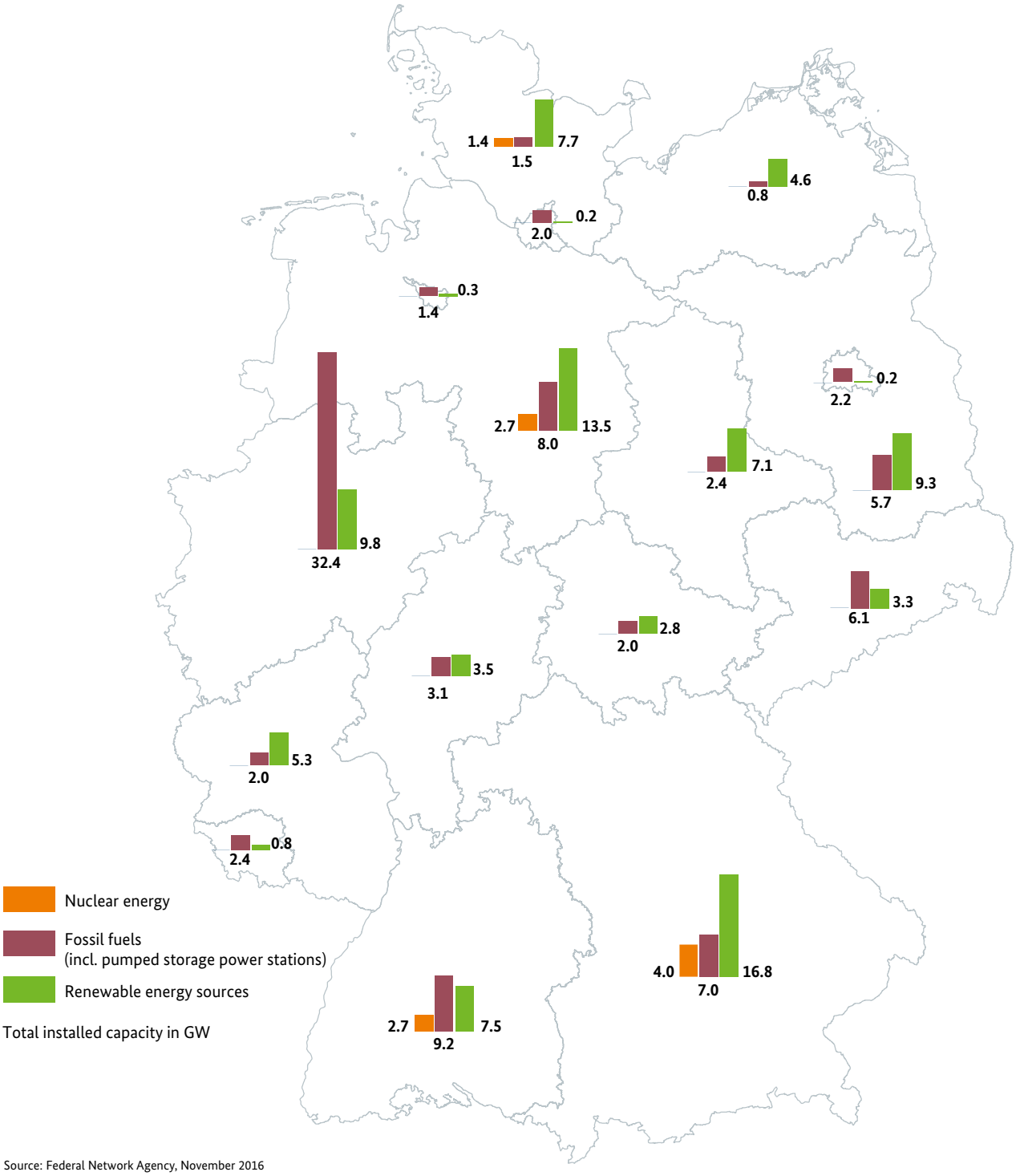
The amendment to the Combined Heat and Power Act (CHP 2016) of December 2015 sets the stage in many important areas. The CHP Act provides incentive for investment in highly efficient, flexible, low-carbon CHP plants. The aim is for CHP plants to also increase their contribution to the electricity supply at a moderate pace, to 110 TWh by 2020 and then to 120 TWh by 2025. By replacing coal with natural gas and with the moderate construction of new CHP plants, an additional 4 million tonnes of CO_2 are expected to be saved in the electricity sector by 2020. In

Diagram 8.1: Installed capacity of the electricity generation plants connected to the German power grid
In GW



Source: Federal Network Agency, November 2016

Diagram 8.2: Distribution of total power plant capacity among the *Länder*



Source: Federal Network Agency, November 2016

this way, CHP plants – particularly those using low-carbon fuels – make an important contribution to reaching German climate goals. In October 2016, the European Commission approved support for CHP plants under the new CHP Act, subject to conditions.

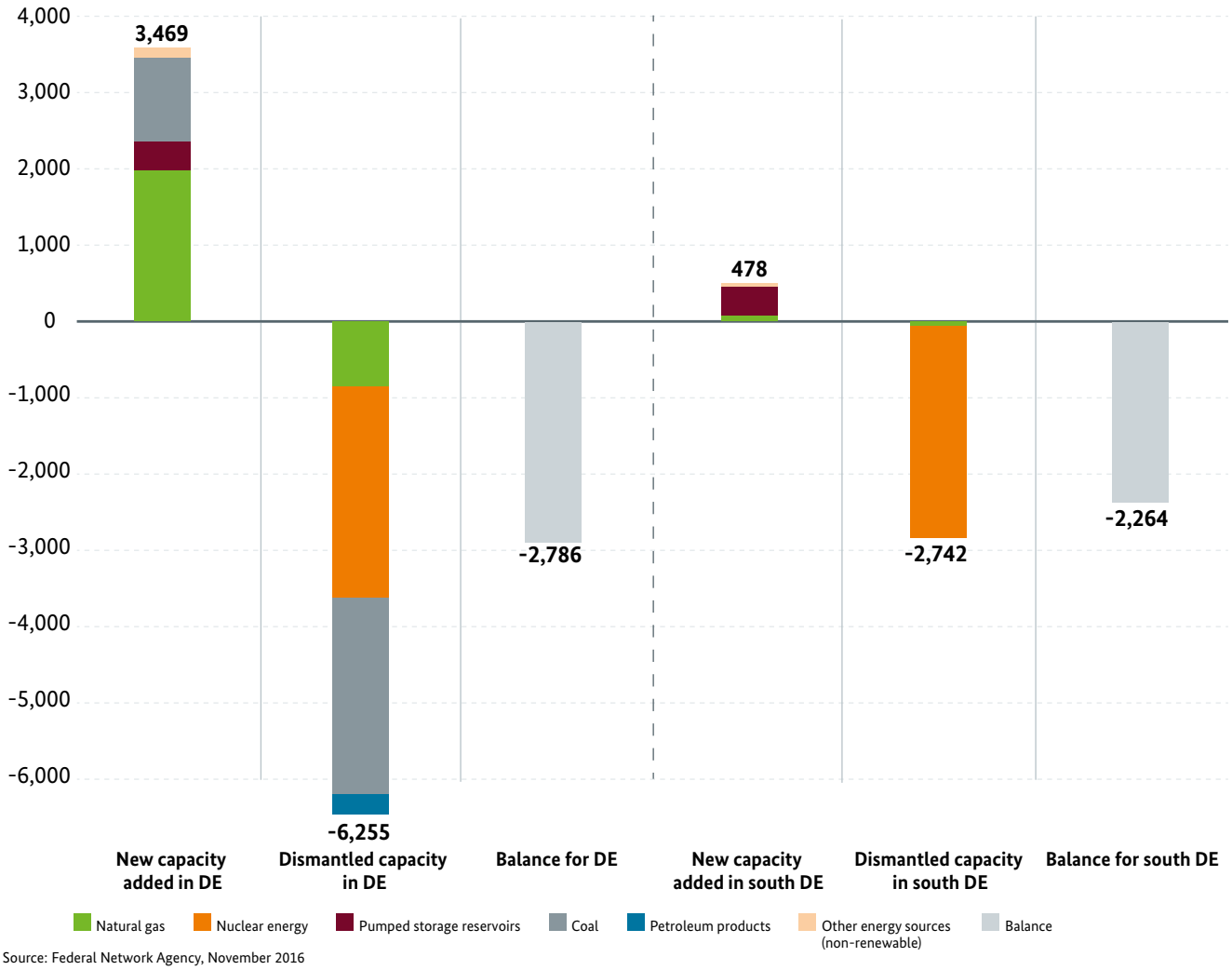
8.2 Conventional power plants: new capacity added and dismantled capacity

The current overcapacity among conventional power stations is expected to decrease somewhat between 2016 and 2019. According to the Federal Network Agency, new conventional power plant capacity added during this time will amount to around 3.5 GW nationwide (see Diagram 8.3), and will primarily involve gas-fired and coal-fired power plants. On the other hand roughly 6.3 GW of conventional power plant capacity will be shut down, the majority of this capacity being nuclear power plants (see also Chapter 8.3). Around half of the dismantling is concentrated in southern Germany, while only around 14% of new capacity will be added in this region.

In the coming years, 13% of lignite capacity will be put on security standby. Under the new Electricity Market Act, lignite-fired power plant units with a capacity of 2.7 GW will gradually go off-line. Before being shut down permanently, the plants will first be transferred to a security standby reserve for a period of four years; this reserve can be called upon as a very last resort to help secure the electricity supply in the case of emergencies.

The security standby reserve should deliver emission reductions of 12.5 million tonnes of CO_2 through to 2020. This reduction is an important contribution to reaching Germany's 2020 climate goal. If this measure does not deliver the desired CO_2 reduction, the power plant operators will be required to make additional carbon savings totalling up to 1.5 million tonnes of CO_2 per year from 2019 onwards.

Diagram 8.3: Conventional generation capacities (including pumped storage reservoirs): new capacity added and dismantled capacity in the period from 2016 to 2019, in Germany overall and in southern Germany
In MW



Source: Federal Network Agency, November 2016
The data for decommissioning take into account power plants that will be permanently shut down according to closure notification pursuant to Section 13a of the Energy Industry Act and nuclear power plants.

Storage system

With a high percentage of renewables in the electricity mix, storage systems along with other flexibility options, such as flexible consumers and producers, can contribute to the security of supply (see also the Electricity Market Green Paper by the Federal Ministry for Economic Affairs and Energy). The aim is for 55–60% of our electricity to come from renewable sources by 2035, and at least 80% by 2050. Wind power and photovoltaics will be the mainstay of the electricity supply (see Chapter 3). As the feed-in from both forms of energy varies greatly depending on the weather and time of day, the electricity system must become more flexible. Electricity storage systems can help separate generation from consumption. In addition, they can also provide balancing capacity and thereby help keep the grid frequency stable.

In the short- and medium-term, the energy transition will not depend on the expansion of electricity storage systems. Other flexibility measures can balance variations between power supply and demand even with a very high percentage of renewables in the mix. In addition, storage systems are still more expensive than other flexibility options in some cases. The Federal Government is promoting the continued development of technologies to unlock cost-cutting potential within the framework of the "Energy Storage Research Initiative" (see Chapter 13).

Battery storage units, pumped storage reservoirs, compressed air energy storage and power-to-gas are important storage technologies. In the case of power-to-gas, electricity is used to produce hydrogen or methane which can then either be used directly or can be converted back to electricity.

Under the Energy Industry Act and the Renewable Energy Sources Act, inter alia, electricity storage systems are categorised as a final consumer with regard to offtake. However, special conditions apply for storage systems, such as in relation to the grid charge, taxes and the EEG surcharge. In principle, the use of individual flexibility options should be determined through competition, with efficiency and economic viability decisive factors in this regard (see Chapter 8.5).

Pumped-storage power stations are a well-established, large-scale form of storage. In 2015, pumped-storage power stations with a capacity of 9.4 GW were connected to the German grid, including pumped-storage power stations in Luxembourg and Austria with a combined capacity of around 3.1 GW. Construction is currently underway on new facilities with a capacity of 372 MW, which will feed into the German grid from Austria.

8.3 Nuclear energy phase-out

The shutting down of the nuclear power plant in Grafenrheinfeld in June 2015 is another step towards the abandonment of nuclear power in Germany. The remaining eight nuclear power plants with a gross generation capacity of 11.4 GW will go off-line gradually by the end of 2022 at the latest (see Table 8.1).

The phase-out of nuclear energy for electricity production comes with several challenges. These include securing the funds for the nuclear phase-out. The Government-appointed Commission to Review the Financing for the Phase-out of Nuclear Energy (KFK) presented its unanimous recommen-

Table 8.1 Schedule for the phase-out of nuclear energy for the production of electricity

Name	Shutdown by	Gross nominal capacity (MW)
Gundremmingen B	2017	1,344
Philippsburg 2	2019	1,468
Grohnde	2021	1,430
Gundremmingen C		1,344
Brokdorf		1,480
Isar 2	2022	1,485
Emsland		1,406
Neckarwestheim 2		1,400

Source: In-house data of the Federal Ministry for Economic Affairs and Energy, October 2016

dations on 27 April 2016. With the Cabinet decision of 19 October 2016, the Federal Government implemented the recommendations of the KFK Commission in the Draft Act on the Redistribution of Responsibility for Nuclear Waste Management. In addition, with the recommendations of the Commission for the Permanent Disposal of High-level Radioactive Waste (Final Repository Commission) of 5 July 2016, Germany now has viable strategies for the search for a final repository.

At its core, the Draft Act on the Redistribution of Responsibility for Nuclear Waste Management centres on clearly dividing responsibility for implementation and financing between the government and the nuclear plant operators. Operators of nuclear plants will continue to be responsible for the management and reserve-backed financing of plant decommissioning and dismantling, and for the correct packaging of radioactive waste. Requirements regarding transparency and a new state right to access information will be introduced for the reserves to be created for this purpose. The Federal Government will have sole responsibility for interim and final storage in the future, and will task a third-party with the management of interim storage. This will be financed by a company-financed fund. To this end, nuclear power-plant operators are required to transfer €17.389 billion from the reserves to a fund established under public law. In addition, they can opt to pay an additional risk surcharge of 35.47%, which will discharge them of any subsequent liability for cost and interest-related risks.

In the search for a suitable final repository, the Final Repository Commission is in favour of a multi-stage, transparent and science-based process, which is open as to the outcome. This is defined in the Repository Site Selection Act. The job of the Final Repository Commission was to define in concrete terms the criteria for final storage and for the site selection process. The most important recommendations of the Commission are as follows: All three potential host rocks in Germany will be considered and the Gorleben site will be included in the comparative selection procedure. The final disposal of the waste should be in deep geological formations with the option of reversibility and the retrieval and recovery of the waste. The selection criteria are to be applied in a three-stage selection process to identify the site that offers the best possible safety for a period of one million years. The public should be involved in all stages.

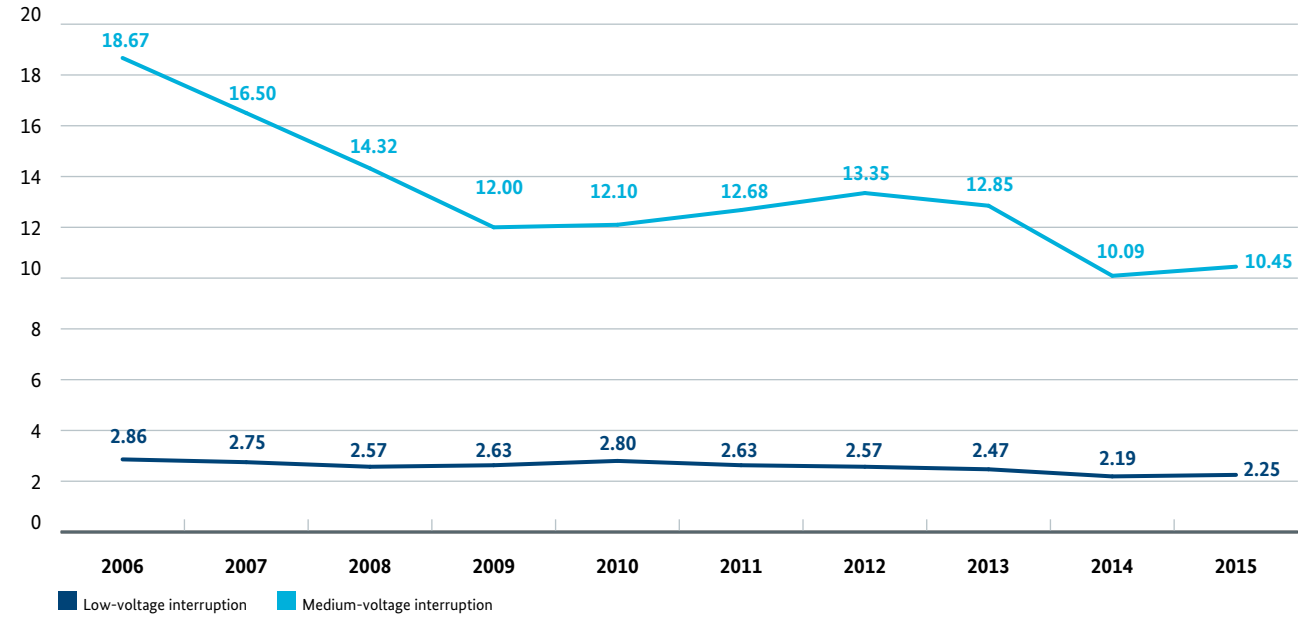
8.4 Security of supply in the electricity market

Supply is secured in the electricity market when supply and demand can be balanced at any time. Studies conducted in 2015 for the study period 2015–2025 reveal that the electricity market in Germany and neighbouring countries can – with reference to Germany – consistently balance demand and generation with a very high probability of almost 100% (Amprion et al. 2015 and Consentec and r2b Energy Consulting 2015). Germany also has a very high level of supply security when compared with other countries, making the German power supply system one of the most secure systems in the world.

Despite growing demands on the grids, grid quality in Germany continues to remain very high – another factor contributing to security of supply. Many indicators are used to rate grid quality. Each year, the Federal Network Agency publishes the "System Average Interruption Duration Index" (SAIDI), which is representative of the average outage duration per connected final consumer. The SAIDI value includes all interruptions lasting longer than three minutes. It stood at 12.70 minutes in 2015, compared with 12.28 minutes the previous year. The slight increase is primarily attributable to weather conditions such as storms and heat waves. Over the long-term, however, the index follows a trend towards optimisation and, after the record year in 2014, in 2015 achieved the second best value since the regular collection of data commenced (see Diagram 8.4). Therefore, compared with other countries, Germany still also ranks among the best in this regard (see Diagram 8.5). However, additional effort is needed on the part of the grid operators to also ensure this high level of grid stability in the future.

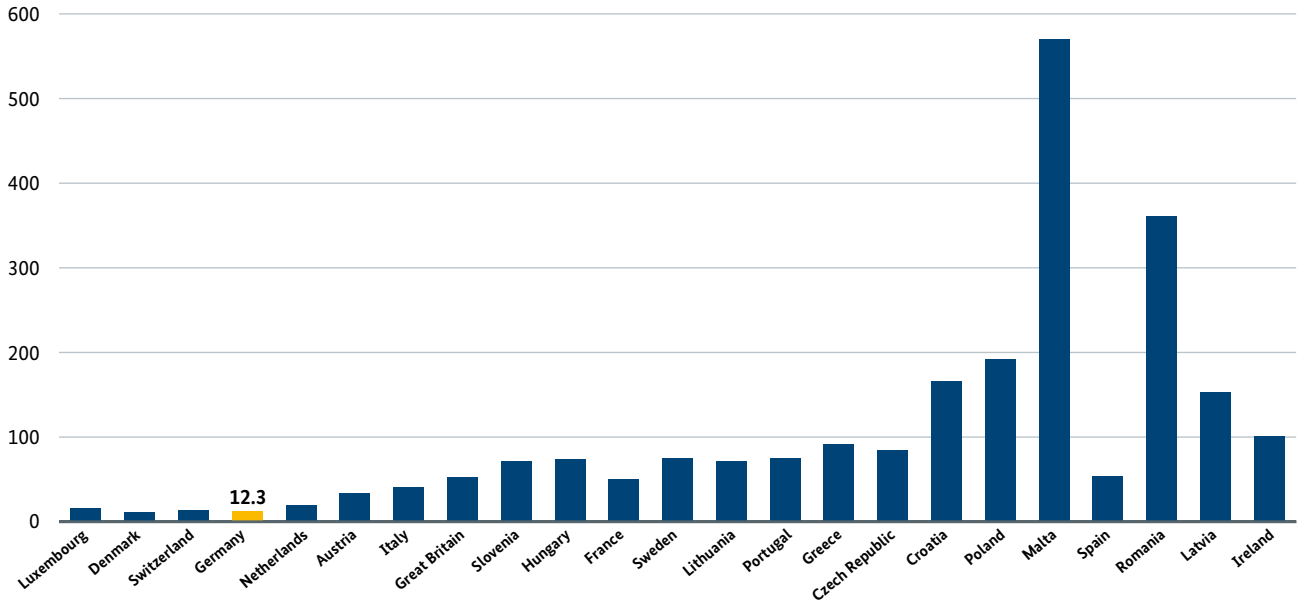
Security of supply is also considered and established in a European context. The German electricity market is closely connected to the electricity markets of its "electricity neighbours", by which is meant its geographical neighbours as well as Norway and Sweden. By taking advantage of smoothing effects across a large area, particularly in the event of peak loads and the feed-in of renewable energy, security of supply can be achieved at a lower cost in the European internal market than in a single country (see Chapter 12.1).

Diagram 8.4: Development of the SAIDI index
In minutes



Source: Federal Network Agency, November 2016

Diagram 8.5: International comparison of the system average interruption duration in minutes in 2014
In minutes



Source: CEER, August 2016

Supply of natural gas

With annual consumption of 88.6 billion cubic metres, Germany is the biggest market for natural gas in the European Union and also a key gas transit country. As an interim technology on our transition from fossil fuels to renewables, in particular, natural gas can also continue to play an important role. Germany imports approx. 93% of its annual gas consumption primarily from Russia, Norway and the Netherlands. Compared with electricity, natural gas can be stored in large quantities. With an effective natural gas storage volume of around 23 billion cubic meters, Germany has the largest storage capacities in the EU. The expansion of the national natural gas infrastructure in line with market needs is guaranteed by the Gas Network Development Plan of the gas transmission system operators (TSO). It is a key component towards maintaining security of supply. The 2015 Gas Network Development Plan makes provisions for 810 km of new pipeline construction and additional compressor capacity of 393 MW by 2025. Investment for this is budgeted at around €3.3 billion.

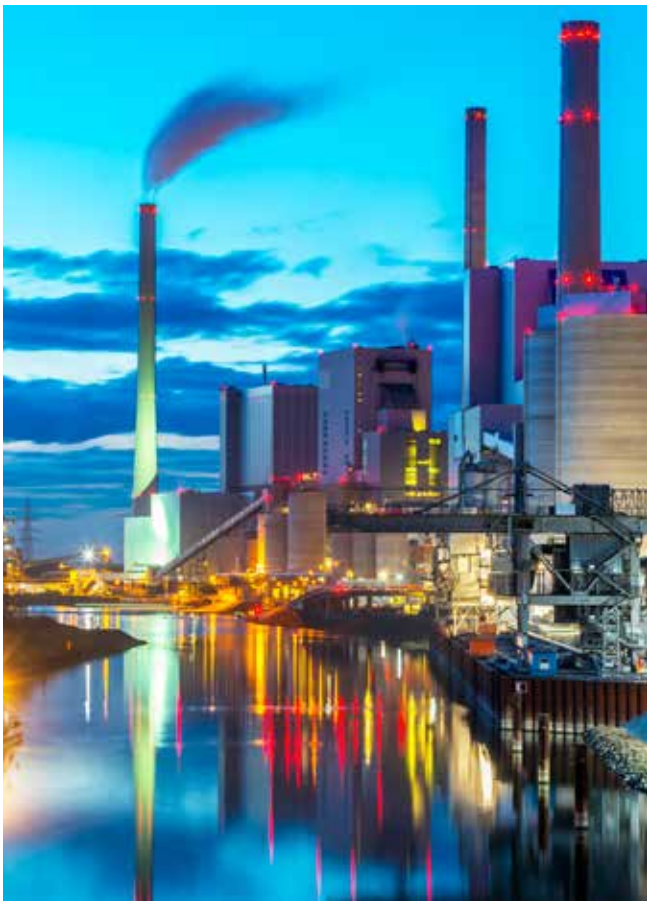
In short, the extensive natural gas network, liquid trading markets, the large storage volume and the diversified portfolio of supplier countries and import infrastructures guarantees that Germany's gas consumers can enjoy a very high level of supply security. Based on the System Average Interruption Duration Index (SAIDI), the average time a customer was affected by an interruption in service in 2015 was just 1.7 minutes. More information about the supply of natural gas in Germany is provided in the Annual Report on Natural Gas Supply Security published by the Federal Ministry for Economic Affairs and Energy (BMWi 2016b).

8.5 Electricity market design

The new Electricity Market Act, which the Bundestag and Bundesrat adopted on 8 July 2016, makes the electricity market ready for renewable energy. Germany must continue to have a low-cost and reliable supply of electricity even if wind and solar power increasingly dictate market activity. The Electricity Market Act plots the course for competition between flexible generation, flexible demand and storage. It also takes electricity traders to task: anyone selling electricity to customers must purchase an identical volume and feed it into the grid at the same time. This ensures that supply remains secure. Free price formation on the electricity wholesale market ensures that investment is made in the necessary capacities. The capacities maintained are precisely the capacities that are demanded by customers.

A capacity reserve additionally safeguards the electricity supply. These power stations are established separately from the electricity market and are only dispatched if, despite free price formation on the electricity market, supply does not cover demand. Power stations that are part of the capacity reserve cannot participate in the electricity market and so cannot distort competition or pricing. Further to this, a security standby reserve with lignite-fired power plants will also be established (see Chapter 8.2).

The electricity market will become more transparent. To this end, the Federal Network Agency is setting up an Internet-based electricity market information platform which is open to anyone. It is geared both toward interested members of the public and informed experts in the field. The platform will go live on 1 July 2017 and provide information on the electricity market in layman's terms with data, graphics and background articles.



Central measures in the area of security of supply and power stations

Electricity Market Act

Goals

- The aim is to make the electricity market fit for the increasing share of renewable energy and to set the course for competition between flexible generation, flexible demand and storage.

Scope

Continued development of the electricity market into an electricity market 2.0, specifically:

- Strengthening of existing market mechanisms
- Removal of barriers to access for providers of demand side management measures
- More efficient grid planning
- Increased monitoring of security of supply
- More transparency in the electricity market
- Introduction of a capacity reserve established separately from the electricity market
- Creation of a security standby reserve

Amended Combined Heat and Power Act (December 2015)

Goals

- Contribute to reaching the climate goals, increase the flexibility of CHP plants and planning security for CHP plant operators

Scope

- Targeted support of low-carbon generation using gas-fired CHP and flexibilisation of CHP plants

Facts and figures

- Financial support volume doubled to €1.5 billion a year

Draft Act on the Redistribution of Responsibility for Nuclear Waste Management

Goals

- Guarantee the financing of the decommissioning and dismantling of nuclear power plants and the disposal of radioactive waste.

Scope

- Operators of nuclear plants will continue to be responsible for the management and reserve-backed financing of plant decommissioning and dismantling. The Federal Government will have sole responsibility for interim and final storage in the future, with the help of a company-financed fund. To this end, nuclear power-plant operators will transfer €17.389 billion to a fund established under public law. In addition, they can opt to pay an additional risk surcharge of 35.47%, which will transfer any subsequent liability for cost and interest-related risks completely to the state.

Commission for the storage of high-level radioactive waste (Final Repository Commission)

Goals

- Develop a proposal for a fair and transparent procedure for the permanent disposal of high-level radioactive waste

Scope

- Comprising representatives from the business community, industry, environmental organisations, religious communities, trade unions, as well as non-voting members of the Bundestag and the *Land* governments, the Commission presented its final report on 5 July 2016. In the search for a final repository, it is in favour of a multi-stage, transparent and science-based process, which is open as to the outcome, and defines selection criteria to identify the best possible site for the final repository.

Establishment of a central market master data register

Goals

- Create a central energy industry register to simplify official and private-sector reporting, reduce the number of registers to which industry must report, and enhance data quality and transparency

Scope

- Starting in 2017, the central market master data register will merge the master data of all the plants in grid-bound energy supply in Germany's electricity and gas market, and the master data of market stakeholders, to create a single online database.

Programme to promote PV battery storage units

Goals

- Strengthen measures to serve the system and deliver more cost reduction in storage technologies

Scope

- The programme supports investment in battery storage units that are installed in connection with a PV installation and connected to the electricity grid.

Facts and figures

- Funding of €30 million for 2016 to 2018

9 Affordable energy and a level playing field

Where do we stand?

Energy prices and costs fell for many businesses and private households in 2015. This was primarily attributable to the sharp decline in the prices for oil and natural gas on international markets.

For the first time in over a decade, electricity prices for household customers fell slightly in 2015, by 1.4% on average. A slight increase in electricity prices is registered in 2016. Electricity prices fell in 2015 by 2.1% for industrial customers not covered by special compensation arrangements.

Growth and jobs in Germany need strong, internationally competitive businesses. Special compensation arrangements for energy prices and costs continue to make a vital contribution to maintaining Germany's position as a centre of industry.

What is new?

With the Renewable Energy Sources Act 2017 and the Electricity Market Act, two important pieces of legislation were adopted in July 2016 that strengthen competition and the market within the context of the energy transition.

Affordability Competitiveness	Maintaining affordability of energy and ensuring Germany's competitiveness.

9.1 Affordable energy for private households

Private household spending on energy dropped in 2015. This is demonstrated by calculations for sample households. A sample four-person household spent around €4,207 on energy in 2015 (see Diagram 9.1), 3.7% less than the previous year. Spending on fuel, in particular, fell significantly, with petrol 9% cheaper compared with the previous year. Spending on electricity and gas fell slightly by 0.7% and 1%, respectively. Estimates suggest that spending on energy will continue to decline in 2016. Comparable developments can be observed in other groups of households.

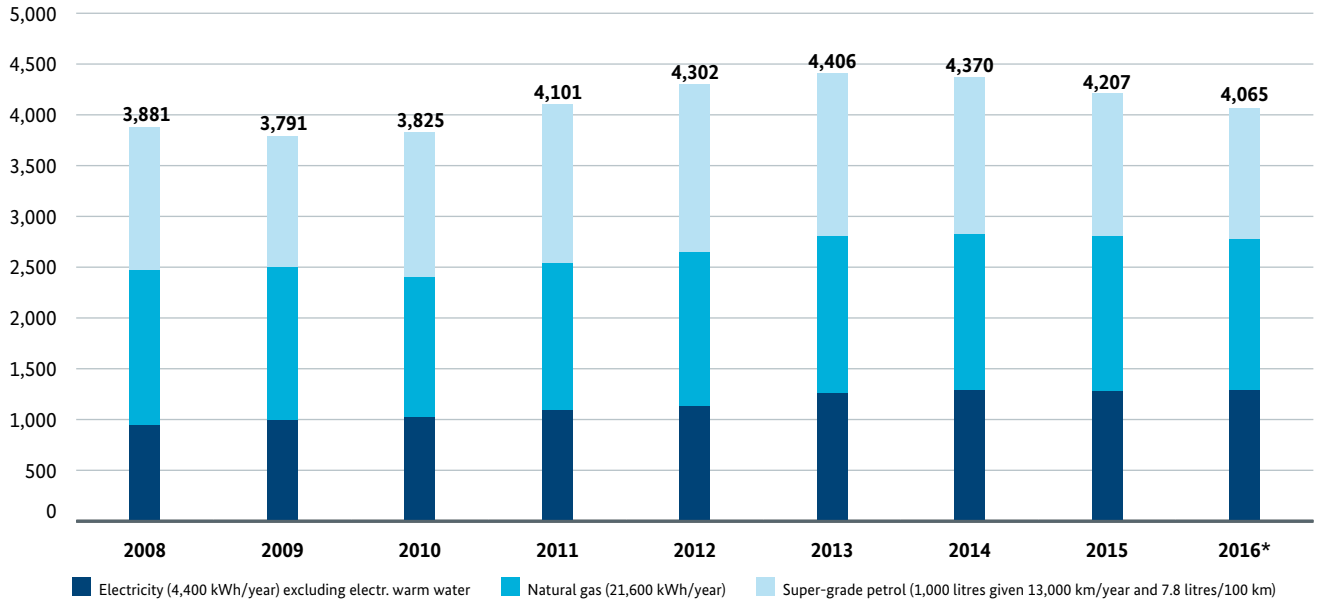
Spending on energy in 2015 had a lower share in net income than in the previous year. The development of absolute spending on energy in relation to net income is relevant for the affordability of energy. The assessment of net income development is based on the 2.4% average increase in wages and salaries in 2015 (Federal Ministry for Economic Affairs and Energy based on data from the Federal Statistical Office 2016). On this basis, the share of energy spending in the average net income of a four-person household amounted to 6.9% in 2015, equating to a drop of 0.4 percentage points on the previous year. Initial estimates suggest that this development will continue in 2016 also.

Affordable energy still remains a challenge, however, for certain groups of households. This is particularly true of relatively low-income households. Assuming that the demand for energy among low-income households is more or less the same as average households, energy spending accounts for a higher share of their available income. For example, if we take a four-person household whose income is 60% that of an average household of the same size, the share of energy spending in 2015 amounts to 11.5%. This corresponds to a slight decrease on the previous year.

Electricity prices fell slightly in 2015 for the first time in over a decade. On the reference date in April 2015, households paid 29.11 ct/kWh on average compared with 29.52 ct/kWh the year before. This equates to a drop of 1.4% on the value for the previous year. The price components for procurement and supply have dropped significantly. In addition, in 2015 the EEG surcharge also fell for the first time since its introduction, dropping 1.1% to 6.17 ct/kWh. The grid charge component crept up slightly by 0.8% to 6.59 ct/kWh (see Diagram 9.2). In 2016, the average electricity price on the reference date stood at 29.80 ct/kWh, up 0.69 ct/kWh on the previous year. In this context, steadily declining procurement prices are counteracting an increase in the grid charges and the EEG surcharge. In 2016, the latter increased 2.9% to 6.35 ct/kWh and will rise by 8.3% in 2017 to 6.88 ct/kWh. On the whole, however, the electricity price for households has remained stable since 2013.

Diagram 9.1: Annual energy spending of a sample four-person household

Spending per year in euro

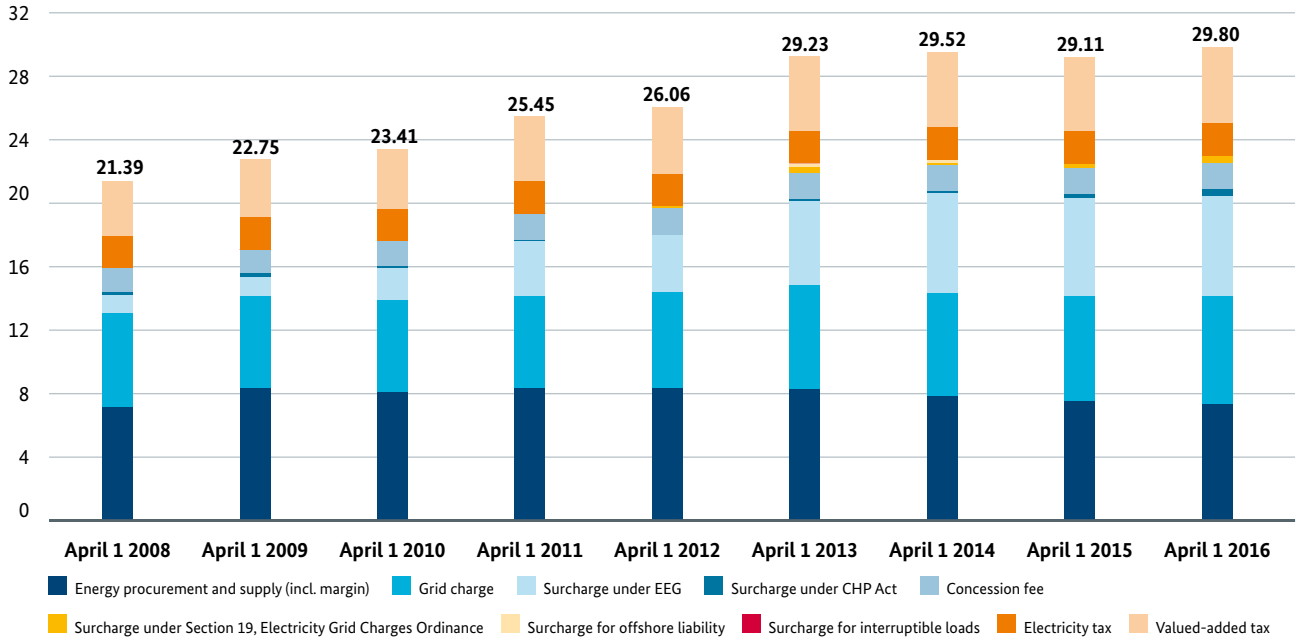


Source: Federal Ministry for Economic Affairs and Energy according to data of the Federal Statistical Office, Association of the German Petroleum Industry (MWI), RWI Economic Research Institute/Forsa Institute, die-stromsparinitiative.de and the Federal Ministry of Transport and Digital Infrastructure/German Institute for Economic Research, October 2016
*estimated values for 2016

The reform of the Renewable Energy Sources Act in 2014 has made an impact. It was possible to curb the cost dynamics associated with the increase in the EEG surcharge in 2015, even though the surcharge did increase again in 2016 and 2017. With the introduction of competitive auction systems for the majority of renewables, the Renewable Energy Sources Act 2017 seeks to move the system of funding for renewables towards more predictability, more competition and more cost efficiency (see Chapter 3.5).

The development in consumer prices for oil and natural gas is primarily attributable to the sharp drop in commodity prices on the international commodity markets in recent years. In 2015 alone, the import prices for crude oil were down 36% on 2014, while the import prices for gas dropped by 14% and those for coal by roughly 7%.

Diagram 9.2: Electricity prices of private households
ct/kWh



Source: Federal Network Agency, October 2016
The data were captured on the reference date of April 1 of each year. A household with an annual consumption of 3,500 kWh was taken as the basis up to 2015. Since 2016, data have been based on an annual consumption of between 2,500 and 5,000 kWh.

Central measures in the area of affordable energy for private households and industry

Legislation

The Reform of the Renewable Energy Sources Act 2014 helped slow down the cost dynamics of the EEG surcharge. Building on this, the Renewable Energy Sources Act 2017 adopted in July 2016 strengthens the principle of the economic, cost-effective and environmentally compatible implementation of the energy transition by marking the transition to competitive auction systems, inter alia (see Chapter 3).

With the **Ordinance on the Transparent Itemisation of State-imposed or Regulated Price Components in the Basic Supply of Electricity and Gas**, the Federal Government increased transparency for consumers, thereby making it easier to compare rates. Changing provider can help consumers reduce spending on energy.

Other measures

The efficient use of energy and energy conservation will be the foundation for less energy spending in future. To this end, the Federal Government launched the following measures in particular:

- **National Action Plan on Energy Efficiency** (NAPE)
- **"Germany Makes it Efficient" awareness-raising campaign** (see Chapter 4).

Despite the progress made in the energy transition, Germany will continue to depend on imports of fossil fuels, at least on the medium term. For this reason, the cost of energy also depends greatly on the import prices. Germany's international energy policy will continue to aim at the greatest possible diversification of energy suppliers and transport routes, also with a view to ensuring the stable development of import prices (see Chapter 12).

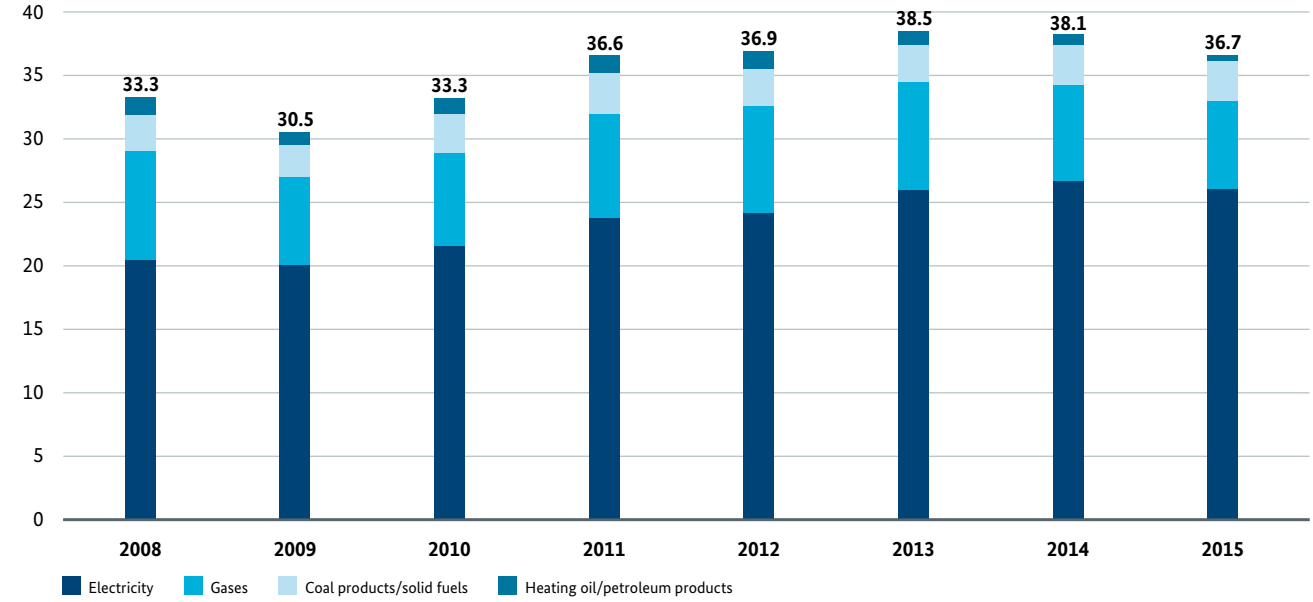
9.2 Affordable energy for industry

Total industry spending on energy fell in 2015 and was at its lowest level since 2011. Energy is an important cost factor for industry and thereby has a bearing on the ability of industry to compete with other countries. Industry spent approx. €37 billion in total on energy in 2015 (see Diagram 9.3), roughly 3.7% less than in 2014. This drop was registered even though consumption increased by 1.2%. The significantly lower prices on the global commodity markets were the main reason for this development. Furthermore, the prices for petroleum products, such as heavy fuel oil, dropped significantly by 38% in 2015 compared with the previous year. The price of gas fell by 6.3% from 3.2 to 3.0 ct/kWh. Spending on electricity decreased by 2.1% in 2015, going from €26.7 to €26.1 billion. This was caused both by slightly lower consumption and lower electricity prices.

Electricity costs account for around two-thirds of total energy costs for industry. Electricity costs are therefore particularly relevant for energy costs. However, the share of electricity in final energy consumption differs significantly in the individual sectors. In addition, the prices can vary widely from business to business. For example, individual offtake amounts and profiles have a bearing on the pricing. Regional differences also exist, such as in the case of grid charges, for instance. Various special compensation arrangements mean that highly electro-intensive businesses that face strong international competition pay lower levies and surcharges under certain conditions.

Electricity prices for industrial customers not covered by special compensation arrangements fell slightly in 2015. According to the findings of the Federal Network Agency, electricity prices for industrial customers (annual offtake 24 GWh) that do not fall within the scope of statutory special compensation arrangements were essentially in the range from 13.45 to 16.48 ct/kWh (excluding VAT) on the reference date 1 April 2015. Average prices on the reference date in 2015 had dropped by 2.1% compared with the previous year, falling from 15.11 to 14.80 ct/kWh (see Diagram 9.5). This was primarily due to a decrease in the price component for procurement, supply and margin. In all likelihood, this decrease can be largely attributed to the downward trend in wholesale prices, which fell again ignificantly (see Box). In contrast, grid charges rose from an average of 1.90 ct/kWh in 2014 to 2.12 ct/kWh in 2015, and had risen on 1 April 2016. In this context it is important to note that many industrial customers that have high annual consumption levels and are not covered by special compensation arrangements agree separate grid use contracts with their system operator, and thereby pay customised grid charges. In 2016, electricity prices had dropped once more on the reference date, 1 April, falling 4.1% to 14.20 ct/kWh.

Diagram 9.3: Energy costs of industry
In billion euros

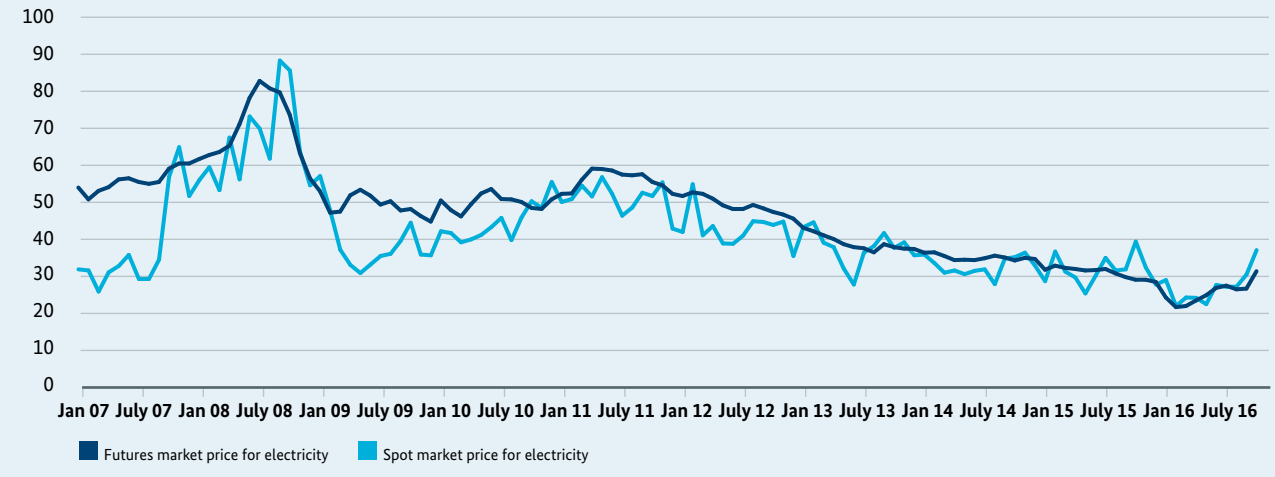


Source: Federal Ministry for Economic Affairs and Energy based on the data of the Working Group on Energy Balances and the Federal Statistical Office, August 2016

Prices of electricity on the exchange

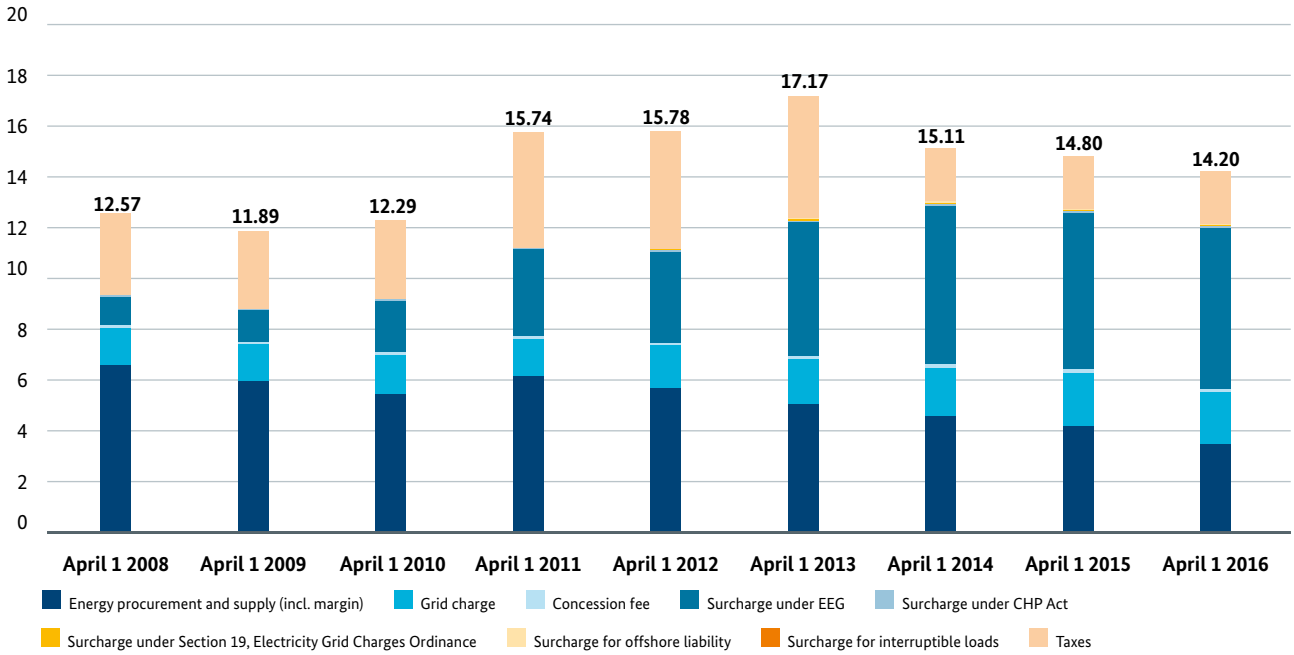
The prices on the European Energy Exchange in Leipzig dropped significantly in 2015, continuing a downwards trend that has been ongoing since 2011. As an annual average in 2015, the price of electricity on the exchange for delivery the following year (baseload year future) stood at €31/MWh (see Diagram 9.4). This translates to a drop of roughly 12% on 2014. The price fell once more in the first 10 months of 2016, standing at €25.5/MWh on average. Inherently more volatile, the spot market price also showed a similar trend. Electricity prices on the futures and spot market continue to remain at an almost identical level. This indicates that participants on the exchange do not expect wholesale electricity prices to rise in the near future. Trade on the exchange is part of wholesale trade with electricity. Further to this, electricity is traded through over-the-counter bilateral contracts which, however, are also influenced by pricing signals from the electricity exchange. Such contracts often have multi-year terms.

Diagram 9.4: Electricity prices on the exchange on the spot market and in futures trading
In euro/MWh



Source: European Energy Exchange, October 2016. Monthly average values for the products "Day Base" (hour contracts) and "Phelix Futures" (baseload, year future)

Diagram 9.5: Electricity prices for industrial companies not covered by special compensation arrangements
In ct/kWh

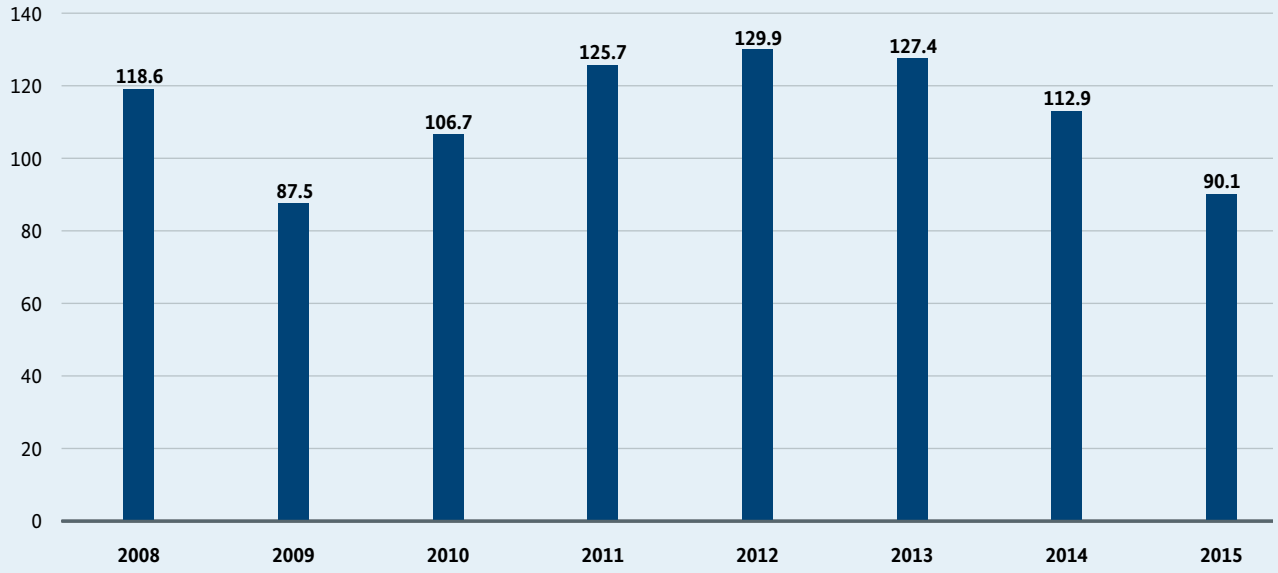


Source: Federal Network Agency, October 2016
The data were captured on the reference date of April 1 of each year. Annual consumption of 24 GWh (annual peak load 4,000 kW and annual duration of use 6,000 hours) at medium-voltage level is assumed.
The prices indicated are inclusive of sales tax up to 2013, and exclusive of sales tax from 2014 onwards.

Macroeconomic energy spending

In addition to an analysis of energy spending broken down by consumer group, a macroeconomic look at energy spending can provide information on the burden for the economy as a whole. To this end, the aggregate spending across all final consumers is considered. The costs for the provision of primary energy dropped significantly by 20.2% in year-on-year terms in 2015 to €90 billion (see Diagram 9.6). This is primarily attributable to the sharp decline in import prices for fossil fuels. Energy costs resulting from the consumption of imported fuels fell from approx. €81 billion to approx. €57 billion. Final consumer spending for final energy consumption dropped in 2015, falling 4% to €215 billion compared with the previous year. At the same time, nominal GDP increased by 3.8%. Therefore, the share of final energy spending in nominal GDP decreased on the previous year from 7.7% to 7.1%. Final consumer spending on electricity rose slightly. It stood at €97 billion in 2015, equating to a growth of 1% on 2014. The share of spending on electricity in nominal GDP amounted to 3.2% in 2015. In 2014 it stood at 3.3%.

Diagram 9.6: Macroeconomic spending on primary energy consumption
In billion euros



Source: Federal Ministry for Economic Affairs and Energy based on data from the Working Group on Energy Balances and the Federal Office for Economic Affairs and Export Control, September 2016

9.3 Affordable energy for a competitive economy

Growth and jobs in Germany require strong, internationally competitive industries. The energy-intensive industries, in particular, are the basis for maintaining closed value chains and for downstream production sites to set up in Germany. Therefore they make a considerable contribution, both directly and indirectly, to creating and keeping skilled jobs in Germany. However, the competitiveness of German companies, and particularly of industry, depends not least on local energy prices compared with other countries.

Fuel and natural gas prices in Germany were around the EU average in 2015. The prices of diesel fuels, for example, were 2.8% below the EU average, while gas prices for industrial customers in Germany were roughly 4% above the European average.

Even though electricity prices did drop for many German industrial and commercial companies in 2015, electricity prices still remained above the EU average. According to figures released by Eurostat for the second half of 2015, the prices for small commercial and industrial customers with an annual consumption of less than 20 MWh were 14.3% above the EU average, while medium-sized industrial customers with an annual consumption of 70–150 GWh had to contend with prices 14.7% above the EU average (figures are exclusive of VAT and recoverable taxes and levies).

Unit Energy Costs (UEC)

Apart from the price of energy, a business enterprise's energy costs are also dictated by the amount of energy it consumes. Energy consumption not only depends on how much is produced but also on how efficiently energy is used. Therefore, higher energy prices compared with another location can be offset to some extent by the more efficient use of energy and thereby by reduced energy intensity in production in individual sectors. Both factors – energy prices and energy efficiency – can be considered together in the Unit Energy Costs (UEC) indicator. The UEC indicator is the aggregate energy costs in relation to gross value added or gross production (gross value added plus intermediate inputs). Calculations based on official statistics find, for example, that the average UEC for German industry in 2014 stood at €18.5 per €1,000 gross production value. The value for 2013 was €20.3.

The "Unit Energy Cost" approach is still relatively new, and its validity as an indicator of the cost burden of businesses and of competitiveness is not without controversy. There has been criticism, for example, that some indirect costs and interdependencies are not factored in. However, these have played an important role in the debate on energy costs. The findings of a recent study by the Oeko-Institute and the German Institute of Economic Research (DIW) (2016) reveal that the UEC of German industry in relation to gross production dropped significantly in 2016 compared with 2010. However, it is important to bear in mind that the informative value of an observation of this kind always also depends on the representativeness of the selected baseline year. A study by the Expert Commission (2015a) looks, inter alia, at the UEC of the chemical industry and the metal industry in the EU. It concludes that the increase in the UEC in these sectors in relation to gross value added between 1995 and 2011 was far less pronounced in Germany than in the EU on average.

With regard to electricity prices for highly electro-intensive businesses, Germany is around average compared with other EU countries owing to various special compensation arrangements – this was the finding of a study conducted by Ecofys, ISI (2015) on the basis of data for 2014. The international comparison of electricity prices is particularly relevant for businesses whose production processes are energy-intensive and which are highly exposed to international competition. Various special compensation arrangements are in place to ensure that the cost of the energy transition does not put such companies at a competitive disadvantage. The electricity price for these companies is primarily determined by the costs for procurement and supply, with the result that, inter alia, the low prices on the electricity exchange have a positive effect.

Special compensation arrangements are essential to maintaining Germany's position as a centre of industry and are in the interests of the economy as a whole. For the Federal Government it is clear that the competitiveness of German industry must not be put at risk. The objective is still to avoid production moving offshore to countries with lower environmental standards and/or lower levies on energy ("carbon leakage") and to secure closed value chains and industrial jobs in Germany on the long term. A study conducted using macroeconomic projection models finds that the abandonment of the special compensation arrangements under the Renewable Energy Sources Act would have a significant negative impact on macroeconomic production and jobs (Prognos, GWS 2015). The special compensation arrangements under the Renewable Energy Sources Act and the Combined Heat and Power Act mean higher electricity prices for private households and non-privileged businesses. On the basis of the current annual accounts, the relief provided through the mechanism of special compensation arrangements was financed in 2015 by 1.38 ct/kWh, or 22.3%, of the EEG surcharge.

Carbon leakage rules help reconcile the competitiveness of German industry with climate change mitigation requirements. It is already a fact today that the German economy produces more but has lower greenhouse gas emissions (see Chapter 7.3). For businesses whose products face strong international competition, the aim is to limit the cost burden of CO_2 reduction so that carbon leakage is avoided, thereby ensuring the local economy remains strong. At the same time, appropriate regulations are needed for global climate change mitigation also, as greenhouse gas emissions are limited and not shifted elsewhere.

Central measures towards establishing a level playing field

Special compensation arrangements in the Renewable Energy Sources Act

Goals

- The aim is to ensure that electro-intensive businesses and rail operators are not put at a disadvantage in relation to international competitors, and that jobs are therefore not lost, as a result of the promotion of renewable energy in Germany.

Scope

- Electro-intensive businesses in sectors facing international competition can apply to pay a lower EEG surcharge.

Facts and figures

- In 2015, 2,111 businesses in the manufacturing industry with an electricity consumption of 95 TWh received privileges under the special compensation arrangements. Total relief, including rail operators, amounted to €4.8 billion (Federal Office for Economic Affairs and Export Control 2016).

Reductions in the surcharge under the CHP Act (CHP surcharge)

Goals

- The aim is to ensure that German businesses are not put at a disadvantage in relation to international competitors, and that jobs are therefore not lost, as a result of the promotion of combined heat and power in Germany.

Scope

- Electricity consumers with more than one GWh of electricity consumption, and certain highly electro-intensive businesses and rail operators pay a lower CHP surcharge.

Facts and figures

- According to the forecast data of the transmission system operators, a lower CHP surcharge was paid for 206 TWh in 2015, as the final consumers drew over one GWh of electricity. In addition, the CHP surcharge was limited for an additional 87 TWh as this energy could be assigned to electro-intensive businesses. Total relief amounted to €493 million. This system is being reorganised with effect from 2016 and the rules for special compensation arrangements under the Renewable Energy Sources Act will also apply under the CHP Act.

Electricity price compensation

Goals

- Prevent manufacturing from moving offshore

Scope

- Since the start of the third trading period, businesses whose production processes are highly electro-intensive and that are at risk of moving production offshore (carbon leakage) – because of high costs due to CO_2 emissions from electricity generation – can apply for compensation for the costs they incur as a result of the indirect CO_2 costs of the EU emissions trading scheme which are passed on in electricity prices. The amount of compensation is based on the CO_2 allowance price for the specific accounting period.

Facts and figures

- In 2015, assistance was approved for 928 industrial plants, as a result of which support amounting to €186 million was disbursed.

Relief in the Energy Tax Act and Electricity Tax Act

Goals

- The aim is to ensure that German businesses are not put at a disadvantage in relation to international competitors, and that jobs are therefore not lost, as a result of excessively high energy costs. Further to this, tax relief is granted for environmentally friendly electricity use (e.g. local public transport, CHP plants), subject to certain conditions.

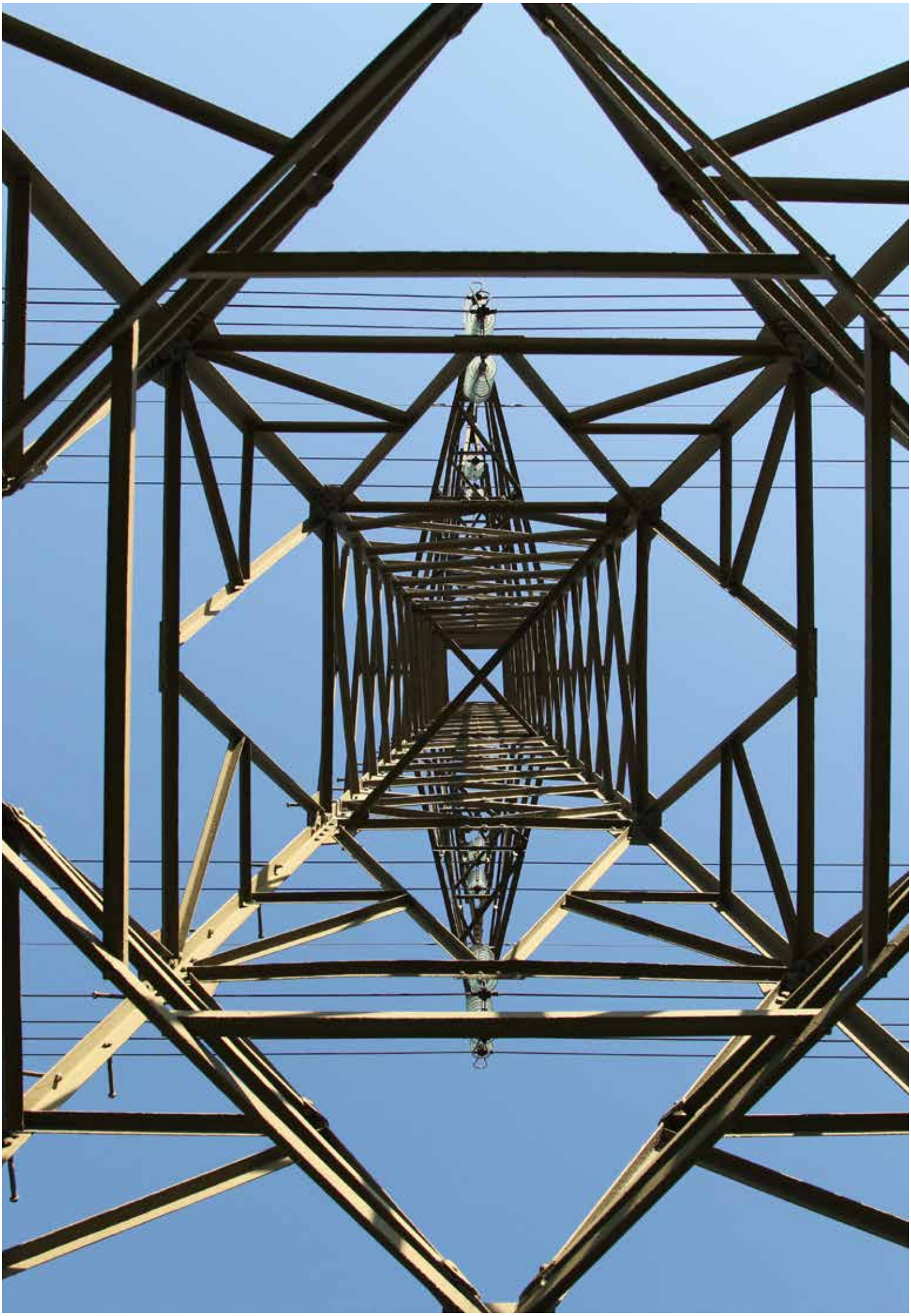
Scope

- Businesses can apply for tax relief on various legal grounds (e.g. relief for particularly energy-intensive or electro-intensive processes, general energy tax and electricity tax relief for the manufacturing industry, tax capping). Energy efficiency requirements must also be met to qualify for the tax cap mechanism.

Facts and figures

- Energy tax relief amounted to €925 million in 2015, while electricity tax relief amounted to €3.57 billion.

CO_2 allowance price and free allocation, in some cases, in the EU emissions trading system (see Chapter 12)



10 Grid infrastructure

Where do we stand?

The grid expansion measures that have been agreed must be implemented without delay. At around 35%, the share of projects under the Energy Line Expansion Act that had been implemented by the end of the third quarter 2016 is still too low. However, around half of all energy line expansion projects are approved.

It is also just as important to implement the projects from the Federal Requirements Planning Act as quickly as possible. In this context, SuedLink and SuedOstLink – the two big extra-high voltage, direct current (EHV-DC) transmission lines – are entering the next planning phase.

In terms of grid stability and quality, the reliability of the grid infrastructure in Germany remains at a very high level.

What is new?

The Renewable Energy Sources Act 2017 helps to better align the expansion of renewable energy and the expansion of the grid. The central aim remains that of ensuring continued swift progress on the expansion of renewable energy.

In future, priority will be given to implementing new EHV-DC lines as underground cables rather than overhead lines.

To strengthen investment, the Federal Government has developed the incentive regulation further and modernised the framework for investment in distribution grids. In addition, the transparency of the costs and revenues of system operators has been improved.

The Act on the Digitisation of the Energy Transition creates the technical framework for demand side and generation management measures and therefore for more flexibility in the power grid.

Grid expansion	Expanding and modernising grids to meet demand.

10.1 Expansion of the transmission grids

The expansion of the extra-high voltage grid infrastructure is of central importance to the success of the energy transition and to Germany reaching its climate goals. As renewable energy expands and nuclear energy is phased-out, electricity is increasingly produced and consumed in separate geographical areas. Therefore the swift expansion of the power grids at the transmission grid level is essential, particularly in order to transport the electricity derived from offshore and onshore wind, which is primarily produced in the north and east, to the power consumption hubs in the south and west of the country.

The expansion of the transmission grids is also a must if we are to make the European internal energy market a reality. European electricity trading boosts the efficiency of the power supply system and increases security of supply. With supply and demand balanced over larger areas, it also enables, inter alia, the cost-effective integration of renewable energy. Besides the domestic expansion of the grid, sufficient cross-border grid capacities are also needed for a functioning internal electricity market (see Chapter 12).

The Energy Line Expansion Act has defined the requirements for the construction of new power lines. Currently the Energy Line Expansion Act comprises 22 projects which were categorised as urgent as early as 2009 (see Diagram 10.1). Taking into account the Federal Network Agency's third quarterly report for 2016, the total length of the lines under the Energy Line Expansion Act amounts to around 1800 km. These projects act as the baseline for calculations in the Grid Development Plan. The Federal Network Agency continuously documents the current state of infrastructure planning and construction projects. At the end of the third quarter 2016, around 900 km, or half, of the projects had been approved. Of these, around 650 km (approx. 35%) are already implemented. Most of the projects under the Energy Line Expansion Act were initially due to be completed by 2015. The majority of the projects have been significantly delayed.

The Federal Requirements Plan in the Federal Requirements Planning Act of 2015 is based on the projects of the 2024 Grid Development Plan that have been approved by the Federal Network Agency. The swift expansion of renewable energy requires further expansion of the grid beyond the projects under the Energy Line Expansion Act. The Federal Requirements Plan currently comprises a total of 43 nationwide projects (see Diagram 10.1), 16 of which are categorized as interstate or cross-border projects. The total length of the lines under the Federal Requirements Planning Act is currently at around 6,100 km. Around 3,050 km are categorised as grid reinforcement projects in the Grid Development Plan. Of the projects, a total of around 400 km had been approved and 80 km implemented by the end of the third quarter 2016. The Grid Expansion Acceleration Act for the Transmission Grid is designed to speed up the planning and approval procedures for the construction of the extra-high voltage lines categorised as interstate or cross-border projects in the Federal Requirements Plan.

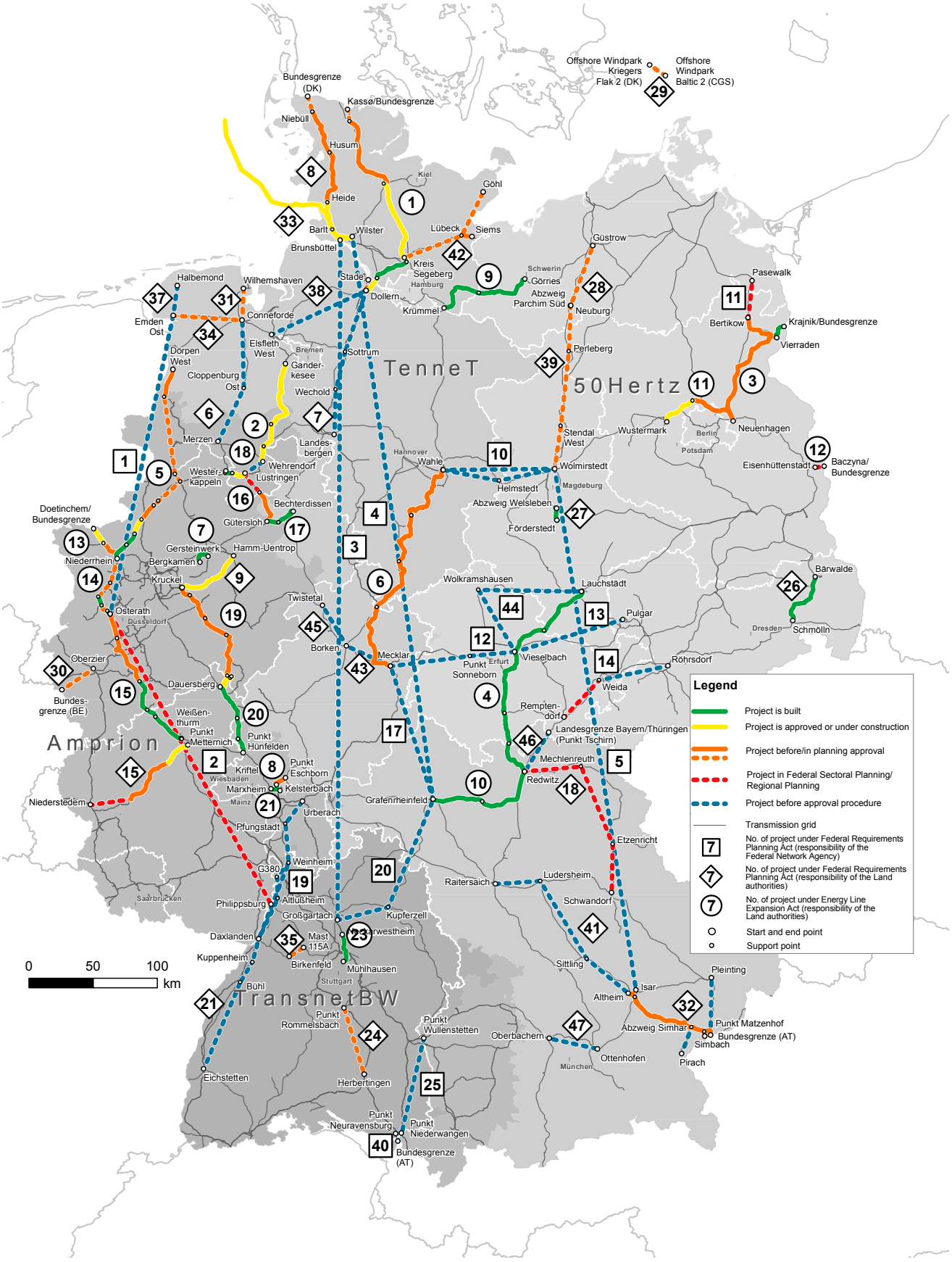
Regular, comprehensive monitoring of the expansion projects creates transparency for all stakeholders on the progress of the infrastructure projects. The Federal Network Agency publishes a quarterly monitoring report. While this previously focussed on projects under the Energy Line Expansion Act, changes were introduced starting from the first quarter of 2016. From then onwards the Federal Network Agency also documents the state of implementation of projects under the Federal Requirements Planning Act and projects from the Offshore Grid Development Plan, i.e. the connection lines for offshore wind farms, in the form of a report and on www.netzausbau.de.

The public is closely involved in the grid expansion planning process. This applies for demand assessment, federal sectoral planning and planning approval procedures. For example, transmission system operators and the Federal Network Agency make draft grid development plans available for public consultation. In each case the public has the opportunity to submit written opinions concerning these plans. In addition to participating in these formal procedures, the public can also get involved in informal dialog processes at an early stage. For example, the TSOs and the Federal Network Agency organise numerous local events. In addition, since 2015 the Federal Ministry for Economic Affairs and Energy has been promoting the "Civil Dialogue on the Power Grid" initiative, which has ten citizens' advice centres nationwide, hosts a wide range of events in the local region, provides online information about its services and offers formats for participation.

Since January 2016, underground cabling has priority for large-scale extra-high voltage, direct current (EHV-DC) transmission lines. The Act to Amend Provisions of the Law Governing Power Line Construction gives priority to the planning principle of underground cabling in federal sectoral planning for new EHV-DC lines. This prioritisation concerns the major north-south power line route projects – SuedLink and SuedOstLink – as well as the northern part of Corridor A. With this approach, legislators are addressing concerns regarding large-scale overhead power lines. The aim is to increase local acceptance for the projects and speed up the expansion of the grid.

The Renewable Energy Sources Act 2017 better aligns the expansion of renewable energy and the expansion of the grid. The expansion of wind energy will temporarily be adapted locally in areas with high grid congestion. In these areas, the volume put out for auction for onshore wind facilities will temporarily be limited – until the end of 2019 –

Diagram 10.1: Projects under the Energy Line Expansion Act and the Federal Requirements Planning Act



Source: Federal Network Agency, September 2016. Note: Graphic representation of the state of development of line expansion projects under the Energy Line Expansion Act and the Federal Requirements Planning Act in Q3 2016. The lines on the map merely represent the connections between the legally defined grid connection points (straight lines) and should not be interpreted as the visualisation of the power line routes.

to 58% of the average capacity added for the years 2013 to 2015. This helps relieve the strain on the transmission grid and avoid further increases in grid congestion. The remaining expansion amounts are distributed across the other regions in Germany. In the case of offshore wind, the auction volume is distributed as follows: 500 MW in 2021 and 2022, 700 MW in 2023 to 2025 and 840 MW from 2026 onwards. This seeks to ensure a continuous deployment path while also guaranteeing that the necessary connection lines for transporting electricity are already in place when new offshore wind turbines commence operation. Furthermore, additional capacity construction for 2021 is focussed on the Baltic Sea. These measures relieve the strain on the grids.

10.2 Expansion of the power distribution grids

Power distribution grids increasingly face new tasks. Traditionally, the role of power distribution grids is to distribute electricity locally within a limited region. Increasingly, the structure of these grids has to contend with new challenges. For example, there is increased electricity feed-in from smaller and medium-sized generation facilities to the distribution grid. Over 90% of the capacity installed in renewable installations is connected to distribution grids. More and more electricity consumers are also electricity producers. Therefore investment is needed in these grids increasingly on account of the fact that they are not designed for such electricity feed-in. Besides the necessary grid expansion, the distribution grids are also to be developed into smart grids. The aim is to integrate the volumes of electricity fed into the grid in the best possible way through the use of smart grids.

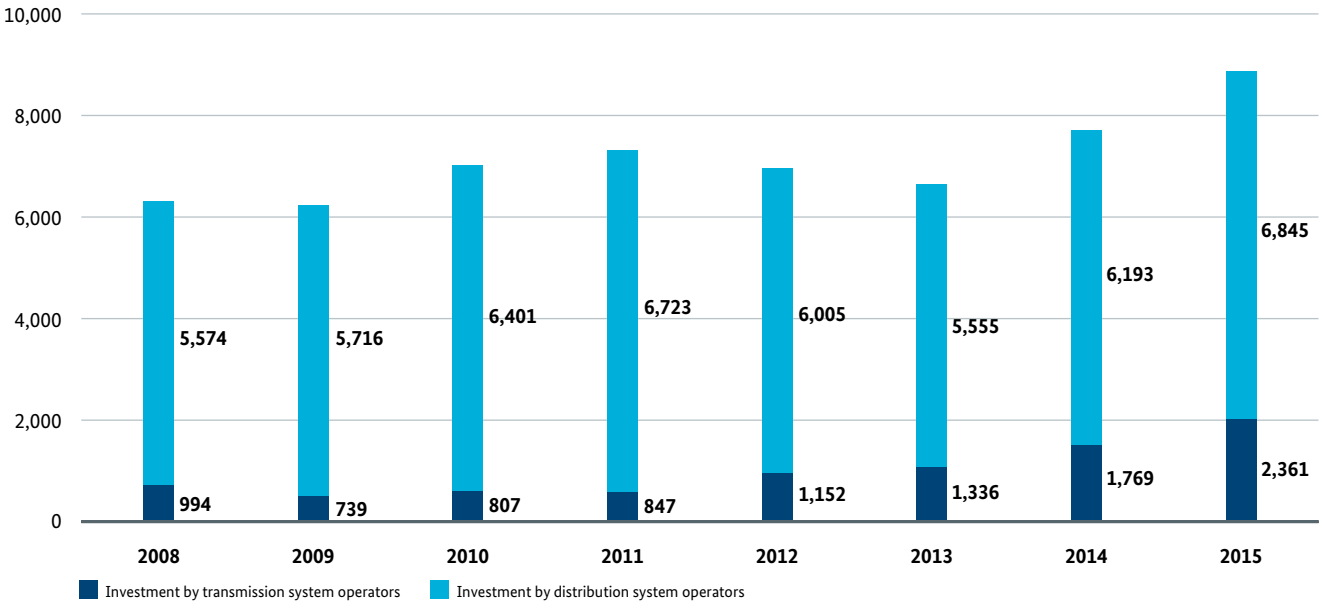
The use of digital technologies plays an important role in the modernisation of the distribution grids. To this end, the Bundestag adopted the Act on the Digitisation of the Energy Transition in July 2016. The "Smart Energy Showcases – Digital Agenda for the Energy Transition" promotional programme, or SINTEG for short, was also launched in February 2015 (see Chapter 11.2).

10.3 Grid investment and grid charges

The expansion of the power grids requires greater investment. The level of investment increased again last year and will continue to rise. Among other things, it is necessary to factor in the costs of financing underground cabling, which are refinanced through the grid use charges and are borne by the grid users. Grid operators invested roughly €9.2 billion in total in German power grids in 2015 (see Diagram 10.2). In the transmission grid, the majority of investment – amounting to €2.1 billion – was in new grid construction and grid reinforcements. Further to this, €299 million were spent on grid maintenance and repair. At the distribution grid level, grid operators invested around €3.8 billion in the expansion and €3 billion in the maintenance and repair of the infrastructure.

The power grids are financed through grid charges. The costs for the operation, maintenance and expansion of the power grids are financed by grid charges, which are borne by the grid users. Grid charges averaging 6.59 ct/kWh were levied in 2015 to supply domestic customers drawing 3,500 kWh annually. When considered in relation to the

Diagram 10.2: Investment in the new construction, expansion, maintenance and restoration of power grids
In million euros



Source: Federal Network Agency, October 2016

average electricity price of 29.11 ct/kWh this is equivalent to a 22.6% share in the price. Grid charges in 2015 increased slightly on the previous year, rising 0.8%. For industrial customers with an annual offtake of 24 GWh that are not covered by special compensation arrangements, grid charges rose by 11.6% to 2.12 ct/kWh in 2015, with the result that the share of grid charges in the electricity price amounted to 14.3%. The grid charges had also increased on the reference date 1 April 2016.

Grid operator revenues are subject to the incentive regulation. The power grid is a natural monopoly. The Federal Network Agency and *Land* regulation authorities protect electricity consumers from any monopolistic abuse. According to the regulatory framework, grid operators can only use the grid charge to refinance costs that would be incurred under efficient management conditions. To this end, before the start of the regulation period, an individual revenue cap is set for each grid operator for every year of the regulation period. This aims to allow grid operators to generate sufficient revenue to cover their actual costs taking efficiency requirements into consideration. The revenue cap is a determining factor for the grid charge amount. The incentive regulation was reformed in August 2016 with the aim of improving investment conditions, boosting incentives for efficiency and increasing transparency.

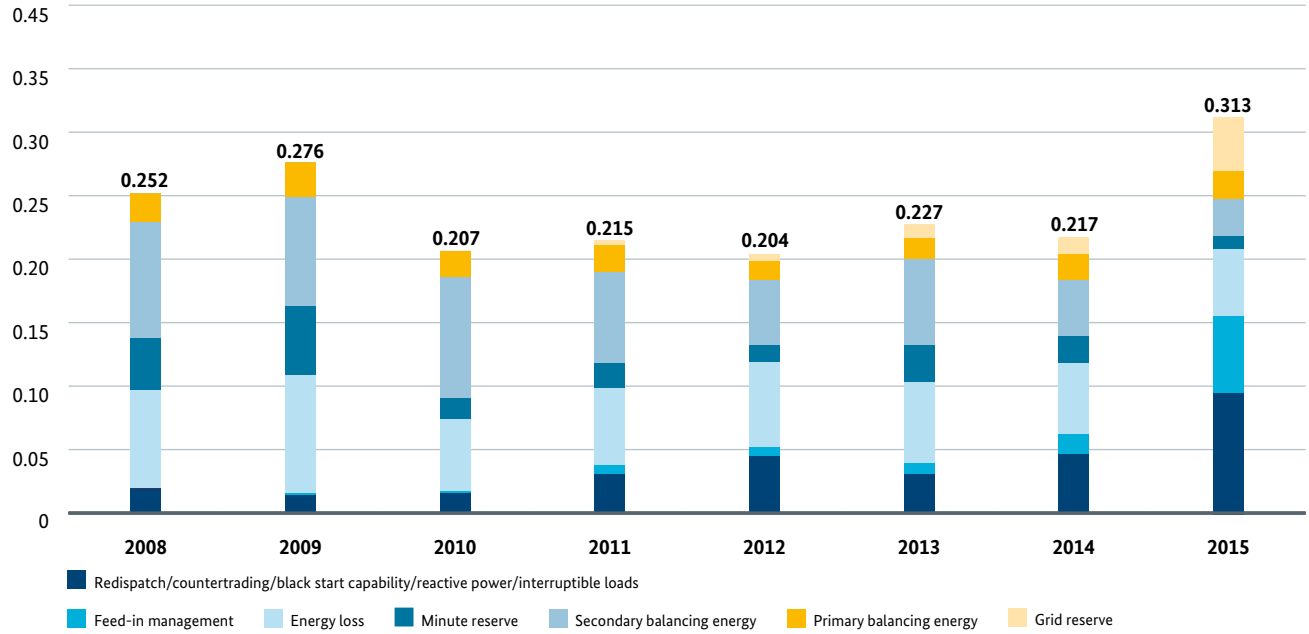
10.4 The stability and quality of the power grids

The grid operators are responsible for the stability of the power grids. Grid congestion and deviations in frequency or voltage can put the stability of the system at risk. To keep the grids stable, the grid operators rely on certain measures, known as ancillary services. For example, balancing capacity is used to correct frequency deviations. Grid congestion is handled by redispatching conventional power stations and managing the feed-in from renewable energy plants. Generally speaking, producers of renewable electricity, as well as storage systems and flexible demand, will also need to contribute more to system stability in the future. Grid operators can already use interruptible loads today, for example. Under the dena Platform for Ancillary Services, grid and plant operators, technology manufacturers and the Federal Ministry for Economic Affairs and Energy are working together on solutions for the further development of grid stability measures.

The costs of ancillary services increased significantly in 2015. In 2015, these costs stood at €1.6 billion, compared with €1.1 billion in the previous year. This results in average costs of 0.31 cent per kilowatt hour of electricity consumed (see Diagram 10.3). The costs for ancillary services are borne by electricity customers largely through the grid

charges (see Chapter 9). The share of ancillary service expenses that can be attributed to congestion in the power grid almost trebled compared with the previous year, increasing from €387 million to €1,035 million. For example, the costs for feed-in management have surged from €83 to €315 million and the costs for the grid reserve from €66 to €219 million. In 2015, the costs for redispatch amounted to €412 million, compared with €185 million the previous year. The rapid growth in onshore and offshore wind in recent years coupled with delayed grid expansion is one reason why grid congestion has worsened. In contrast, traditional ancillary services to maintain the frequency and voltage level were less a cost factor in 2015 compared with the previous year. These costs continue to follow a long-term downward trend. One reason for this favourable development is that the electricity market is functioning more and more efficiently, resulting in less need for balancing energy.

Diagram 10.3 Average costs for ancillary services per kilowatt hour consumed
ct/KWh



Source: Federal Ministry for Economic Affairs and Energy based on data from the Working Group on Energy Balances and the Federal Network Agency, October 2016

Central measures for the grid infrastructure

Revision of the Incentive Regulation Ordinance

Goals

- Improve investment conditions for distribution grids and strengthen incentives for efficiency, while keeping the costs for consumers to a minimum and increasing transparency.

Scope

- Revenue caps are set for the transmission system operators (TSOs) for each year of the 5-year regulation period. These caps are determined based on a comparison of operator efficiency. Particularly efficient TSOs receive a financial bonus. New publication obligations render the decisions of the regulation authorities and the costs and revenues of the TSOs more transparent.

Act to Amend Provisions of the Law Governing Power Line Construction

Goals

- Increase acceptance for grid expansion, and accelerate the expansion of the grid as a result

Scope

- Priority for underground cabling is established as a planning principle in federal sectoral planning for new EHV-DC lines. In the case of AC or three-phase power lines, the number of pilot routes for underground cabling is increased and the criteria for underground cabling expanded. Key grid expansion projects from the 2024 Grid Development Plan approved by the Federal Network Agency are legally enshrined in the Federal Requirements Planning Act.

Continued development of the monitoring of German grid expansion projects

Goals

- Create transparency and awareness among all stakeholders with regard to realistic planning and implementation assumptions, and identify delays in grid expansion at an early stage.

Scope

- Previously concentrating on projects under the Energy Line Expansion Act, the quarterly Monitoring Report published by the Federal Network Agency (www.netzausbau.de) was refined with effect from the first quarter of 2016. In future a separate report will be published for projects under the Energy Line Expansion Act (22), the Federal Requirements Planning Act (43) and offshore projects (20), along with a summary bar chart, to indicate progress in the planning and approval procedure for the individual projects. In addition, the bar chart for projects under the Energy Line Expansion Act and Federal Requirements Planning Act also indicates the planned launch dates.

Further development of the Ordinance on Agreements Concerning Interruptible Loads

Goals

- Ensure grid stability and therefore security of supply

Scope

- Interruptible loads are industrial operations that continuously consume a large volume of electricity and which, when called upon, can temporarily "interrupt/reduce" their demand. The procurement and use of interruptible loads has undergone continued, consistent development since the previous regulation that was in place. In particular, the procurement process has become more competitive and the framework to utilise interruptible loads has been extended and optimised.

Status

- The revised version of the Ordinance entered into force on 1 October 2016. The European Commission has confirmed that it complies with European rules on state aid.

Facts and figures

- On average, 944 MW of interruptible capacity was available in 2015 of which 398 MW were immediately interruptible loads.

Electricity Market Act (see Chapter 8)

Act on the Digitisation of the Energy Transition (see Chapter 11)

11 Integrated development of the energy system

Where do we stand?

The economically efficient integration of the electricity, heating and transport sectors contributes increasingly to decarbonisation, greater efficiency and a more flexible energy system.

Digitisation links the energy sector with modern information and communication technology. With new, customer-friendly business models, digitisation creates new potential for efficiency improvements and for the integration of renewable energy. Data protection and data security are a high priority in this regard.

What is new?

The Act on the Digitisation of the Energy Transition of July 2016 signals the start of the smart grid, smart meter and smart home in Germany. The smart meter system introduced by the Act serves as a secure communication platform to make the power supply system ready for the energy transition.

Sector coupling Digitisation	Unlocking the potential of efficient sector coupling and digitisation for a successful energy transition.

11.1 Coupling the electricity, heating and transport sectors

Renewable electricity is becoming the most important source of energy. The demand for energy that remains after tapping existing efficiency potential and using renewable energy directly in the heating and transport sector will increasingly be covered by renewable electricity (sector coupling). In the transport sector, this will be accomplished, in particular, through the roll-out and uptake of direct-electric drive technologies based on a power supply increasingly derived from renewables. In the buildings sector, alongside other renewable energy sources electricity from renewables is playing an increasingly important role in the heating supply, e.g. through the use of heat pumps. Considering the limited amounts available, sustainably produced renewable fuels (e.g. biomass) will be employed where the use of electricity is not technically or economically feasible. This can apply to the aviation or shipping sectors, in particular, and to some parts of industry.

High-efficiency heat pumps and electric vehicles require comparatively little electricity and can make a major contribution to decarbonisation and efficiency improvements in the heating and transport sectors. As Table 11.1 illustrates, both these technologies need less electricity to generate the same quantity of heat or propulsion energy than conventional fossil fuels or technologies involving several conversion steps (e.g. hydrogen heating systems).

The importance of heat pumps for heat generation has increased dramatically in recent years. In 2015, the market share of heat pumps in newly installed heating systems stood at around 21%. Since 2008, the number of installed systems has risen by 83%, from around 500,000 to almost 900,000. This is attributable both to the continuous reduction in the cost of the systems and to regulatory minimum requirements with regard to renewable energy and energy efficiency (e.g. Energy Savings Ordinance, Renewable Energies Heat Act), as well as funding programmes (e.g. CO_2 Building Modernisation Programme, Market Incentive Programme). Over the same period, the installed thermal capacity even grew by 124%, from roughly 4,000 to 8,894 MW. This is because the increasing numbers of pumps being installed are also increasingly bigger and more powerful. The development of the electricity consumption of all heat pumps has been largely in step with the thermal capacity, and stood at roughly 5 TWh in 2015.

The number of electric and plug-in hybrid vehicles on German roads rose again in 2015. Having said that, with the exception of the rail sector the electrification of vehicle drives in Germany is still in its infancy (see Chapter 6). Nonetheless, electricity consumption deriving from electric mobility using two-wheel and three-wheel-plus vehicles increased in 2015 by around 35% to roughly 163 GWh compared with the previous year (see Diagram 11.2). Due to the increasing share of renewables in the electricity sector, transport-related final energy consumption from renewables increased.

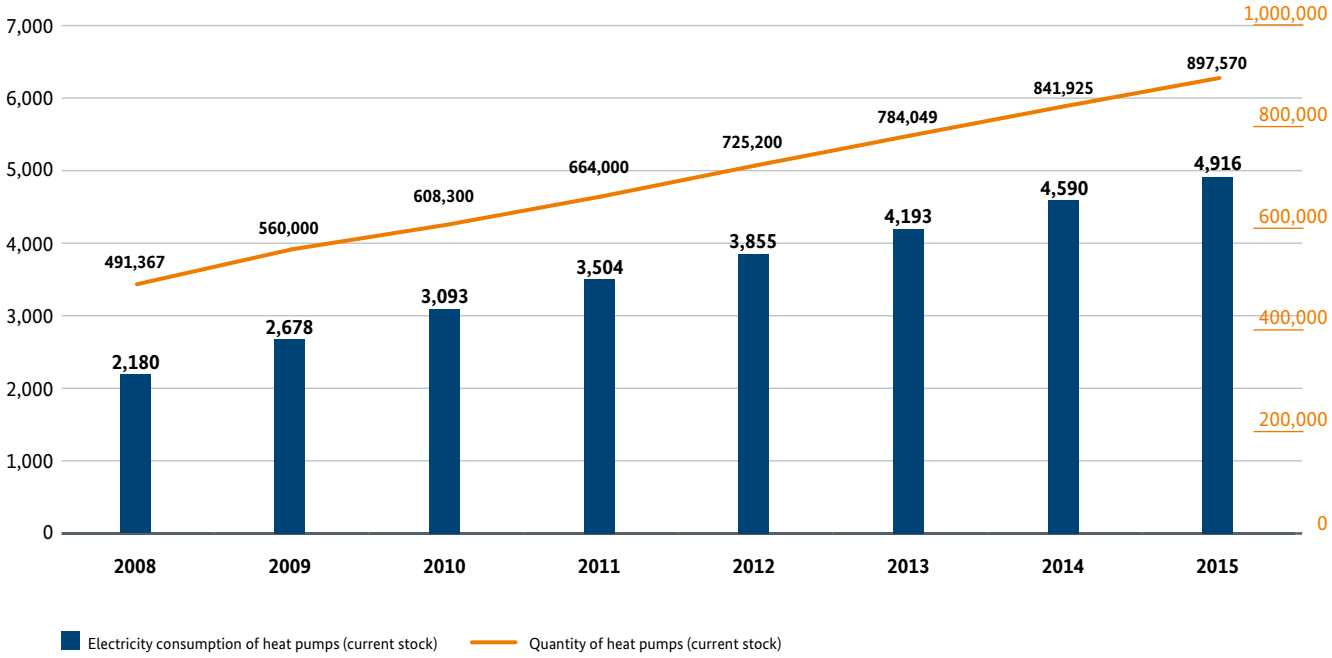
The integrated development of the energy system will drive forward interaction between the energy, transport and buildings sectors as well as industry. Electricity generation is a key factor when designing suitable frameworks. Forward-looking frameworks avoid the effects of technical, economic or policy lock-in. Alongside this, flexible infrastructures also play a central role.

Table 11.1: Different quantities of fossil fuels replaced by different sector-coupling technologies with one kilowatt hour of electricity (in the heat supply and transport sector)

RES-based provision of energy			Fossil savings		Substitution ratio
Input	**Technology**	**Energy/benefit provided**	**Technology**	**Input**	
1 kWh RES electricity	Power-to-heat heat pump	3.3 kWh heat	Condensing boiler	3.1 kWh natural gas	**3.1**
1 kWh RES electricity	Electric vehicle	4.6 km	Combustion engine	2.6 kWh diesel	**2.6**
1 kWh RES electricity	Power-to-heat direct-electric	1.0 kWh heat	Condensing boiler	0.9 kWh natural gas	**0.9**
1 kWh RES electricity	Power-to-heat (hydrogen) as substance	0.7 kWh hydrogen	Steam reforming	0.9 kWh natural gas	**0.9**
1 kWh RES electricity	Power-to-gas (methane)	0.6 kWh methane		0.6 kWh natural gas	**0.6**
1 kWh RES electricity	Power-to-liquid	0.5 kWh liquid fuel		0.5 kWh liquid fuel	**0.5**

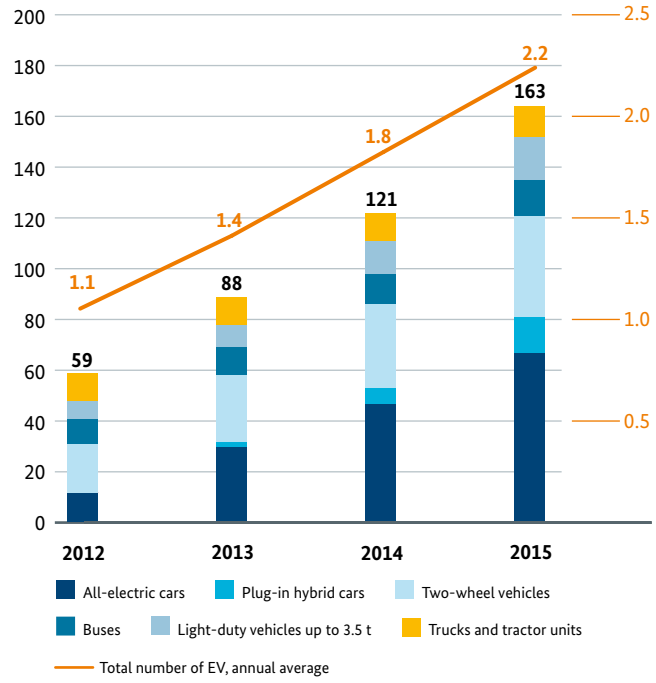
Source: Federal Environment Agency (2016a) and (2016b).
The calculations in the sources are based on plausible assumptions. The values in the table have been rounded off.

Diagram 11.1: Quantity and electricity consumption of heat pumps
In GWh



Source: Working Group on Renewable Energy Statistics based on data from the Centre for Solar Energy and Hydrogen Research and the Bochum Geothermal Centre, August 2016

Diagram 11.2: Quantity and electricity consumption of two-wheel and three-wheel-plus electric vehicles
In GWh In millions



Source: Federal Environment Agency based on data from the Federal Motor Transport and ITD/ifeu September 2016. All-electric drives and plug-in hybrids are considered

Central measures in the area of sector coupling

Initial measures that aim to help Germany make greater use of efficient sector coupling include:

Electric mobility eco-bonus (see Chapter 6)

Promotion of heat pumps

Goals

- In addition to supporting other technologies for the generation of heat and cold from renewables, the Market Incentive Programme also promotes the increased use of electric-powered heat pumps. This serves to increase the share of renewables in the provision of heat, and at the same time helps promote the continued uptake of heat pump technology.

Scope

- Electric-powered air-to-water heat pumps as well as water-to-water and brine-to-water heat pumps, inter alia, are promoted within the framework of the Market Incentive Programme. The revision of the funding programme in early 2015 improved the existing funding framework for heat pumps, and scaled funding to align it more with the efficiency of the various heat pump technologies. In addition, since the revision of the programme highly innovative heat pump systems are also eligible for funding even when installed in a new building.

Facts and figures

- Support was granted for around 16,000 heat pumps through the Market Incentive Programme in 2015. Since the revision, systems with air as the heat source receive support of at least €1,300 while support of at least €4,000 is granted for heat pumps with geothermal energy or water as the heat source.

Low-temperature heat networks with seasonal thermal energy storage

Goals

- Low-temperature heat networks (4th generation heat networks) require flow temperatures of 30–40 degrees Celsius which can be effectively provided by renewable energy sources. Combined with large-scale heat pumps and seasonal thermal energy storage units, they offer additional flexibility potential for the electricity market. With plans currently in place to fund larger pilot projects, the aim is to test and demonstrate the viability of such innovative overall concepts for wide-spread practical implementation.

Status

- The measure was proposed in the Efficiency Strategy for Buildings, the details of the support measure are currently being prepared.

Promotion of innovative CHP systems under the CHP Act

Goals

- The promotion of innovative CHP systems is an innovation pilot scheme designed to gather practical experience with these systems.

Scope

- Further development of CHP toward future-oriented systems for particularly energy-efficient, low-GHG co-generation and heat supply in the heating system. An example of an innovative CHP system is one that combines natural gas-fired CHP plants with technologies for the provision of heating based on renewables and ambient heat. Funding will be determined through a competitive auction process. The details of the auction system are currently being prepared.

11.2 Digitisation of the energy transition

With regard to digitisation, the German energy industry was in the mid-range in 2015 compared with other sectors. This is the finding of the DIGITAL Economy 2015 Monitoring Report (BMWi 2015c) based on a survey of businesses in the energy and water supply industry. The study examined the usage intensity of digital technologies and services, the extent to which companies are geared towards digitisation and how digitisation affects business success. In the survey, the energy and water supply sector scored 47 out of 100 points on the digitisation index. The index score increases to 48 points in the DIGITAL Economy 2016 Monitoring Report (BMWi 2016a), and the survey expects an increase to 52 points for 2021. The aim of the Federal Government's Digital Agenda 2014 – 2017 is to move the digital transformation forward in business and society – particularly also in the energy sector.

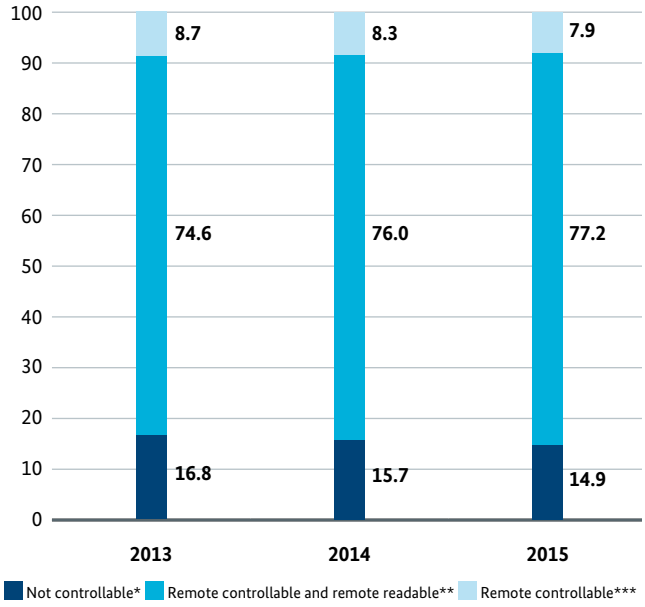
Digitisation affects all levels of the value chain in the energy industry: generation, grids, trade, supply and consumption. One overarching trend is the availability of increasingly larger volumes of data, known as big data. This results in new analytical approaches – for instance to identify efficiency potential. However, a priority must also be placed on data protection and security. Digitisation can also alter roles in the value chain, and electricity consumers can increasingly become electricity producers ("prosumers"), for example. Different challenges are posed to some extent at the individual levels of the chain, and progress towards digitisation varies here. Specifically, the following quite positive developments can be identified:

In particular, larger installations for the generation of renewable energy are generally already equipped with modern information and communication technology. To ensure the optimum integration of the intermittent supply of renewables into the electricity system, it is important to

be able to access information about capacity at all times, and to adapt the capacity if necessary. In 2015, over 77% of installed renewable capacity could be controlled and read remotely (see Diagram 11.3). Only around 15% of the installed capacity did not have remote-control capabilities. Compared with 2014, the amount of capacity that can be controlled and read remotely increased by around 11%. If we consider the number of plants with remote-control and remote-reading capabilities, instead of the installed capacity, the result is a share of around 7%, while more than 75% of plants were not controllable. This is because general peak shaving applies for the majority of smaller PV installations, instead of fitting the installations with a system for remote reading and control.

Power grids can be interconnected and also linked to power generation and consumption using smart, modern technologies. Conventional electricity grids become smart grids when they are fitted with communication technology, instrumentation and control (I&C) technology and IT components. In particular, a smart grid results in the better utilisation of the existing infrastructure, reducing the need for grid expansion and improving grid stability. According to a 2014 study commissioned by the Federal Ministry for Eco-

Diagram 11.3: Remote control and remote read capabilities of RES installations
Percentage of installed capacity



Source: Federal Network Agency, November 2016
*) not controllable, includes PV installations that have a 70% limitation pursuant to Section 9 (2) Renewable Energy Sources Act 2014
**) remote-controllable, remote-readable RES and CHP plants pursuant to Section 9 (1) Renewable Energy Sources Act 2014
***) only remote-controllable plants pursuant to Section 9 (2) Renewable Energy Sources Act 2014

"Smart Energy Showcases – Digital Agenda for the Energy Transition" (SINTEG)

In large-scale pilot regions, the SINTEG programme aims to demonstrate the feasibility of a climate-friendly, secure and efficient power supply with a high percentage of intermittent power generation derived from wind and PV. The solutions from these showcase regions will then serve as an important basis for widespread implementation in Germany.

Under this funding programme, five showcase regions are established to pool the knowledge, experience and activities of different systems. The Federal Ministry for Economic Affairs and Energy will provide a total of over €200 million in funding to the showcase regions which have over 200 participating companies and additional stakeholders. Together with additional investment from the participating businesses, over €500 million will be invested in the digitisation of the energy sector. SINTEG is part of the Federal Government's Digital Agenda and also an important component of the energy transition.

The following showcases were selected in a competition for funding and commenced at the end of 2016:

1. "C/sells: large-scale showcase in the 'solar arch' in southern Germany". The 'C/sells' showcase spans the states of Baden-Württemberg, Bavaria and Hesse, and focuses on the regional optimisation of energy generation and consumption.

2. "Designnetz: a modular concept for the energy transition – from isolated solutions to an efficient energy system of the future". The "Designetz" showcase in North Rhine-Westphalia, Rhineland-Palatinate and Saarland seeks to use solar and wind power to supply energy to urban and industrial consumers.

3. "enera: the next big step in the energy transition". The "enera" showcase located in Lower Saxony looks at regional ancillary services that stabilise the grid at the local level and further increase the reliability of the electricity supply based on renewable energy.

4. "NEW 4.0: the energy transition in the north of Germany". The aim of the "NEW 4.0" showcase in Schleswig-Holstein and Hamburg is to demonstrate that it will be possible to supply 70% of the entire region's energy demand from renewable sources by 2025 – in a way that is both secure and efficient.

5. "WindNODE: showcase for smart energy from the north-east of Germany". The "WINDNODE" showcase spans the five eastern German states plus Berlin. It aims to efficiently integrate renewable energy generation in a system comprising the electricity, heating and mobility sectors.

nomic Affairs and Energy, new grid planning approaches and smart grid technologies can reduce the costs of the expansion of the distribution grids expected through to 2032 by up to 20% (E-Bridge, IAEW, OFFIS 2014). In pilot regions, the "Smart Energy Showcases – Digital Agenda for the Energy Transition (SINTEG)" funding programme trials how generation and consumption can be interlinked using innovative technology and procedures. Smart grids and innovative grid technologies play a particular role in this context (see Box). With the smart meter system, the Act on the Digitisation of the Energy Transition introduces a technology that can be used for numerous applications of the smart grid.

Digital infrastructures give rise to new business models in the area of commerce and distribution. These infrastructures play a central role in the market integration of renewable energy. For example, to qualify for the market premium under the Renewable Energy Sources Act (see Chapter 3), renewable energy facilities need to offer remote-control capabilities. Remote-control capabilities give plant operators and direct sellers the technical means to ramp down feed-in or curtail the facility if the situation on the market so requires. In this way, they integrate renewably generated electricity into the market and relieve the burden on the EEG surcharge compared against plants in the system of fixed feed-in tariffs.

Digitisation also enables improvements in energy efficiency through new business models and the provision of better information to consumers and planners. New possibilities of analysis and user information become possible. On this basis, it is possible to develop energy efficiency services, which – in this format – were previously technically and organisationally impossible or too expensive. For example, the "Energy Savings Meter pilot programme", which was launched in May 2016, promotes innovative and IT-based pilot projects to reduce energy consumption using energy services that are based on the digital collection and processing of energy consumption data. Further to this, digitisation enables the management of electrical consumers in line with the needs of the power grid, and business models building on this that are supported with the Energy Savings Meter pilot programme.

The digitisation of planning processes in buildings, known as building information modelling, or BIM, supports energy optimisation and enables clear, transparent solutions for all processes in a facility that are relevant from an energy standpoint. The smart networking of energy meters and consumers in buildings can result in the efficient use of energy, while also increasing user convenience and comfort (smart home). Digital applications in the transport sector can ensure better vehicle-to-vehicle connectivity and the better networking of vehicles with the transport infrastructure and the energy system. This can contribute to a more efficient transport system and to the optimum integration of electric vehicles into the energy system (see Chapter 6).

The digital transformation of the economy and, moreover, the digitisation of industrial production processes along the entire value chain – known as Industry 4.0 – present enormous potential to make production processes more energy-efficient and climate-friendly and to thereby make a major contribution to the energy efficiency goal of the energy transition. The Federal Government supports these efforts with funding programmes for investment in modern sensing technology, software, hardware and smart efficiency solutions. Specific programme examples include Autonomics for Industry 4.0, E-Energy, Climate-smart Production Processes, SINTEG and Copernicus projects for long-term research questions (see Chapter 13).

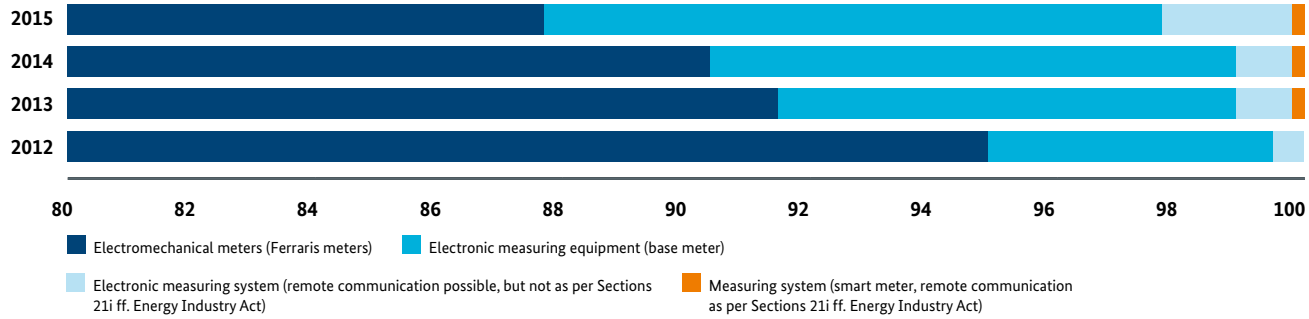
When it comes to measuring energy consumption in industry, meters that support remote automatic meter reading (AMR) are already standard. In 2015, there were 408,325 metering points for interval-metered business and industrial customers with an annual consumption of over 100,000 kWh. A further 60,729 meters were meter systems that are incorporated into a communication network and measure electrical power, actual consumption and actual utilisation time.

In the case of domestic customers, digital applications to reduce energy consumption are still not very common. For example, electricity meters that support remote AMR are still very rare in domestic households: only around 2.3% of the 50 million plus domestic meters can be read remotely. However, their numbers did practically double from 2014 to 2015. Roughly 90% of all meters in the domestic sector are still traditional electromechanical meters, known as Ferraris meters (see Diagram 11.4).

Data protection, data privacy and reliable standards are basic prerequisites for the successful digitisation of the energy transition. This is addressed by the Act on the Digitisation of the Energy Transition. Energy consumption data must be increasingly protected to prevent abuse and to guarantee consumer privacy as the pace of digitisation picks up. In addition, it is also necessary to prevent the energy system from becoming increasingly vulnerable to hacking and virus attacks during the further course of the digital transformation. Therefore the implementation and certification of suitable protection measures is a decisive factor in order to guarantee security of supply also as digitisation increases, and to prevent economic damage. This issue is addressed, inter alia, by comprehensive data protection profiles and technical guidelines of the Federal Office for Security in Information Technology (BSI).

The digitisation of the energy transition has begun. With the Act on the Digitisation of the Energy Transition, the Federal Government has taken an important step towards defining the framework for digitisation in the power sector. It must now continue along this path resolutely. With its Green Paper on Energy Efficiency and the "Electricity 2030" discussion paper, the Federal Ministry for Economic Affairs and Energy has launched consultative processes that look, inter alia, at how energy efficiency can be significantly increased and how to reliably push ahead with the digitisation of the energy system to help ensure the success of the energy transition and to achieve energy policy goals.

Diagram 11.4: Metering and measuring technology used in the domestic customer sector
Percentage of meters



Source: Federal Network Agency, October 2016

Central measures in the digitisation of the energy transition

Act on the Digitisation of the Energy Transition

Goals

- The Act aims to signal the start of the smart grid, smart meters and the smart home in Germany.

Scope

- With the smart meter gateway, the Act introduces a secure communication platform to interconnect all energy transition stakeholders in a secure and efficient manner. In particular, the technical basis is created for variable electricity rates, the visualisation of power consumption, the provision of grid condition data and demand side management measures. Certification based on BSI data protection profiles and technical guidelines ensure a high degree of data protection and data security. In addition, the Act also creates a new regulation system for the installation and operation of new technology (price caps) and regulates permitted data traffic. Starting in 2017 work will begin on the installation of smart meter systems initially for consumers with annual power consumption in excess of 10,000 kWh and for producers with an installed capacity of between 7 and 100 kW. An obligation to install smart meters can only apply to other consumers, including those with an annual consumption of less than 6,000 kWh, from 2020 onwards at the very earliest.

"Smart Energy Showcases – Digital Agenda for the Energy Transition" (see box p. 103)

Energy Savings Meter pilot programme

Goals

- The funding announcement seeks to promote the development and demonstration of digital solutions that support the energy transition in industry, commerce, households, buildings, municipalities and other target groups and provide incentive to save energy using smart solutions (smart home/building/production).

Scope

- Since May 2016, the "Energy Savings Meter pilot programme" has been promoting pilot projects and smart business models geared towards saving energy and the management of distributed electrical consumers to serve the needs of the power grid. In this context, the way in which the electricity, gas, heating or cold are saved is irrelevant – all that matters is the actual amount of energy conserved: funding is disbursed for each verifiable kWh of energy saved ("energy savings meter").

12 The energy transition in the European and international context

Where do we stand?

With regard to the goals for 2020, the EU is on target overall and, among participating Member States, Germany's performance scores high.

The importance of the expansion of renewables and better energy efficiency is gaining traction worldwide and there is growing interest in international collaboration with Germany.

What is new?

Diverse collaboration formats strengthen the trade and exchange of electricity between Germany and its neighbours.

In talks with the European Commission, a comprehensive energy policy package (CHP Act, Electricity Market Act and Renewable Energy Sources Act) was ensured under European law, subject to formal Commission procedures.

Important reforms were implemented in 2015 with the introduction of a market stability reserve and the backloading of allowances in the EU emissions trading system.

The Paris Convention on Climate Change has paved the way for international energy and climate policy.

Europe **International**	Establishing a reliable European and international framework for more climate change mitigation, renewables and energy efficiency.

12.1 European energy policy

The EU is on track overall to meet the 2020 energy and climate targets. According to a report by the European Environment Agency, 13 of the 28 EU Member States are on track to meet the three "20-20-20" targets for GHG emissions, efficiency and renewables (see Table 12.1), (EEA 2015a). However, there are significant differences in progress towards the targets in the individual sectors and with regard to the binding national goals of the individual Member States. In this context, Germany's performance scores high among the participating EU Member States.

- With regard to the GHG target (excluding ETS sectors), the majority of Member States – including Germany – are making good progress.
- With regard to the 2020 target for renewables, the EU is also on track overall, as are most of the individual EU Member States. In its recent progress report, the EU Commission expects that most of the Member States, including Germany, will slightly or significantly exceed their 2020 renewables target. However, some Member States will need to redouble their efforts in the coming years to meet their specific national goals.
- In terms of the efficiency target, the majority of Member States are on track – also owing to the rather weak overall economic development of many Member States in recent years. According to EEA projections in 2015, however, Germany is not completely on target to reduce primary energy consumption by 20% by 2020. Energy efficiency measures most recently introduced still have to take effect (see Chapters 4 and 11).

In 2014, the level of interconnection of cross-border electricity transmission lines stood at 10% of the generation capacity installed in Germany. This interconnection value was also at least 10% in 15 other Member States. The on-schedule implementation and completion of additional cross-border transmission lines that are already planned or under construction is essential if Germany is to maintain this level of interconnection in 2020 and thereby meet the EU 10% interconnection target.

European cross-border electricity trading and exchange continued to increase in 2015 also. Electricity is exchanged between Germany and its neighbours and third-party countries across various electricity bidding zones. In this context, electrical energy can only be controlled to a limited extent, which is why there is a difference between the physical flows of electricity and commercial flows (i.e. cross-border commercial electricity trading). One reason for this can be loop flows, where trade within one bidding zone causes physical flows of electricity through other bidding zones. Another reason can also be cross-border redispatch measures implemented by grid operators, for example.

On the trade side, Germany exports more electricity than other EU states and has set a new export record. In 2015, Germany exported 97.8 TWh of electricity and imported 36.9 TWh. The export balance – based on commercial flows of electricity – therefore amounts to 60.9 TWh.

At over 50 TWh, the physical electricity exchange balance also reached an all-time high. While the balance stood at around 36 TWh in 2014, in 2015 it had risen to 51.8 TWh and was therefore around 10 TWh less than the trade balance (see Diagram 12.1).

Regional collaboration is a key ingredient of the current and future EU electricity market design. The increasing integration of European electricity markets also calls for greater coordination of national energy policies, which is why Germany was actively involved in three regional electricity cooperation formats in 2015 also:

- **PENTA Forum:** Pentalateral Energy Forum, together with the BeNeLux countries, France, Austria and Switzerland.
- **CEEE Forum:** "Central-Eastern European Electricity Forum", with Croatia, Austria, Poland, Romania, Slovakia, Slovenia, Hungary and the Czech Republic.
- **BEMIP:** "Baltic Energy Market Interconnection Plan", with the Baltic states, Denmark, Finland, Sweden and Poland.

Table 12.1: Overview of EU 2020 and 2030 targets

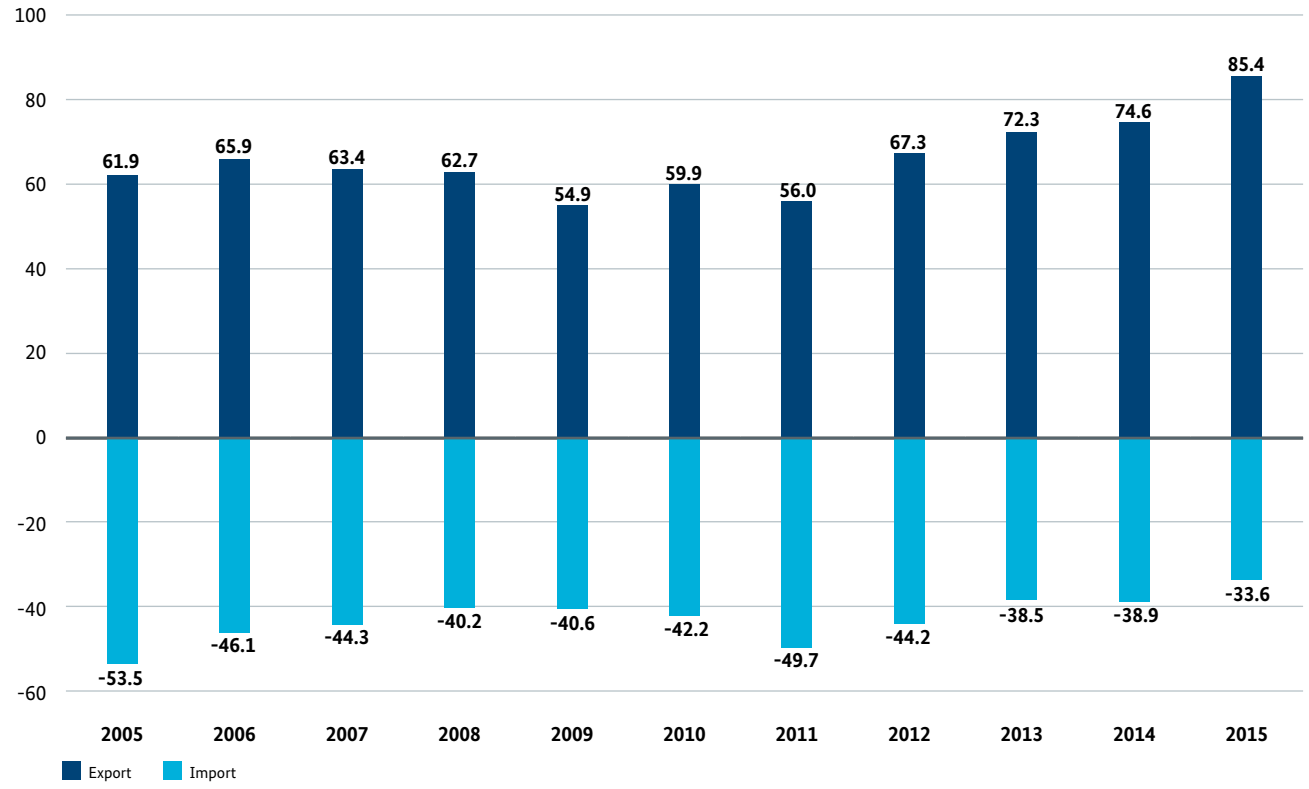
	EU 2020 target	EU 2030 target
GHG reduction (from 1990)	-20%	at least - 40%
Energy efficiency (as per EU Energy Efficiency Directive)	-20%	at least -27%
RES share in gross final energy consumption	20%	at least 27%
Interconnection	10%	TBD
Electricity trading/exchange	Make overall system more efficient and increase security of supply	

Source: In-house data of the Federal Ministry for Economic Affairs and Energy based on EEA 2015a

The outcome of such collaborative efforts is expected to be the development of concrete common measures to create a stronger link between the national electricity markets. In addition, Germany has also initiated policy exchange among its "electricity neighbours", i.e. the countries bordering Germany as well as Sweden and Norway. Currently this group is specifically discussing measures for the continued development and flexibilisation of the European electricity market design.

Following the European Council decision of October 2014 concerning a framework for climate and energy through to 2030, the priority now must be to implement this framework in a reliable manner. In addition to the ambitious climate and energy targets listed in Table 12.1, the new 2030 Framework also includes a battery of European legislative proposals for new EU energy efficiency and renewable energy directives, a reformed EU emissions trading scheme, the allocation of emissions reduction commitments to EU Member States in areas outside the emissions trading scheme (non-ETS) and the incorporation of GHG emissions and removals from land use, land-use change and forestry (LULUCF) into the EU climate framework. Central decisions are also pending with regard to grid expansion and the electricity market. In addition to the measures in the individual directives, a new binding control and monitoring system is also designed to ensure delivery of the 2030 targets. This system aims to merge the sectoral control and monitoring systems that already exist, such as those in the area of renewable energy and energy efficiency. Against this backdrop, the Federal Government is particularly committed to establishing reliable framework conditions that unlock synergies between the instruments already in place while maintaining scope and quality, and in doing so ensure goals will be achieved and offer security for investors and national support systems.

Diagram 12.1: Physical flows of electricity in cross-border capacities
In TWh



Source: Working Group on Energy Balances based on data from the Federal Association of the German Energy and Water Industry (BDEW) and ENTSO-E, October 2016

Central measures of EU energy policy

2030 Framework for climate and energy

Goals

- Cut internal greenhouse gas emissions by at least 40% (from 1990), increase the share of renewables in gross final energy consumption to at least 27%, boost energy efficiency by making energy savings of at least 27% (compared with the 2007 EU reference scenario) and review whether the target will be increased to 30%.

Status

- Goals implemented through legislative acts in the individual sectors (ETS reform, allocation of effort in areas outside the emissions trading scheme, inclusion of land use, land-use change and forestry into the climate framework, amended Energy Efficiency Directive, and Renewable Energy Directive – see below). Corresponding proposals are currently being developed by the Commission or are being negotiated with the EU Member States.

Governance of the Energy Union

Goals

- Establish a comprehensive energy strategy for the EU and ensure better dovetailing of the individual energy policy measures and targets in the areas of energy supply security, the internal energy market, energy efficiency, decarbonisation of the economy and energy research (the "Five Dimensions" of the Energy Union).

Scope

- Create integrated national energy and climate plans for the 2021–2030 period. Set up a pan-European system to monitor progress towards the goals of the Energy Union and establish sustainable financing structures in favour of low-carbon technologies.

Status

- The Commission is expected to put forward a legislative proposal at the end of November 2016.

New Directive for the Expansion of Renewable Energy post-2020

Goals

- Implement the binding EU goal of at least 27% renewable energy in final energy consumption by 2030, create a reliable framework for investors and national RES funding systems for the post-2020 period.

Status

- Public consultation hosted by the Commission at the start of 2016. The Commission's legislative proposal has been announced for the end of November 2016.

New post-2020 Energy Efficiency Directive

Goals

- Implement an EU goal of at least 27% energy savings by 2030 and continuation and simplification of the Energy Efficiency Directive with a greater degree of legal certainty.

Scope

- The Energy Efficiency Directive addresses the actual percentage target for EU efficiency for 2030 and the binding nature of this target. In so doing, it sets the framework (e.g. annual savings) and additional sector-specific measures (e.g. energy audit in larger companies and rate of building modernisation in the buildings sector).

Cross-border grid expansion

Goals

- Push ahead with the expansion of cross-border interconnectors to create the physical conditions for a functioning internal electricity market, simplify the integration of renewable energy and strengthen security of supply. Additional grid expansion projects must be implemented and ongoing projects completed to also reach the European 10% interconnection target in 2020.

Status

- German grid expansion plans comprise ten interconnector projects to further expand numerous interconnection points with our neighbours. The majority of the projects are in the approval or construction phase.

Commission Communication concerning a 15% electricity interconnection target for 2030

Goals

- The expansion of cross-border interconnectors is to be strengthened in order to reduce current congestion and thereby also create the physical framework for a functioning internal electricity market, simplify the integration of renewable energy and strengthen security of supply. This is why the European Council underlined the significance of cross-border interconnector capacity for the internal electricity market in October 2014 and confirmed the 15% interconnection target for 2030 which had been proposed by the European Commission.

Status

- The European Commission is currently examining how to best organise and achieve the desired higher interconnection target of 15% for 2030.

Regional partnerships

Goals

- Regional partnerships currently address a number of different topics, including the implementation of market coupling, a strong regional approach to security of supply and measures to flexibilise electricity markets across borders.

Status

- Flow-based coupling of the day-ahead markets was introduced in the Pentalateral Energy Forum in May 2015, a form of market coupling which is also sought within the CEEE Forum. Further to this, the Pentalateral Energy Forum also published Europe's first regional generation adequacy report in March 2015. In addition, new topics were adopted in a political declaration in the summer of 2016, including more extensive exchange of information regarding emergency response plans and measures to flexibilise the electricity markets, such as the continued development of the intraday and balancing energy markets. Within the framework of the BEMIP, the further development of regional electricity markets and a more regional approach to security of supply were also agreed on the basis of a new policy declaration.

Electricity neighbours

Goals

- Participating states have agreed to place a greater priority on flexibilising supply and demand, to ensure that cross-border electricity trading is not restricted even in times of high prices on the exchange, and to take a more regional and European approach to security of supply in the future.

Status

- The Joint Declaration was signed by Germany and its eleven "electricity neighbours" in June 2015. The sharing of knowledge and ideas to flexibilise the electricity markets was stepped up further on this basis in 2015 and 2016. In this context, the electricity neighbours have identified various barriers that stand in the way of greater flexibility and pinpointed initial measures to remove such barriers. It was also agreed that the participating states intend to examine their own national markets for any barriers to flexibility.

Regional cooperation in renewable energy/opening up the Renewable Energy Sources Act

Goals

- Open up some of the auctions under the Renewable Energy Sources Act to bidders from other Member States.

Status

- Cooperation with Denmark for ground-mounted PV installations was signed in July 2016 on the basis of the Renewable Energy Sources Act 2014 (pilot opening). Cooperation with another Member State in the area of ground-mounted PV installations is planned in early 2017. In addition, work is currently underway on the opening of auctions under the Renewable Energy Sources Act 2017 (auctions for 5% of the annual capacity to be installed will be open to installations from other EU countries).

Legislative package concerning the electricity market design, capacity mechanisms, regional aspects

Goals

- Continue to refine the European electricity market design and organise it so that an increasing share of renewables can be integrated into the system and security of supply can be guaranteed in a cost-effective manner, while taking full advantage of the flexibility potential and synergies of the internal market.

Status

- Commission Communication in July 2015 and opinions of the Member States submitted by October 2015. Legislative package announced for the end of November 2016.

Understanding with the European Commission regarding the energy package

Goals

- Create a German energy package (Act to Promote Combined Heat and Power, Electricity Market Act and Renewable Energy Sources Act 2017) that complies with European law.

Status

- In summer 2016, the Federal Ministry for Economic Affairs and Energy held intensive talks with the European Commission on the drafting of the details of energy legislation to ensure that it complies with European rules on state aid. In the talks, both sides reached an understanding as to how this can be addressed in a manner that complies with state aid rules. This understanding cannot pre-empt official proceedings in which the European Commission reaches its decisions.

12.2 European emissions trading

The Paris Agreement paves the way for a global energy transition. The Paris Convention on Climate Change has laid the foundations for ambitious, global climate change mitigation (see Chapter 7). Germany is pursuing the delivery of these goals as a matter of priority. To reach the climate goals, the EU is also continuing to rely on the EU emissions trading system as a central instrument.

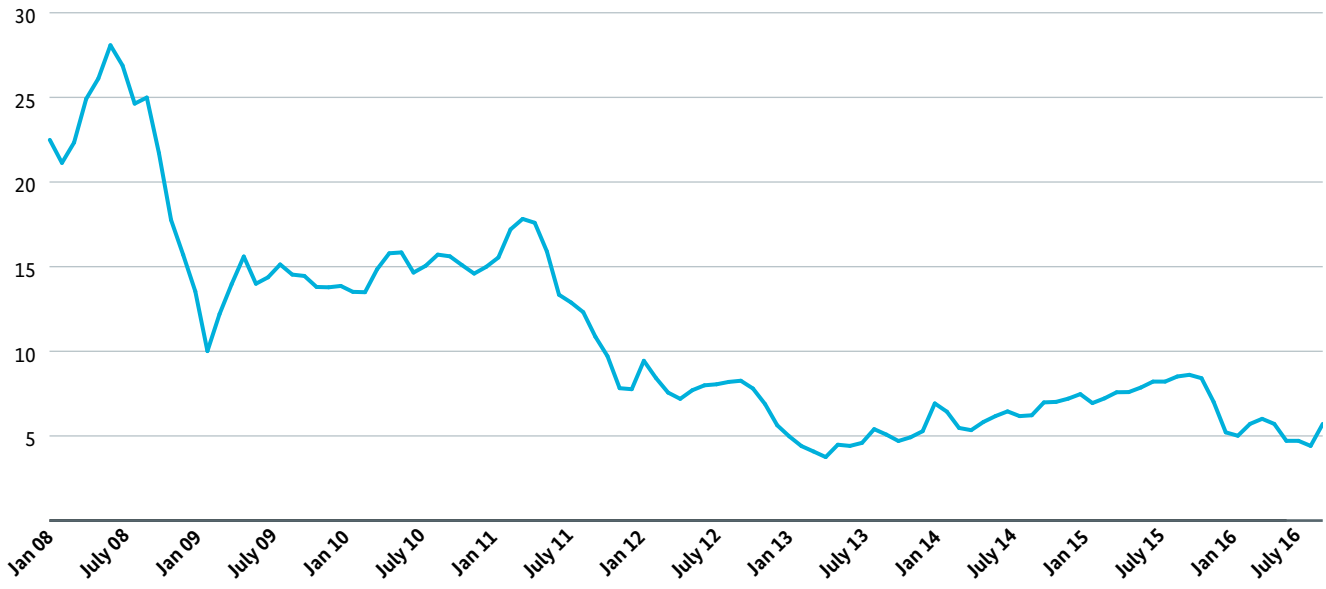
Since 2005, emissions trading has been the central pan-EU instrument to cut greenhouse gas emissions in the energy and industry sectors. The emissions of around 12,000 plants and installations of the energy sector and energy-intensive industry fall under the EU emissions trading system (ETS). Together, these plants account for roughly 40% of all emissions in Europe. In Germany, around 50% of emissions fall under the emissions trading system. Furthermore, the aviation sector has been included in the emissions trading system since 2012. As a result of the temporary limitation of the original scope of the Emissions Trading Directive between 2013 and 2016, the number of air operators participating in the ETS was reduced from 2,500 to 700. A follow-up decision regarding the application of the ETS system in the aviation sector will need to be made in 2017.

The greenhouse gases under the EU emissions trading system are decreasing and the 20% goal has already been reached. Estimates by the European Commission indicate that the greenhouse gas emissions of the installations taking part in the ETS fell last year by roughly 0.4% to 1,800 million tonnes of CO_2 equivalent, thereby corroborating the downward trend seen over the past five years. Compared with 2005, EU greenhouse gases in the sectors covered by the ETS have dropped by a total of 24%, from 2,375 to 1,800 million tonnes of CO_2 equivalent (German Emissions Trading Authority (DEHSt), 2016). The EU 2020 goal to reduce greenhouse gases in the ETS system by 20% from 2005 levels has therefore already been reached ahead of schedule.

In 2015, emissions from the approximately 1,900 energy and industrial installations in Germany that are required to take part in emissions trading amounted to around 456 million tonnes of CO_2 equivalent. The number of free allowances granted for certain industrial installations in Germany totalled 159 million. In addition, 144 million allowances from Germany's allotted share were auctioned on the EEX energy exchange. Due to the overabundance of allowances, a decision was made in 2015 to backload allowances, reducing the number of allowances available for auction EU-wide by 300 million, and cutting Germany's share by 58 million.

The price of carbon has plummeted since 2008, and following a slight increase in 2015 fell again in 2016. During the course of 2015, the allowance price increased from €7.2 to €8.4/t CO_2 (see Diagram 12.2). The annual average price in 2015 (€7.80/t CO_2) was around 26% more than in 2014 (€6.18/t CO_2). Following a period of increasing allowance prices between 2013 and 2015, a fall in the price was registered again at the start of 2016, to stand at €5.7/t CO_2. This concerns both the short-term and the long-term prices (known as "futures"). The price is currently in the range of €4 to €4.5/t CO_2.

Diagram 12.2: CO_2 allowance price in the EU emissions trading system
In euros/t CO_2



Source: European Energy Exchange, October 2016. Monthly average price for European emission allowances (EUA; European Carbon Future).

The Federal Government has called for the further strengthening of emissions trading as a market-based instrument of climate change mitigation. The introduction of a market stability reserve in 2019 is another important step towards reform which the Federal Government has actively supported. For the package of reforms that is now pending for the 2021–2030 period, it is important to ensure that the reform already agreed is continued and that the market stability reserve is not weakened. In addition, effective safeguards must be established for industry facing international competition ("carbon leakage rules"). In the 2050 Climate Action Plan, the Federal Government agreed to work towards strengthening price signals and a more effective emissions trading system, using additional agreed measures of the Member States, if necessary. Effective carbon leakage rules for industry, specifically such as the increased budget for the free allocation of allowances, should also aim to prevent a cross-sectoral correction factor.

Central measures with regard to European emissions trading

Reform of the European emissions trading system – introduction of a market stability reserve

Goals

- Reduce the current surplus of allowances and provide stronger incentives for investment in low-emissions technologies through the emissions trading system once more.

Status

- The market stability reserve will start operation in 2019. From this time onward, the supply of allowances in the emissions trading market will be adapted on the basis of a surplus analysis which is performed annually. If the total number of allowances in circulation (TNAC) is too high, the amount of allowances available for auction will be reduced by moving allowances into the reserve, and if the TNAC is too low more allowances will be released from the reserve. 900 million allowances backloaded between 2014 and 2016 will be transferred directly to the market stability reserve, as will allowances that were not auctioned between 2013 and 2020 (subject to a review for further use for free allocation to industry post-2020).

ETS legal framework 2021–2030

Goals

- Implement the 2030 EU climate target of reducing CO_2 emissions from sectors covered by the EU ETS by 43% in 2030 compared to 2005 by lowering the allowance cap each year by a linear reduction factor of 2.2%.

Status

- The proposed directive is currently being discussed at the European level. It includes rules for determining the emissions cap, the reduction factor and the division of the certificate amounts into amounts for auction and amounts for free allocation. It also contains detailed rules for the free allocation of allowances to industrial facilities which aim to prevent the risk of carbon leakage (displacement of emissions from inside to outside the EU ETS), and special rules for funds and the free allocation for eastern European power producers.

12.3 Climate action in the sectors outside the ETS

Currently around 60% of emissions in the EU do not fall under the emissions trading system. These include, in particular, the transport sector (excluding aviation), buildings, the waste management industry, non-CO_2 emissions from agriculture and smaller industrial operations.

According to current estimates, the EU is likely to exceed its goal of a 10% reduction in emissions from 2005 levels by 2020 within the effort sharing framework. It is down to the Member States themselves to decide how to implement the goals of the effort sharing decision at national level. Germany is also likely to meets its commitment under the effort sharing decision to cut emissions by 14% relative to 2005 by 2020.

The European Commission has already presented a proposal for an Effort Sharing Regulation with targets through to 2030. This proposal adheres closely to the direction given by the European Council in October 2014.

Central measures in non-ETS sectors

Effort sharing decision (ESD) regarding national GHG emission reduction targets for sectors outside the scope of the ETS by 2020

Goals

- EU-wide reduction of GHG emissions outside the EU ETS by 10% by 2020 compared with 2005 levels. The national targets for GHG reduction range from -20% to +20%.

Status

- With the national policies and measures currently in place, 23 Member States are likely to meet their 2020 targets. The remaining 5 Member States can probably reach the targets with additional measures or through the transfer of emissions budgets from other Member States.

EU draft regulation on national GHG reduction targets for sectors outside the scope of the ETS for the period 2021-2030 (Effort Sharing Regulation, ESR)

Goals

- Emissions reduction contribution of Member States towards the EU climate target for 2030 is shared among the Member States, with targets ranging from 0 to -40% (again compared with 2005 levels).

Status

- The proposal of 20 July 2016 put forward by the EU Commission concerning an EU Regulation is currently being discussed in the Council and the EU Parliament.

Land Use, Land-use Change and Forestry Regulation (LULUCF)

Goals

- Greenhouse gas emissions and removals from land use, land-use change and forestry are to be incorporated into the 2030 EU climate framework.

Status

- The proposal of 20 July 2016 put forward by the EU Commission is currently being discussed in the Council and the EU Parliament. It builds in large part on the LULUCF framework from the Kyoto protocol which is currently valid, and on the LULUCF Decision. The proposals for the Effort Sharing Regulation and the LULUCF Regulation also make provisions for a limited connection between the two areas for the first time ever.

12.4 International energy policy

Germany supports the development of a pioneering energy policy at the international level also. This involves promoting the German energy transition, and identifying and supporting partners and initiatives for the joint development of sustainable energy systems. The energy alliances which the Federal Government has established with selected countries (e.g. Brazil, China, India, Turkey and South Africa) under the leadership of the Federal Ministry for Economic Affairs and Energy and with the participation of the Federal Ministry for Economic Cooperation and Development (for development policy) and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (for climate policy) are a strategic instrument in this context. An energy partnership led by the German Foreign Office has also been established with Nigeria. Germany's external policy on energy also aims to secure the long-term reliability and affordability of energy imports which Germany will continue to rely on in the foreseeable future.

The expansion of renewable energy is a global trend. As the 2016 Global Status Report shows, around 76% of global electricity consumption was derived from coal, oil, gas and nuclear in 2015, while around 24% was already being generated from renewable sources (of which hydropower accounted for 17%), (REN21 2016). In addition, at 147 GW the biggest ever global increase in generation capacity based on renewables was registered in 2015, corresponding to around 60% of total global capacity expansion that year.

The number of people employed in the renewables sector rose again sharply worldwide in 2015. According to estimates by the International Renewable Energy Agency (IRENA) around 8.1 million people were employed in this sector in 2015, up around 5% on the previous year. Worldwide, most jobs in the renewables sector are in China (approx. 3.5 million), followed by Brazil (918,000) and the United States of America (approx. 769,000).

Global new investment in renewable energy reached a new all-time high in 2015. 2011, the last record year, registered new investment of around USD 279 billion. This was exceeded in 2015 with total investments of around USD 286 billion (excluding large-scale hydropower), (REN21 2016). For the first time ever, more investment was directed into renewables in developing and emerging economies than in industrial countries. At USD 102.9 billion, over one third of global investment in RES was made in China, followed by USD 44.1 billion in the United States and a total of USD 36.2 billion in Japan.

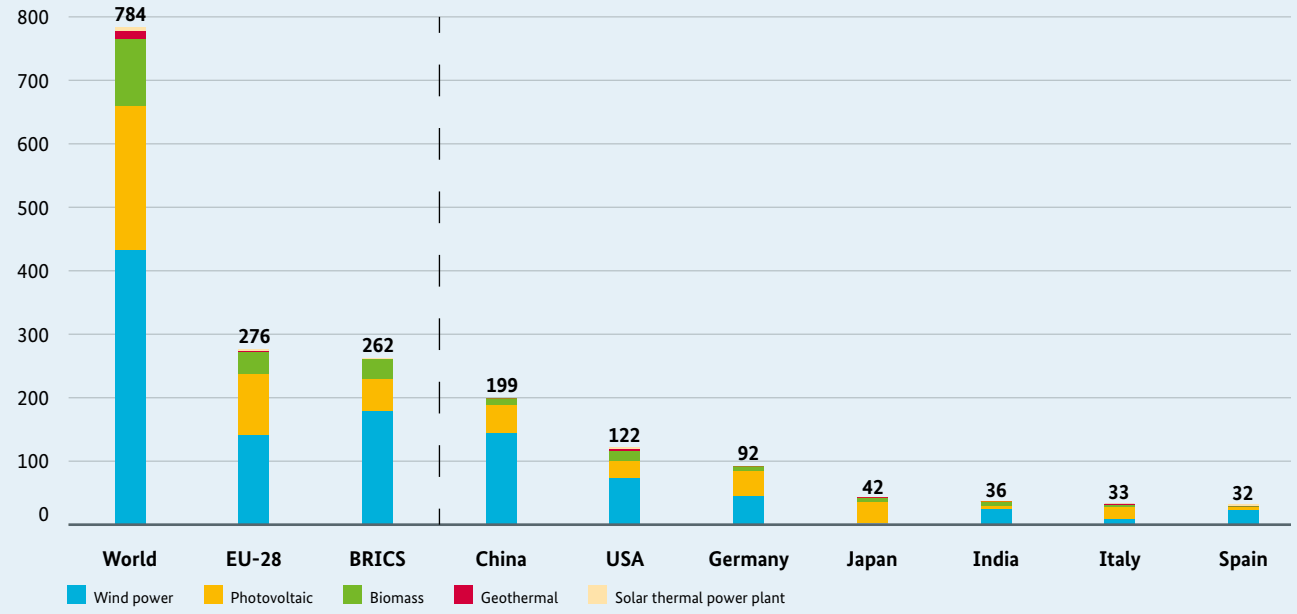
Significant global investment was also registered in the area of energy efficiency in 2015. According to the IEA Energy Efficiency Market Report 2016, USD 221 billion were invested in energy efficiency worldwide in 2015, with the buildings sector accounting for 53% of the investment, transport for 29% and industry for 18%. Investment in energy efficiency was therefore up by around 6% on the previous year, a development which was particularly attributable to the buildings sector.

The energy transition in Europe and worldwide

When the installed renewable capacity is compared worldwide, it is clear that Europe and Germany occupy a leading position in this context (Diagram 12.3). The energy transition is and will remain a central economic factor.

Contrary to the global trend, investment in renewable energy in Europe has been declining since 2011 and fell again to around €49 billion in 2015 (REN21 2016). In contrast, China and the United States, as well as some developing and emerging economies, are seeing strong growth in this area.

Diagram 12.3: Global installed renewable capacity, 2015
In GW



Source: Global Status Report (REN21 2016). Deviations from German data sources are due to different data origins and data collection methodologies.
Hydropower not depicted in the graphic. BRICS = Brazil, Russia, India, China and South Africa

Effective climate change mitigation requires global effort. Global CO_2 emissions in 2014 were around 59% higher than in 1990 and have also increased on 2005 levels by around 18% (IEA 2016b). However, the increase in global emissions has slowed in recent years. The EU's share in global CO_2 emissions stood at around 9.5% in 2014, and Germany's share at around 2.2%. This makes it all the more important to collaborate at international level and develop sound methods to internationally compare contributions towards emissions reduction (see Chapter 7).

International interest in energy relations with Germany has increased steadily – particularly since the adoption of the Paris Climate Agreement. Germany is therefore sharing its experience and best practices in formalised energy partnerships and in many bilateral energy collaborations and will continue to do so in the future. It also supports the development of attractive frameworks for sustainable energy policy, as well as markets that are also open to German businesses, in the target partner countries.

The Federal Government continues to be actively involved in multilateral energy organisations and forums. In particular, it has been active within the International Energy Agency (IEA), the International Renewable Energy Agency (IRENA) and the Clean Energy Ministerial (CEM). Further to this, Germany supports the Renewable Energy Policy Network for the 21st Century (REN 21). As part of G7 and G20 Energy Ministerial meetings, decisions were made to deepen cooperation in the field of energy. Under Germany's G7 presidency, the heads of state and government decided in summer 2015 to decarbonise the global economy over the course of this century and to restructure their energy systems by 2050.

Germany currently covers around two-thirds of its energy needs through energy imports. This considerably exposes the German economy to the often volatile global market prices (see Chapter 9). The prices of these fossil fuels have declined considerably in recent years, thereby relieving the burden on consumers to some extent. However, in an effort to reduce Germany's dependency on individual supply sources on a permanent basis, the Federal Government is also seeking to diversify energy providers and transport routes in addition to improving energy efficiency and expanding renewable energy.

Central measures in international energy policy

Berlin Energy Transition Dialogue 2016

Goals

- On March 27 and 28, 2016 more than 1,000 energy experts from 71 countries, including 29 ministers and state secretaries, met at the international energy transition conference held at the Foreign Office in Berlin to share ideas and opinions on how to make a successful global transition to a secure, affordable and environmentally friendly energy supply system.

Scope

- As the first international energy transition conference after the Paris Agreement, the central question was how the energy sector can and should contribute to reaching the Paris goals. The conference covered a wide array of areas that are necessary for a successful energy transition and addressed the need for a holistic approach.

Energy Export Initiative

Goals

- The Federal Government specifically supports German businesses in tapping into foreign markets and expanding exports of German renewable energy and energy efficiency technologies. To this end, the Renewable Energy Export Initiative and the Energy Efficiency Export Initiative were merged into a single "Energy Export Initiative".

Scope

- The focus is on technical solutions in the field of renewable energy, energy efficiency, storage technologies and smart grids. For more information, visit www.german-energy-solutions.de.

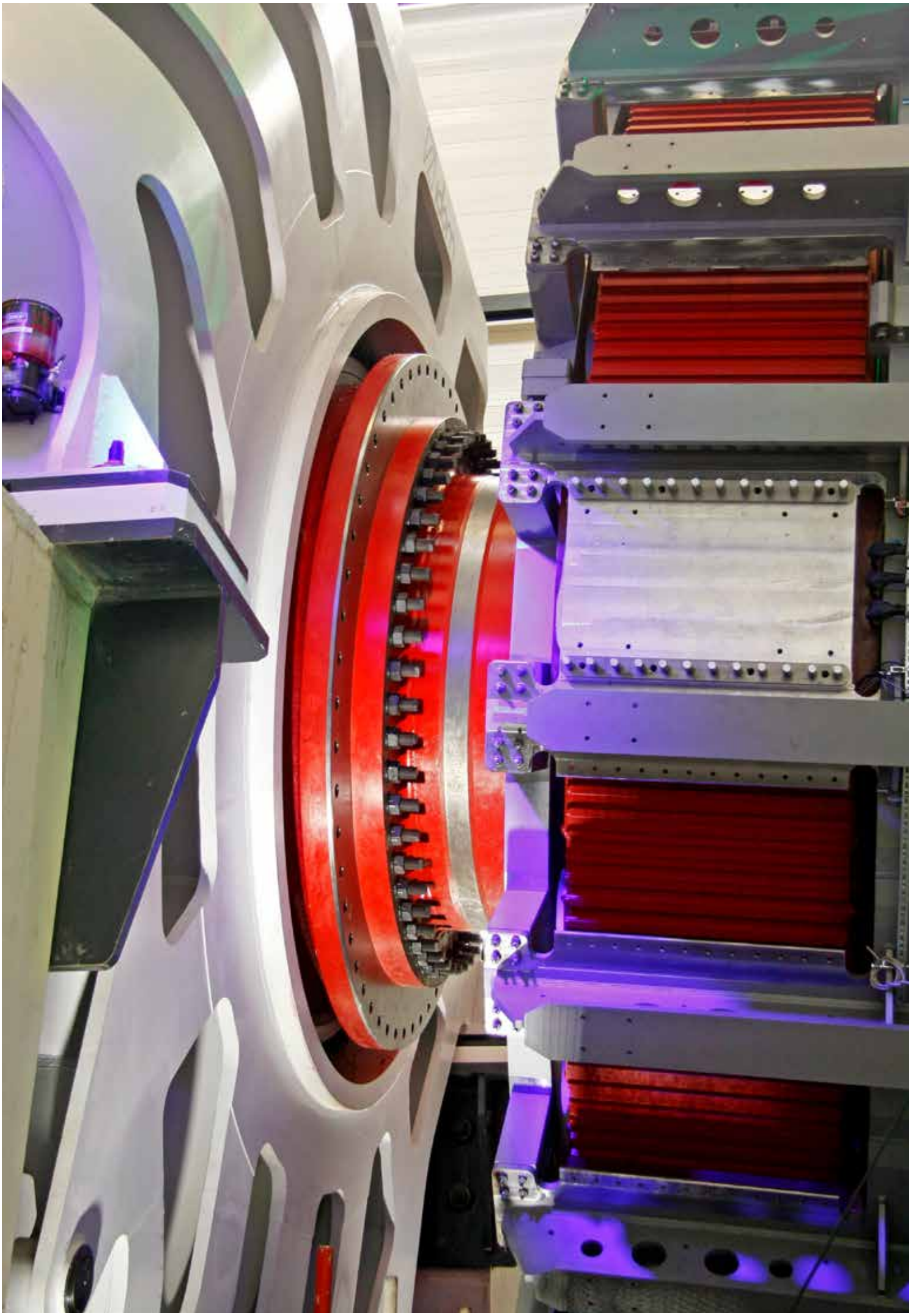
G20 energy cooperation under the German G20 presidency in 2017

Goals

- When it holds the G20 presidency in 2017, Germany will focus G20 energy cooperation on addressing how the energy sector will develop following the adoption of the 2015 Paris Convention.

Scope

- The focus on the development of the energy sector in the wake of the Paris Agreement will train the lens on policy frameworks for investment in the energy sector, address previous G20 activities centred, inter alia, on the expansion of renewable energy, the strengthening of energy efficiency and the dismantling of inefficient subsidies for fossil fuels, and develop these activities further.



13 Energy research and innovation

Where do we stand?

In 2015, €863 million were mobilised as part of the Federal Government's 6th Energy Research Programme, with three-quarters of the funds channelled into the renewable energy and energy efficiency research fields.

Innovative technologies, characterised by greater efficiency, the use of fewer resources and the optimisation of the overall system, are found across the board in all areas of the energy transition.

What is new?

The focus of energy research is increasingly trained on the growing importance of sector coupling – i.e. the integration of the electricity, heating and transport sectors – and the integration of innovative technologies into the system to deliver on the goals of the energy transition.

Research Innovation	Fostering forward-looking innovations for the restructuring of the energy supply.

13.1 Research and development

The research, development and demonstration of innovative energy technologies is first and foremost the remit of the business sector. Besides supporting basic research, public-sector research funding generally also aims to support applied research, technological developments and innovative activities in the business community, research institutions and universities. Apart from research funding, however, support in the form of suitable policy frameworks is also essential to make innovative technologies cheaper and marketable. This involves regular changes to regulatory law, as well as specific measures to support the transfer of research and market preparation.

Business investment in research and development continued to increase in 2015. Within the framework of publicly funded energy research projects alone, businesses invested around €185 million in the development of innovative energy technologies in 2015. Added to this are third-party funding payments to universities and research centres as part of collaborative projects. The total volume invested by the business community in the research and development of energy technologies is probably far higher than this. In 2015, the business community spent roughly €59 billion, i.e. 4.6% more than the previous year, on research and development overall, including energy technologies (Donor's Association for the Promotion of Sciences and Humanities in Germany, 2016).

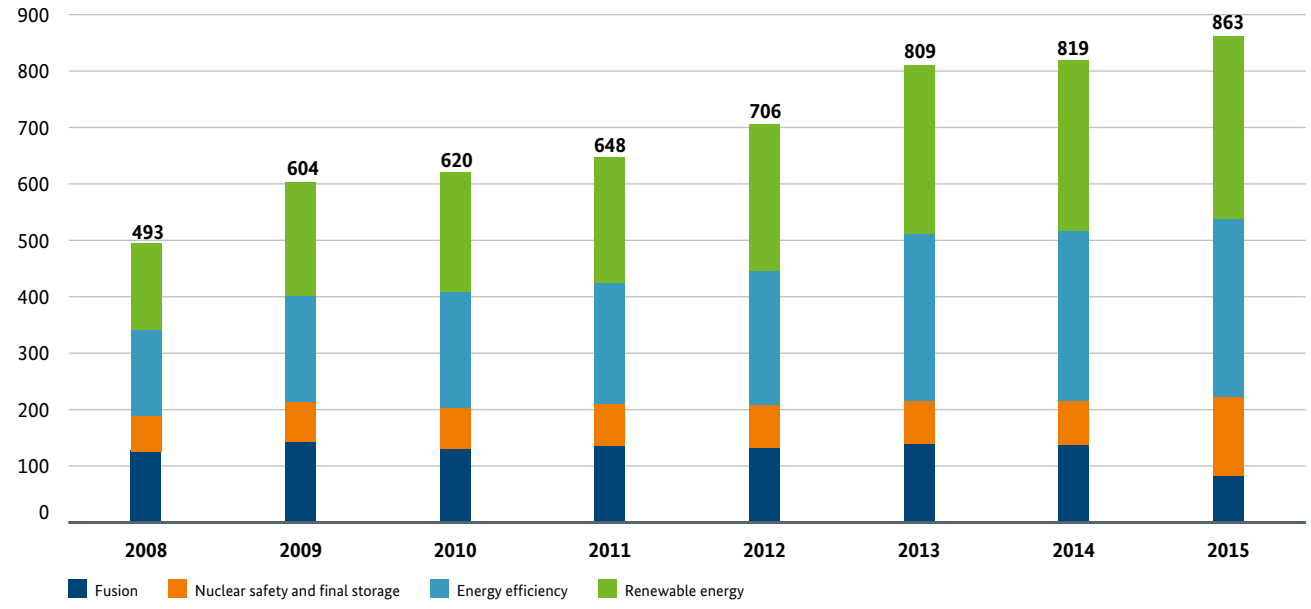
Industry-oriented energy research safeguards the competitiveness of German industry. In the case of applied research and technological development, the focus is on industry-led projects conducted in close cooperation with research institutes and universities.

The Federal Government also increased the budget for energy research in 2015. From 2013 to 2016, around €3.4 billion in total are being provided to promote the research and development of modern energy technologies. Germany has doubled its spending on R&D in energy overall in the last ten years. Funds in 2015 amounted to €863 million, an increase of €44 million on the previous year (see Overview in Diagram 13.1). Around three-quarters of this amount (€640 million) have been channelled into the research fields of renewable energy and energy efficiency. In the 2015 Federal Report on Energy Research, the Federal Government provides an overview of the energy research supported in Germany.

No other country is as deeply involved in the EU Framework Programme for Research and Innovation as Germany. Of the total budget of approximately €80 billion for the "Horizon 2020" Framework Programme, around €6 billion are earmarked for non-nuclear energy research projects (see 2015 Federal Report on Energy Research). Funds amounting to around €580 million were available for the area of energy in 2015. In 2015, 188 recipients of funding in the field of energy came from Germany. Within the context of the projects approved, some 16% of the funds will go to Germany.

The increasing complexity of R&D leads to deeper knowledge-sharing at the international level. At present, Germany is actively involved in 24 of the 39 IEA Technology Collaboration Programmes (TCP) currently running. The "Mission Innovation" initiative was launched at the 21st

Diagram 13.1: Federal Government research spending in the Energy Research Programme
In million euros



Source: Federal Ministry for Economic Affairs and Energy, April 2016

session of the Conference of the Parties to the Framework Convention on Climate Change in Paris in December 2015. Through this initiative, 22 countries and the EU are taking action to double their clean energy R&D investment over five years.

Continuous development of energy research as a strategic element of energy policy. The direction of energy research policy will undergo continuous development and be adapted to the current policy and energy framework with the participation of all the relevant stakeholders. For example, long-term aspects are dealt with in "agenda processes", while application-related issues are discussed in the Energy Transition "Research and Innovation" Platform with all the relevant stakeholders from the fields of science and business and from civil society. Topics at the interfaces to other programmes and sectors are also increasingly addressed. In a step-by-step approach, the scope and focal areas of future funding programmes are first developed in tandem with the relevant stakeholders in a targeted discussion process. Afterwards, these stakeholders oversee and organise the innovation process through to the application stage. The focus here is on systemic approaches and on expanding the groups of stakeholders, specifically with a view to the efficient transfer of research and innovation. New structures in the form of open, topic-oriented research networks provide additional impetus here.

Energy research will become even more important going forward. Medium-term financial planning makes provisions for a budget of around €1 billion in 2019. In the European context also, Germany will push for a holistic approach geared towards the transformation of the energy system.

Cross-sectoral energy research makes a central contribution to the energy transition. The focus of energy research is increasingly trained on the growing importance of the integration of the electricity, heating and transport sectors (sector coupling) and the integration of innovative technologies into the system to deliver on the goals of the energy transition (see Chapter 11). Joint research initiatives into storage systems, grids, construction and housing, hydrogen and fuel cell technology will be continued and, going forward, will potentially incorporate new activities looking into smart sector coupling within the context of the energy transition using electricity-based fuels.

Energy research networks

Several energy research networks have been gradually launched since 2015 to transfer the results of energy research directly to stakeholders in the energy transition:

- Energy in buildings and neighbourhoods
- Power grids
- System analysis
- Renewable energy
- Energy efficiency in industry and commerce
- Flexible energy conversion

As the interface between research, practice and policy-making, the networks will help to provide subject-specific guidance for support strategies with a practical orientation, and coordinate new measures. This also puts transparency and efficiency at the centre of energy research. The Energy Transition "Research and Innovation" Platform (R&I platform) brings together and coordinates the energy research networks, which are established on a long-term basis.

For further information, visit:
www.forschungsnetzwerke-energie.de

Central measures in the area of energy research

Research and Innovation Platform

Goals

- Greater coordination between the Federal Government, the *Länder*, the business sector and the scientific community in the development of energy research policy, with greater consideration also given to European support measures. Overall the aim is to strengthen the innovation process as the result of research and development.

Scope

- Central action areas include aspects regarding the continued development of energy research policy and new approaches, inter alia, in the field of strategic energy system analysis, the system integration of individual technologies, particularly using smart ICT systems, and the role of start-ups in the innovation process and for demonstration projects for market-oriented technology applications. The results will feed into the preparation of a new energy research programme. To this end, a process of broad consultation was launched on the R&I platform, with the aim of integrating central formats and ongoing measures of energy research policy. It is flanked by the strategic "Energy Research Trends and Outlook" flagship project.

Structure

- The platform brings together and coordinates the long-term energy research networks (currently these are renewable energy, power grids, buildings and neighbourhoods, energy system analysis, flexible energy conversion, energy efficiency in industry and commerce, biomass). Issues that need to be addressed at shorter notice are discussed in flexible ad hoc working groups which are set up for a limited period, such as the Start-Up Working Group.

Energy Transition Research Forum

Goals

- Key players from the *Länder*, the business community, academia and civil society have been meeting since 2013 to drive forward the effective coordination and long-term direction of energy research.

Scope

- Conclusions are reached with regard to the structures, instruments and future topics of research policy.

Copernicus projects

Goals

- Bridge the gap between basic research and practical applications in key areas of the energy transition. Using the basic research pending in the first phase of funding provided by the Federal Ministry of Education and Research, the aim is to create the basis for a technologically outstanding and economically competitive energy system which also enjoys the greatest possible level of public acceptance.

Status/scope

- Power grids in the context of a high share of renewables in the energy mix, storage and conversion, realignment of industrial processes to intermittent energy supply and sector coupling.

Facts and figures

- The first funding phase of the projects is set for three years, and planned funding is up to €120 million.

"Energy Systems of the Future" Academies' project

Goals

- 120 representatives from German science academies develop systemic policy options for the area of basic research with a focus on the energy system of the future, and in doing so provide a scientifically sound basis for society-wide debates on issues that are of medium- to long-term relevance to a successful energy transition. In addition to questions about technological feasibility, the project also addresses economic and legal issues, as well as aspects regarding the efficient use of resources and public acceptance.

Scope

- http://www.acatech.de/de/projekte/projekte/energiesysteme-der-zukunft-phase-2.html

"Sustainable Power Grids" research initiative

Goals

- Joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research to create the necessary technological framework for the future transmission and distribution of electricity to deliver a reliable, affordable and environmentally friendly power supply system.

Scope

- http://forschung-stromnetze.info/

Facts and figures

- Around 300 projects since 2014 with €150 million

"Energy Storage" research initiative

Goals

- Joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research to support research and development projects from the fundamental R&D work right through to demonstration projects geared towards practical application.

Scope

- http://forschung-energiespeicher.info/

Facts and figures

- Around 250 projects and €200 million since 2012

"National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP)"

Goals

- Joint initiative of the Federal Ministry for Economic Affairs and Energy, the Federal Ministry of Transport and Digital Infrastructure, the Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety as well as industry and the scientific community designed to speed up technology development and the process of producing marketable products based on these technologies.

Scope

- http://www.now-gmbh.de/de

Facts and figures

- More than 200 research projects with around €1.4 billion for 2007 to 2016

Programme collaboration: Energy Transition Research Alliance at the German Federation of Industrial Research Associations (AiF)

Goals

- Joint initiative of energy research and industrial collective research launched by the Federal Ministry for Economic Affairs and Energy to specifically strengthen the innovative capacity of non-research-focussed SMEs in the development of energy solutions.

Scope

- First projects started at the end of 2016.

Facts and figures

- An additional €18 million in funding will be available from 2016.

"Carbon2Chem" research initiative

Goals

- A consortium from industry and science (including thyssenkrupp, Linde, BASF, Covestro, AkzoNobel, Max Planck Society and Fraunhofer Gesellschaft) is trialling the conversion of smelting gas from steel production into base chemicals using renewable energy. The aim is for research and innovation to help guarantee the competitiveness of high-emission industries.

Scope

- Valuable chemical primary products for fuels, plastics or fertilizers that replace fossil fuels are produced from blast furnace gas. Thanks to the project, 10% of annual CO_2 emissions from German industrial processes can be used commercially. The goal is to transfer this knowledge to steel production centres abroad or to other branches of industry.

Facts and figures

- The Federal Ministry of Education and Research will make more than €62 million available for this project in the next four years.

"Renewable Resources" funding programme

Goal

- Initiative of the Federal Ministry of Food and Agriculture for the promotion of research, development and demonstration projects in the use of renewable resources as a material and for energy purposes.

Scope

- http://www.fnr.de/projektfoerderung/fuer-antragsteller/foerderprogramm-nachwachsende-rohstoffe/

Facts and figures

- €61 million are available in 2016. Another €24.6 million will be provided from the Energy and Climate Fund for bioenergy projects.

"Biomass Energy Use" funding programme

Goals

- Research and development work, with a practical orientation, on forward-looking technologies and the optimisation of processes which enable the efficient, economic and sustainable use of bioenergy and help contribute to security of supply.

Scope

- Programme launched in 2009 and reorganised in 2015. Support granted in particular to solutions with a practical orientation that are promising for demonstration projects and pilot schemes and help flexibilise the generation of electricity and heat from biomass. In particular, the aim is to tap the potential of biomass residual and waste material to improve sustainable energy-related use in the (coupled) heating and electricity sectors.

Facts and figures

- So far there have been 300 individual projects, mostly collaborative projects, with funding amounting to around €44 million. €61 million are available in 2016. In addition, funding of €24.6 million will be provided from the Energy and Climate Fund for bioenergy projects.

13.2 Innovative energy technologies

Promising results of research are the basis for new, low-cost and marketable energy technologies. As illustrated below, examples of the growth of innovative technologies that are characterised by greater efficiency, lower costs or resource conservation can be found across the board in all areas of the energy transition.

The number of patents filed in the area of renewable energy are testament to the high level of innovation in this field. In 2015, 1,378 patents were filed in the area of renewable energy (German Patent and Trademark Office 2016), which means that patent applications have more than trebled in 10 years. Patents, however, are just one of many facets of innovation and therefore are not an indicator in their own right. What matters is the extent to which the patents are put to practical use and the economic advantages presented by new products. The number of patents cannot provide this information. In addition, the rate of patent applications varies greatly in different technological disciplines.

The patents filed in the area of automotive engineering are a reflection of innovative transformation processes. Patent applications for hybrid and electric drives have more than doubled since 2009 (German Patent and Trademark Office 2016). Overall, the number of patents filed for combustion engines still exceeds the number of patents for alternative drives. The Federal Government is committed to ensuring further progress is made in the field of alternative drive technologies (see Chapter 6).

Entrepreneurial potential and start-ups in the energy transition

The energy transition creates opportunities for business start-ups: the products and services of around 17% of all new businesses set up in Germany contribute to the restructuring of the energy system. Therefore, after retail, the cross-cutting sector of the green economy is the biggest area for start-up potential in the country. Between 2006 and 2014, around 190,000 businesses were set up in areas relevant to the energy transition, with 36% focussing on renewable energy and 32% on energy efficiency. Accounting for 14% of start-ups, businesses whose products or services are geared towards the prevention of emissions also play a key role. This information and more is available from the Green Economy Startup Tracker: www.gruendungsmonitor.de.

There is a serious entrepreneurial drive in the renewable energy market segment owing, in particular, to young energy production companies. In addition, it has been found that new businesses in this field are often started with more workers and higher sales revenues (Centre for European Economic Research 2014). They have a higher level of revenue in the year they are founded and require higher levels of financing. At the same time, the business founders have a higher capacity for innovation compared with non-energy entrepreneurs in the same business sectors: they invest a lot in research, file a large number of patents and often develop national or global market innovations.

Digital start-ups and other new players entering the market can be particularly instrumental to the success of the energy transition. Many start-ups are already entering the market with innovative business models in areas such as virtual power plants, the smart grid and the smart home. For established businesses, on the other hand, digitisation often presents the major challenge of having to optimise their business model either on their own or through collaboration with start-ups. Therefore the aim should be to ensure both that young, innovative businesses have a place in the energy industry and that established, successful companies can adapt to the challenges of the energy transition.

The Federal Ministry for Economic Affairs and Energy has a wide range of measures in place to support start-ups, which are brought together in the “New Era of Start-ups” initiative. This also includes forging links between start-ups and established businesses (with the “Digital Energy World start-up night” specially for the energy sector).

Technological advancements and innovations in RES technology in the field of power generation are driving down costs. This is particularly true of photovoltaics (PV) and wind energy. While the remuneration rates for PV were over 50 ct/kWh ten years ago, they now stand at around 12 ct/kWh for roof-mounted installations and are well below 10 cent for PV ground-mounted installations. In the round of auctions for PV ground-mounted installations in April 2016, average contract prices had fallen to below 8 ct/kWh (see Chapter 3).

The technologies used in combined cycle power plants are being constantly optimised and upgraded. In research and development, there is an increasing shift in priority towards the flexibilisation of power plant processes as the increasing integration of renewable energy in the electricity market has given rise to new requirements. Research activities in this area create the framework to ensure that Germany's power plant fleet can continue to meet these requirements satisfactorily in the future.

The trend towards products with the highest energy efficiency ratings continues. Energy-efficient technologies and devices experienced increasing popularity again in 2015. The EU eco-design and the EU energy labelling system continue to make a central contribution to this development. In 2016, the European Council and the European Parliament agreed to strengthen the EU energy label as part of the reform of the EU energy labelling system (see Chapter 4).

Energy efficiency continues to be the focus of building modernisation measures. This is also demonstrated by the efficiency trends in the energy retrofits supported through the KfW. In addition, incentives to use renewable energy in the heating market were strengthened once more with the reform of the funding guideline for the Market Incentive Programme on 1 April 2015 (see Chapter 5). Efficient condensing boilers also managed to expand their market share significantly in the heating and warm water sector in 2015. Furthermore, the share of electric heat pumps is also increasing continuously (see Chapter 11.1). Other generators of heat, such as biomass and solar thermal, are also part of the market (see Chapter 5).

There is an increasing number of electric vehicle drive systems among the new passenger cars registered each year. By the end of 2015, 29 series production models by German car makers were on the market (see Chapter 6). Efficiency improvements can also still be made in fossil fuel-based vehicles. The "New Vehicle and System Technologies" programme was launched to this end. Vehicles with hydrogen-powered fuel cells and natural gas-powered vehicles are also gaining traction (see Chapter 6).

The operation of demonstration facilities still dominates market activity in the area of power-to-X technologies. Power-to-X and, in particular, power-to-gas or also power-to-fuel technology, offers promising opportunities to interlink the power generation, gas and mobility sectors both technologically and economically (see Chapter 11.1). While pioneering research projects have helped the technology to make significant progress towards reducing the costs of facilities and components and towards increased flexibility in plant operation, it has not yet been possible to cover the costs of day-to-day operation.

Digital solutions are making their mark across all industries and sectors. This is particularly true with regard to the power sector and grids (smart meter rollout) and the buildings sector (smart home, grid-supportive buildings), (see Chapter 11.2).

With regard to automated and connected driving, Germany currently leads the way in key technology fields. By implementing the "Strategy for Automated and Connected Driving – Remain a lead provider, become a lead market, introduce regular operations", the Federal Government is creating the framework to exploit the opportunities for growth and prosperity which the mobility system of the future will offer. Automated and connected driving will make road traffic safer and, with increasing market penetration and the gradual optimisation of the flow of traffic, will also reduce emissions caused by the transport sector. The first milestone is the introduction of highly automated driving on motorways and on roads that are near-motorway standard (motorway system) and parking in multi-storey car parks (multi-storey parking system).

Central measures for the promotion of innovative technologies

WIPANO – "Knowledge and Technology Transfer via Patents and Standards"

Goals

- Promotion of public research, support for companies to help them patent and exploit their ideas, and support for innovative projects.

Scope

- To promote patenting, some of the costs are covered for patent advice, consulting a patent attorney or for filing the patent.

Status/facts and figures

- The measure is in place from 1 January 2016–31 December 2019 with a budget of €23 million. Businesses, third-level institutes, universities and non-university research centres are eligible to apply.

Promotion of stationary fuel cell heating as part of the Energy Efficiency Incentive Programme

Goals

- Support the introduction of fuel cell technology in the heating and electricity supply system for residential buildings

Scope

- Support is granted for the installation of fuel cell systems with a capacity of between 0.25 kWel and 5 kWel in residential buildings if the fuel cell is incorporated into the building's heating and power supply system. Both new buildings and energy retrofits in existing buildings are eligible for support. Support is provided in the form of a grant and can be combined with funding under the CHP Act.

Facts and figures

- A total of €150 million will be available annually in the period 2016–2018 for investment support measures under the Energy Efficiency Incentive Programme (heating package, ventilation package and fuel cells)

Hydrogen and Fuel Cell Technology Government Programme for the 2016–2026 funding period

Goals

- The goal is to bring products and applications based on hydrogen and fuel cell technology to the market.

Scope

- The focus is on continued technological advances to create competitive products. Planned investment on the part of industry is supported by public-sector funding.

Facts and figures

- Budget of around €1.4 billion for 2016 to 2026

Strategy for Automated and Connected Driving

Goals

- Create the framework and necessary prerequisites to roll out automated and connected driving systems in conjunction with smart traffic systems.

Scope

- Implement measures in the areas of infrastructure, law, innovation, interconnectivity, cyber security and data protection, and promote social dialog to unlock the potential of these technologies - better road safety and traffic efficiency, lower transport-related emissions, and strengthening of Germany's position as an innovative business hub.

As illustrated above, measures to promote innovation are in place in all the action areas mentioned.

Examples include

- Energy Efficiency Incentive Programme (see Chapter 4)
- "Energy-efficient Buildings 2050" funding initiative (see Chapter 5)
- "Solar Construction/Energy-efficient Cities" funding initiative (see Chapter 5)
- Electric mobility showcase (see Chapter 6)
- "PV battery storage systems" funding programme (see Chapter 8)

14 Investment, growth and jobs

Where do we stand?

2015 was another year in which billions were invested in the restructuring of the energy supply. This is particularly true of measures to improve the energy performance of buildings, to increase the amount of renewable energy, notably wind energy, and to expand the power grids.

What is new?

Investment requires predictability: The Acts adopted by the Bundestag in July 2016 (Renewable Energy Sources Act 2017, Electricity Market Act, Act on the Digitisation of the Energy Transition) and the amended incentive regulation create a stable economic and legal framework for investment within the context of the energy transition.

Investment **Growth** **Employment**	Retaining and creating jobs in Germany and laying the foundations for sustainable prosperity and quality of life.

14.1 Investment

Investment is key to greater competitiveness, long-term prosperity and a better quality of life. The Federal Government is taking a comprehensive approach to achieve this goal. In addition to implementing the Digital Agenda and the High-tech Strategy, reducing the bureaucratic burden and creating a more dynamic start-up environment, this also includes successfully moving ahead with a cost-effective energy transition. Economic and energy policies have a considerable bearing on the decisions of businesses and private households to invest, such as in building energy retrofits, renewable energy, power grids and better energy efficiency. A clear and stable framework increases investment and planning certainty. This framework was strengthened in July 2016 with the adoption of the Renewable Energy Sources Act 2017 (see Chapter 3), the Electricity Market Act (see Chapter 8) and the reform of the Incentive Regulation Ordinance (see Chapter 10). The Act on the Digitisation of the Energy Transition adopted in July 2016 paves the way for new business models in the field of digital technology (see Chapter 11). All the key measures of the National Action Plan on Energy Efficiency (NAPE) and the Immediate Action Programme have since been rolled out to promote more private investment in efficiency technology (see Chapter 4).

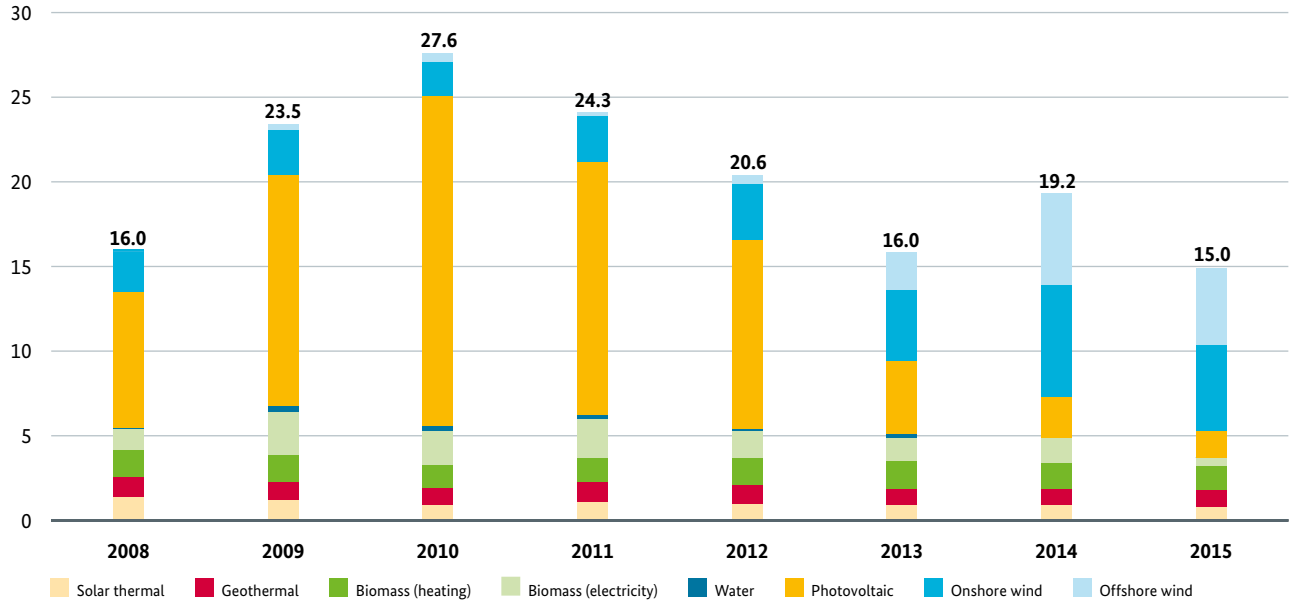
Investment in building energy retrofits has increased slightly on the previous year. In 2015, €36.4 billion were invested in the existing residential building stock, following investments of €35.7 billion in 2014. In addition, €16.8 billion were invested in the existing non-residential building stock, up from €16.1 billion in 2014 (German Institute for Economic Research 2015). Building energy retrofitting continues to be one of the main areas where measures to increase energy efficiency are concentrated. Advisory services and funding programmes support investment in this area (see Chapter 5).

The addition of renewable energy capacity requires less investment. In 2015, €15 billion were invested in the construction, and to a lesser extent in the expansion and upgrading, of facilities to use renewable energy. This represents a drop compared to the level of investment in 2014. At the same time, the expansion of renewables is pushing ahead. The installed renewable capacity in 2015 grew on the same scale as in the previous year (see Chapter 8). This could be interpreted as an indicator of the drop in costs per installed facility. Structural effects could also be a reason, i.e. more capacity added among lower-cost technologies. Investment is concentrated on the technologies of wind power and PV, which account for around 75% of total investment.

Investment in the power grids remains high. In particular, investment in the expansion of renewables triggers additional investment in the energy system. This also includes investment in the grid infrastructure. In 2015, TSOs and DSOs invested roughly €5.9 billion in the construction of new infrastructure and in grid reinforcement. In addition, grid operators also invested €3.3 billion in the maintenance and repair of the grid infrastructure (see Chapter 10).

Between €7.9 and €9.5 billion were invested annually in the conventional electricity supply system between 2008 and 2014. These figures do not include investments made in RES installations but do include prorated investments in

Diagram 14.1: Investment in renewable energy
In billion euros



Source: Federal Ministry for Economic Affairs and Energy based on data from the Centre for Solar Energy and Hydrogen Research, August 2016

the power grids. Together with the numbers already cited, they underline the importance of the energy sector for investment activity in Germany. After all, an energy system in an advanced economy like Germany requires constant new investment, replacement investment and expansion investment in generation capacities, system integration, grids, storage systems, demand side management and transport infrastructures.

14.2 Growth

Investments made as part of the energy transition have a positive impact on growth. Owing to the interdependencies of intermediate inputs, these investments have a knock-on effect, generating value add in many areas of the national economy. A recent study finds that GDP was around 0.3% higher in 2015 as a result of investment triggered by efficiency instruments than it would have been in a hypothetical reference scenario without these measures (Ecofys et al. 2016). A more in-depth analysis of the overall effects of the energy transition on growth is due to be provided in the next progress report.

Developments on the world energy markets continue to have a stronger impact on prices than the energy transition. Experts are of the opinion that, as a result of energy transition measures, inflation in Germany was slightly higher in 2015 than it would have been in the absence of the energy transition (GWS, Prognos, EWI 2014). This moderate impact on inflation was masked by the drop in prices for oil, gas and other fuels on the world markets. At the same time, wholesale electricity prices have continued to fall significantly. The expansion of renewable energy is one reason for this drop in prices (see Chapters 3 and 9).

Businesses in Germany lead the field in modern energy technologies and are consolidating their position. By making the energy transition a model for environmental and economic success, the chances are high that other countries will follow suit. This creates potential in Germany for additional value creation and employment. At the same time, capital goods to help restructure the energy supply system will be purchased from suppliers within and outside the country.

The energy transition makes Germany less dependent on imports of fossil fuels. This is because energy efficiency improvements dampen demand for energy overall (see Chapter 4), and renewable energy is increasingly replacing primary fossil fuels. In 2015, the electricity generation, transport and heating sectors saved a total of 539.1 billion kWh of fossil fuels through the use of renewable energy. Total fossil fuel savings have increased continuously in recent years. As fossil fuels are largely imported in Germany, these savings in fossil fuels drive down the cost of German energy imports. As a resource-poor country, Germany had to import 99.5% of its oil and 88.9% of its gas in 2015. Overall, primary fossil fuels valued at around €55 billion were imported and consumed in Germany in 2015.

The demand for imports of fossil fuels would have been higher in the absence of renewable energy and energy efficiency efforts. According to current scenario models (GWS, DLR, DIW 2016), the estimated dampening effect of renewables on the demand for imports of fossil fuels in 2015 is calculated at €8.8 billion net. In addition, savings are also made from the reduced consumption of energy as a result of efficiency measures, which are estimated at around €16 billion in 2015. Businesses and households are therefore saving considerable amounts in their heating and fuel bills, money which can be channelled into private consumption or higher business profits. The diversification of energy supply sources and commodity transport routes remains a foremost objective of the Federal Government.

14.3 Jobs

The expansion of renewables and investment in energy efficiency have an impact on employment due to increasing demand for associated goods and services. This boosts production in the economic sectors that supply these goods and creates jobs in this area. At the same time, this spills over to the upstream sector, triggering an additional indirect impact on job-creation. However, not all sectors benefit equally from this surge in demand.

The energy transition is a restructuring process: employment structures change and adapt. Employment incentives deriving from renewable energy and energy efficiency go hand in hand with structural changes, which also impact jobs in other areas of the energy industry and in the remaining sectors of the economy. At the same time, not all the employment effects observed in these sectors can be attributed to the energy transition. In addition, the integration of digital technologies into the energy system can give rise to new professions and jobs in the energy sector.

An estimated 117,000 people were employed in the conventional system of electricity supply in 2015, around the same level as the previous year. These official statistics primarily capture people who are directly employed in the conventional electricity supply system, with people working in the areas of electricity generation, transmission and distribution as well as electricity trading. It should be noted that other areas of the energy sector, such as gas and district heating supply, coal mining and production, the extraction of crude oil and natural gas, and petroleum refining make key contributions to employment which are not captured here, however.

The debate on the cost of the energy transition

Reports about the cost of the energy transition draw widespread public attention. It is not uncommon that a cost factor is mentioned that only describes the financial cost of one specific intervention measure of energy policy, such as the Renewable Energy Sources Act (EEG) and the EEG surcharge. This can give the public the impression that certain costs would never have been incurred if it were not for the energy transition.

It is undeniable that the energy transition requires investments to be made and cannot be had for free. In future, the priority will also be to implement the energy transition in a manner that is economically viable and cost-effective. Any assessment, however, requires a proper comparison of the costs. This must include the investments, and therefore costs, that would also be incurred without the transition of the energy system. This includes investments to upgrade the power grids or for the construction of new conventional power plants, for instance. At the same time, the traditional system of generating electricity from conventional sources pollutes our climate and the environment, and carries potential health risks that are not fully reflected in the market prices and costs but that are borne by society. The same is true for the residual risk from nuclear energy. These costs are gradually being scaled back with the energy transition and an energy supply system based on renewable energy and efficiency.

At this stage, renewables are an important economic factor, giving work to around 330,000 people in 2015. This translates to a drop of around 25,000 workers compared with 2014 (GWS, DLR, DIW 2016). In addition to energy generation, these calculations – which include the production of electricity, heat and biofuel – also factor in interdependent delivery and input chains, including public-sector workers (public-sector research, inter alia). Wind energy continued to be a key employer, giving jobs to a total of 143,000 people, the majority of which – approx. 122,000 – were employed in onshore wind operations. Employment in offshore wind increased slightly in 2015. The PV sector has been affected by market consolidation and the loss of jobs witnessed in this sector in the two previous years continued to a lesser extent in 2015. At the same time, there were indications that employment in this area was stabilising. A stable policy framework is essential to ensure that the level of employment and investment remains high in the coming years and can develop in a sustainable manner. The Federal Government will remain committed to this objective.

Investment in energy efficiency also has positive effects on the national economy. Model calculations by Ecofys, Fraunhofer (ISI), IREES, Oeko-Institute (2016) suggest that comprehensive measures to improve energy efficiency through to 2020 could give up to 190,000 people employment. In this context, the positive effect on employment is primarily felt in the construction industry. This is attributable to building energy retrofits and the construction of new energy-efficient buildings, among other factors. It can be assumed that the Initiative to Boost Energy Efficiency, which was launched by the Federal Government in May 2016, will provide additional incentive for investment in efficiency and thereby help create jobs.

15 Overview of measures

	Instrument	State of implementation
	Chapter 3: Renewable energy	
1.	Revision of the Renewable Energy Sources Act 2017 (EEG 2017)	As a result of the Renewable Energy Sources Act 2017, adopted on 8 July 2016, the rate of remuneration for renewable electricity will be set through an auction system, and will no longer be fixed by the state as was previously the case. Further renewable expansion will therefore be at competitive prices. Dovetailing between the expansion of renewables and grid expansion by temporarily limiting local onshore wind expansion in areas with high grid congestion.
2.	Renewable Energy Sources Act/Act to Revise the Renewable Energy Sources Act	A funding system designed in a way that respects state aid law, and better systematisation of the rules governing self supply. With vested rights adequately protected, existing self-supply installations will have to contribute partially to the EEG surcharge in the future if they undergo modernisation measures. Reporting obligations for self-supply which were previously regulated by both the Equalisation Mechanism Ordinance and the Renewable Energy Sources Act are now harmonised in the Renewable Energy Sources Act 2017.
3.	2015 Revision of the Market Incentive Programme	Promotion of the installation of solar thermal collectors, biomass heating systems or heat pumps for private citizens, freelance professionals and businesses based (1) on grants from the Federal Office for Economic Affairs and Export Control (BAFA) for smaller installations in private households and business enterprises or (2) on low-interest loans and repayment grants from the Kreditanstalt für Wiederaufbau (KfW) for large, commercial installations. The revision came into force on 1 April 2015 with a funding budget of €300 million per year.
4.	EU Directive on biofuels and indirect land-use change	To prevent indirect land-use change, Directive 2015/1513/EC introduced a cap on the contribution of conventional biofuels produced from food crops, which must now be transposed into national law in the Member States.
5.	"Renewable Energy Storage" KfW funding programme	See Chapter 13
6.	Renewable Energy Export Initiative	See Chapter 12
	Chapter 4: Energy consumption and energy efficiency	
7.	National Action Plan on Energy Efficiency (NAPE)	With the National Action Plan on Energy Efficiency (NAPE), the Federal Government launched a raft of measures in 2014, which – in addition to existing instruments – promote energy efficiency in central areas such as buildings and production. NAPE defines immediate actions and farther-reaching work processes in order to meet the national efficiency and climate goals. The most important action areas are to: step up energy efficiency in the buildings sector, establish energy efficiency as a business model and a model for generating returns on investment, and increase personal responsibility for energy efficiency. For these action areas, the NAPE defines cross-cutting measures designed to reduce energy consumption on the demand side.
8.	Green Paper on Energy Efficiency by the Federal Ministry for Economic Affairs and Energy	Development of a medium- to long-term strategy by the Federal Ministry for Economic Affairs and Energy to reduce energy consumption. Formulation of key questions and hypotheses and launch of a process of consultation with all the stakeholders concerned, following by an appraisal by the Federal Ministry for Economic Affairs and Energy.
9.	Energy Efficiency Incentive Programme (alternative to tax-based promotion of energy retrofits)	See Chapter 6
10.	Continued development of the Market Incentive Programme for renewables in the heating market	See Chapter 3
11.	Updated CO_2 Building Modernisation Programme (KfW funding programmes for energy-efficient construction and retrofitting)	Support particularly encompasses new building construction and building energy-retrofits to meet the KfW energy efficiency standards. Support is provided in the form of grants or low-interest loans combined with repayment subsidies. The funding budget is up to €2 billion per year in 2015 and 2016. In 2015 and 2016 the programme was updated as follows: 1) Promotion of new building construction and the modernisation of commercial buildings. 2) Raising of the maximum credit amount and the "assessment basis" for grants towards KfW energy-efficient buildings from €75,000 per residential unit to €100,000; introduction of repayment subsidies for individual energy measures and increase of the building stock eligible for funding from year of construction up to 1995 to year of construction up to 2002. 3) Promotion of the new construction of municipal buildings. 4) Introduction of a new "Energy-efficient Building 40 Plus" standard for funding in the residential housing sector and a 20-year period of fixed interest in the "Energy-efficient Construction" programme for building energy efficiency levels EH 40 and 55.
12.	National Efficiency Label for old heating systems	From January 1 2016 onwards, the new efficiency label applies for boilers that are more than 15 years old. The aim is to label approximately 13 million boilers in the next 8 years. The measure seeks to increase the annual replacement rate by approx. 20% to 3.7%.

	Instrument	State of implementation
13.	Promotion of heating optimisation using high-efficiency pumps and hydraulic balancing	The funding programme seeks to support the replacement of up to 2 million pumps in buildings and the additional optimisation of up to 200,000 heating systems per year by 2020, with the aim of cutting around 1.8 million tonnes of CO_2 by 2020. The programme commenced in August 2016 and funding of around €100 million is available.
14.	Updated "Production Facilities and Processes" KfW efficiency programme	The level of funding is aligned with the amount of energy savings achieved. In addition, collaboration with institutions that provide financial support at *Land* level is being expanded and the measure is being openly advertised. 257 loan approvals with a total value of roughly €970 million were granted in 2015. In the first quarter of 2016, 136 loan approvals had been granted with a total value of around €400 million.
15.	Introduction of mandatory energy audits for non-SMEs/large corporations (implementation of Article 8 of the Energy Efficiency Directive)	Article 8 of the Energy Services Act requires large businesses (non-SMEs) to perform energy audits by 5 December 2015, and every four years thereinafter, or alternatively introduce an energy management system to ISO 50001 or an environmental management system to EMAS by 31 December 2016. Since January 2016, the Federal Office for Economic Affairs and Export Control has been conducting spot checks to check compliance with this requirement. The Act is a key step towards implementing the EU Energy Efficiency Directive (Article 8 (4) EED)).
16.	Programme to Promote High-efficiency Cross-cutting Technologies	New groups qualify for support so now big companies with over 500 workers can also qualify for funding. The programme commenced in May 2016. In the past three years, roughly 35,000 small and medium-sized enterprises received support of around €189 million to invest in energy-efficient cross-cutting technologies.
17.	Waste Heat Prevention Campaign	The programme was launched in May 2016. The "SME energy advice" programme of the Federal Office for Economic Affairs and Export Control was continued and extended from January 2015. Consulting services also with regard to the utilisation of waste heat; up to 80% of the costs are eligible for funding. A new programme to promote the prevention and utilisation of waste heat in commercial enterprises entered into force in May 2016.
18.	Programme to Promote Energy-efficient and Climate-smart Production Processes	Support is given to measures to improve energy efficiency in commercial and industrial production processes. With support granted to around 60 projects and an anticipated investment budget of €7 million, around 180,000 tonnes of CO_2 have been avoided annually so far, which translates to primary energy savings of 2.54 PJ per year.
19.	Competitive tendering scheme for electrical energy efficiency measures (STEP up!)	Open to all technologies and sectors, the STEP up! programme that started on 1 June 2016 promotes electricity savings within the framework of a competitive auction system.
20.	Promotion of energy savings contracting	Since the start of 2015, the Federal Government has supported advisory services for municipalities and SMEs with a focus on the development of energy savings contracting projects and associated bid invitation processes. 24 of the 26 applications made received approval, with 18 applications for orientation advice, 5 for implementation advice and 1 for advice regarding bid invitations.
21.	Contracting default guarantee	The measure, which commenced in 2016, promotes the removal of barriers facing small and medium-sized businesses in industry and freelance professionals when it comes to the financing of energy savings contracting. The maximum guarantee amount of €2 million can be tapped with projects that achieve energy savings of at least 25% compared to the status quo.
22.	Refinement of the SME Energy Transition and Climate Action Initiative	Notice of the first allocation decisions was served at the end of 2015, and the kick-off event was held in April 2016. Funding for this measure amounts to €2 million in total through to 2018. So far, over 16,000 contacts with businesses have been established, 60 model businesses identified and some 300 energy scouts trained.
23.	Further development of SME energy advice	Funding guideline entered into force on January 1 2015.
24.	Energy Management Systems funding programme	A total of 610 applications for funding were submitted between July 2013 and May 2016.
25.	Energy Savings Meter pilot programme	See Chapter 11
26.	Review of the efficiency requirement in the Federal Pollution Control Act	The Federal Government is examining the extent to which the economical and efficient use of energy in the Federal Pollution Control Act can be further clarified as an operator obligation.
27.	Energy Efficiency Networks Initiative	The aim is to set up around 500 networks with 8-15 businesses between 2014 and 2020. By setting energy savings goals and implementing suitable measures, the aim of these voluntary alliances is to improve the energy efficiency of the participating businesses. To this end, an agreement was signed with 18 business associations and organisations in December 2014. Three more associations have since joined the alliance for action. Practical guidelines were published in June 2015 and the administrative office for the initiative commenced work in January 2016. A monitoring process to identify the measures implemented as part of the initiative and the savings achieved will be carried out for the first time in 2017.
28.	Revision of the EU Energy Label Directive	To ensure the EU energy efficiency labelling system – also known as the EU energy label – also remains effective in the future, the EU Energy Label Directive will be revised. The Commission presented a draft regulation to this end in July 2015. The plan is to complete trialogue negotiations between the European Council and Parliament by the end of 2016. Regular workshops with the relevant stakeholders have been held within a dialog process framework to prepare Germany's position and to support ongoing negotiations.

	Instrument	State of implementation
29.	Support for market monitoring	This projects aims to improve the effectiveness of the EU label by refining testing methods and by increasing the number of product tests performed to further reduce the possibility of fraud.
30.	National Top Runner Initiative (NTRI)	Bundle of measures to accelerate the market penetration of top-quality services and products that help reduce energy consumption. The NTRI seeks to strengthen and expand motivation for the electrical efficiency and energy efficiency of products across all sectors. The measure commenced on 1 January 2016.
31.	Promotion of energy efficiency managers to unlock potential, e.g. in business parks for example	Integrated into the “Energy-related urban renewal” KfW programme; entered into force in autumn 2015.
32.	Energy Efficiency Export Initiative	The Initiative of the Federal Ministry for Economic Affairs and Energy supports German technology and solution providers to tap into foreign markets. The portfolio of services includes the provision of market information, introduction to contacts to initiate business deals and measures to support marketing efforts abroad.
33.	Energy Efficiency Platform	In 2015, the work of the Energy Efficiency Platform was concentrated in the following working groups: “Innovative financing instruments”, “Legal framework/energy services”, “Advice and information”, “Competitive auction systems” and “System issues”.
34.	Development of KPIs and benchmarks in the commercial sector and for households	Support is given to R&D projects focussing on the development of comparative KPIs, standards and benchmarks for households, the trade, commerce and services sector, and industry. Data collection and R&D notices are planned for 2016.
35.	Development of ICT electricity needs in Germany	A study conducted in 2015 forecast trends in consumption and identified savings potential for the various subsectors of ICT. On the basis of this information, measures to unlock the identified potential are developed in a stakeholder process.
36.	Federal programme of the Federal Ministry of Food and Agriculture to improve energy efficiency in the agricultural sector.	Advisors approved by the Federal Office for Agriculture and Food are to develop energy savings strategies for single farms. The programme is planned to start in 2016.
37.	Relaunch of the Federal Programme to Promote Energy Efficiency in Agriculture and Horticulture	Programme that ran from 2009–2012 is reintroduced for the period 2016–2018 to support SMEs in the modernisation and construction of new low-energy buildings for plant and vegetable production.
38.	Energy Campaign of the German Hotel and Catering Association (DEHOGA)	Successful Energy and Climate Action Campaign of the German Hotel and Catering Association (DEHOGA) with numerous specific tips for saving energy, tools for assessing investment and economic viability, energy-saving fact sheets, close collaboration with qualified energy advisers, energy discussion groups and hotel energy efficiency networks, and participation in an environmental check for the hotel and catering industry. In addition, a “virtual” hotel in the form of a 3D animation that provides interactive information about modern building services engineering and relevant user behaviour, as well as an electronic trading platform for regional products in close collaboration with existing regional initiatives.
39.	“Germany Makes it Efficient” mobilisation and awareness-raising campaign.	Launched successfully in May 2016; website: www.machts-effizient.de
	Chapter 5: Buildings	
40.	Efficiency Strategy for Buildings	The Efficiency Strategy for Buildings is the strategy paper for the energy transition in the buildings sector and addresses both technical and energy aspects, as well as first approaches for economic and social interests in this area. Issues related to interaction with other sectors, such as the interaction between electricity and heat, are also considered as a cross-sectoral task. The Federal Cabinet adopted the Efficiency Strategy for Buildings in November 2015, and initial measures were already implemented in 2016.
41.	Tenancy law	The Federal Government is examining rules concerning rent increases following building modernisation measures, including the hardship clause. This seeks to protect tenants from being overburdened financially. In this context, it is important to ensure that – from a climate and energy policy perspective – incentives remain in place to encourage building energy retrofits.
42.	Customised renovation roadmaps for buildings	Development of standardised, building-specific renovation roadmaps for residential buildings, allowing building owners to implement the optimum solutions, from a technical and financial perspective, for the gradual modernisation of their buildings. A bid invitation for scientific accompanying research was held to this end. The development of the methodology, design concept and guides for the energy consultants is completed and is being incorporated into the energy adviser software. Work is currently underway on a print application. Following field tests on the software-supported implementation modules at the end of 2016, the instrument has been ready for operation since the start of 2017 and is implemented in onsite consultation sessions.
43.	Energy-efficient Buildings 2050 – Innovative Projects for a Virtually Climate-Neutral Building Stock in 2050 funding initiative	The initiative aims to transfer the results of research into the building shell, building services engineering, and the use of renewables with a view to widespread implementation.

	Instrument	State of implementation
44.	Guidelines on the promotion of onsite energy consulting services in residential buildings – onsite consulting	Amendment of BAFA onsite consulting (BAFA: Federal Office for Economic Affairs and Export Control) to improve support conditions, include home owners' associations, and consider in future the renovation roadmaps that are to be developed. Entered into force on 1 March 2015. Evaluation is planned for 2017.
45.	Energy advice for municipalities and non-profit organisations	The aim is to provide energy advice for energy retrofitting or for the construction of non-residential buildings by municipalities and non-profit organisations. In this context, energy advice makes a key contribution to increasing willingness to invest in, and acceptance of, modernisation measures in the buildings of municipal and non-profit organisations. Around 300 applications have been submitted since the measure was rolled out by the Federal Office for Economic Affairs and Export Control on 1 January 2016
46.	Energy Efficiency Incentive Programme (alternative to tax-based promotion of energy retrofits)	The programme was launched in January 2016 and integrated into the established programme structure of the CO_2 Building Modernisation Programme and the Market Incentive Programme: 1) Annual programme budget of €165 million through to 2018 inclusive. 2) Alternative to the tax-based system of promoting building energy retrofits which was not implemented. 3) Grants towards new fuel cell heating technology. 4) Grant for the installation of ventilation systems in conjunction with measures on the building shell to avoid the formation of mould and mildew, inter alia: ventilation package. 5) Grant for particularly efficient heating systems: heating package. The grant programmes started in January (heating and ventilation package) and August (fuel cell) 2016.
47.	Promotion of Heating Optimisation using High-efficiency Pumps and Hydraulic Balancing	See Chapter 4
48.	Updated CO_2 Building Modernisation Programme – KfW-funding	See Chapter 4
49.	Market Incentive Programme for the promotion of renewables in the heating market	See Chapters 3 and 11
50.	Energy advice for municipalities and support for municipal energy efficiency networks	The "Energy Efficiency Networks and Energy Advice for Municipalities and Non-profit Organisations" policy was rolled out in January 2016 by the Federal Office for Economic Affairs and Export Control.
51.	Standardisation including the development of system components for structural engineering and systems engineering	Expert report on the standardisation of systems for structural engineering and systems engineering. The report was completed in 2016, and the results will be incorporated into the development of measures for industrial modernisation.
52.	Solar Construction/Energy-efficient Cities funding initiative	Under the joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research concerning new technologies and strategies for better energy efficiency and the integration of renewables, up to €150 million in project funding will be available from 2017 onwards to move the energy transition forward in buildings and in urban areas.
53.	Energy Transition Platform for Buildings	The Energy Transition Platform for Buildings was set up in 2014, and is the permanent platform for dialog on the energy transition in the buildings sector. Given the ambitious goals in the building sector, the potential, challenges and measures are discussed with stakeholders from the property sector, business, industry, consumer representatives and the public sector in both the plenary session and in working groups.
	Chapter 6: Transport	
54.	Continued development of the 2013 Mobility and Fuels Strategy	The Mobility and Fuels Strategy is continued as an important vehicle for implementing the energy transition in the transport sector. One module is the dense network of fast charging stations for electric vehicles which the Federal Ministry of Transport and Digital Infrastructure plans to set up at the roughly 430 service stations on the federal motorways. Work is currently underway on installing fast charge points at the roughly 400 service stations run by Autobahn Tank & Rast GmbH, and talks have commenced with the remaining licensed companies. As part of the continued development of the Mobility and Fuels Strategy, pilot projects and market ramp-up programmes will be launched to demonstrate what is technically possible.
55.	New procedure for the type approval and market monitoring of vehicles	By introducing a new framework for type approval, the aim is to strengthen independent tests, market monitoring and the implementation of requirements in Europe. The goal is to have an EU regulation to harmonise and tighten the approval procedure and market monitoring of motor vehicles and their trailers as well as other vehicle components.
56.	New World Harmonised Light Vehicle Test Procedure (WLTP)	The aim is to make available more representative and reproducible values for CO_2 emissions and fuel consumption so that the vehicle fuel consumption rates in the test scenario once again correlate more with real-life, on-the-road values. The emission standards and consumption standards for passenger cars and light vehicles are defined for the post-2020 period on the basis of this new procedure, wherein the stricter requirements of this procedure must be taken into account. Once the relevant EU Directive is amended, the new test cycle will also be incorporated into the passenger car energy consumption labelling system (car label).
57.	Reform of EU Regulations to reduce CO_2 emissions in new passenger cars and light vehicles	The goal is to set CO_2 fleet targets for the post-2020 period. The amendment to the EU Regulation on CO_2 emissions for passenger cars and light vehicles is expected in the first quarter of 2017.

	Instrument	State of implementation
58.	Strategy for Automated and Connected Driving – Remain a lead provider, become a lead market, introduce regular operations	With the Strategy for Automated and Connected Driving, the Federal Government has adopted guidelines to exploit the opportunities for growth and prosperity presented by the mobility system of the future. Mobility of the future is safe, efficient and clean. Implementation will focus on the activities identified in the strategy in the areas of infrastructure, law, innovation, interconnectivity, cyber security and data protection. Social dialog is also important in the implementation of the strategy. The gradual optimisation of the flow of traffic and the growing market penetration of technologies for automated and connected driving will not only make traffic safer but will also reduce emissions deriving from the mobility sector.
59.	Passenger car label	The aim is to reduce the fuel consumption and emissions of passenger cars. Since 2011, new cars have had a passenger car label that indicates the energy efficiency of the vehicle, with green standing for energy-efficient. In addition, it also provides clear information on the fuel consumption, fuel costs and CO_2 emissions of the vehicle.
60.	Programmes to promote energy-efficient light vehicles	The aim is to support the market roll-out and market penetration of energy-efficient and/or low-carbon light vehicles with a fixed-term funding programme. According to the draft funding guideline, the aim is to promote the purchase of trucks and tractor units with compressed natural gas (CNG), liquefied natural gas (LNG), hybrid, plug-in hybrid or electric drives that are designed for road haulage services and whose permitted total weight is at least 7.5 tonnes. The plan is to launch the programme in 2017 with a budget of €10 million. The programme is expected to run for 3 to 4 years.
61.	Electric Mobility Market Incentive Package	The aim is to force the pace on the expansion of electric mobility and the charging infrastructure. A premium of €4,000 is paid for purchases of new vehicles (all-electric vehicles) and of €3,000 for plug-in hybrids, which is equally financed by the Federal Government and the automotive industry. Funding will be provided by the Federal Government until the federal funds of €600 million, which have been set aside for this measure, are fully exhausted, and up to 2019 at the latest. The Federal Government is making €300 million available for the 2017–2020 period to improve the EV charging infrastructure. Adopted in May 2016. Car buyers have been able to submit their applications to the Federal Office for Economic Affairs and Export Control since 2 July. Number of applications in September 2016: roughly 3,000. To ensure that electric vehicles have a wider range, work has commenced on installing fast charging stations at the roughly 430 service stations on the federal motorways since autumn 2016.
62.	2015 Electric Mobility Act	The Electric Mobility Act and the new regulations based thereon – 50th Ordinance to amend road traffic regulations and accompanying administrative provisions – give cities, towns and municipalities the legal framework to grant privileged status to electric cars. Local incentive measures can include the provision of free parking spaces or the exemption of electric vehicles from access restrictions. The opening of bus lanes or special lanes to electric vehicles is also a possibility. By making an exception in driving licence legislation for electric-drive category N2 vehicles, battery-powered vehicles with a maximum total weight of up to 4.25 tonnes can be driven with a Class B driver's licence (passenger car licence).
63.	2011 Government Programme on Electric Mobility	The aim is to support the market uptake of electric-drive vehicles. Many measures from this programme have already been implemented.
64.	Electric Mobility Procurement Initiative	The share of all new vehicle purchases or hires with a vehicle emissions rating of less than 50 g (alternatively: minimum electrical range of 40 km) is to be increased beyond the already agreed share of 10% to at least 20% in the future.
65.	Tax regulations concerning the use of electric vehicles for private purposes	The Act on Tax Incentives to Promote Electric Mobility in Road Transport of 7 November 2016 was announced in the Federal Law Gazette on 16 November 2016 and entered into force on 17 November 2016. Under the Income Tax Act, employees who charge an electric or hybrid electric vehicle at their employer's place of business or at an affiliated business and who use in-company charging facilities temporarily for private purposes can treat this as a tax-free benefit in their income tax returns (Section 3, number 46 of the Income Tax Act). Employers can also apply a 25% flat income tax rate for non-cash benefits deriving from the free or reduced-rate provision of charging facilities and for grants towards employee expenses for the purchase and use of a charging facility (Section 40 (2), sentence 1, number 6 of the Income Tax Act). The new regulations apply from 1 January 2017 through to 31 December 2020.
66.	National Innovation Programme for Hydrogen and Fuel Cell Technology	The programme is to be continued from 2016–2026 within the framework of a follow-up programme. Funding of €161 million was made available for this purpose in the 2015 supplementary budget (2016: €25 million, 2017: €50 million, 2018: €86 million).
67.	"Renewable and Mobile" funding programme – field trial with trolley trucks	Based on a vehicle development project and test routes that have already been funded, the Federal Government is preparing for field trials under real conditions. As part of the funding announcement of October 23, 2015, the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety called for the submission of outline proposals for the field trial announced in the NAPE and the 2020 Climate Action Programme. Three project proposals were submitted, two of which can be considered for funding.
68.	Electric mobility funding guideline	The aim is to promote application-oriented R&D measures and the procurement of electric vehicles (drives, value chain optimisation, information and communication technology) across all modes of transport.
69.	Motor vehicle tax	With the Second Act to Amend Transport Tax of June 2015, the exemption from motor vehicle tax for all-electric passenger cars registered for the first time by 31 December 2015 is extended from five to ten years and now includes all categories of all-electric vehicles. A five-year tax exemption applied from 1 January 2016 to 31 December 2020 for such vehicles registered for the first time. This tax exemption period was extended to 10 years with the Act to Promote Electric Mobility in Road Traffic through Tax Incentives. Motor vehicles which have been converted to all-electric drives also receive preferential treatment, see No. 65.

	Instrument	State of implementation
70.	Round Table on Gas-based Mobility	Two sessions of the Round Table have been held, accompanied by eight meetings of the working groups. Inter alia, eight large-scale focal regions in Germany were identified where the battery of measures developed are designed to move gas-based mobility forward, both with regard to the supply of vehicles and with regard to customers and users of mobility services. Three additional meetings of the working groups will be held in December 2016, with the final session planned for January 2017.
71.	Taskforce on LNG in heavy-duty vehicles	Founded at the initiative of the Federal Ministry of Transport and Digital Infrastructure in November 2015, the goal of the taskforce on LNG in heavy-duty vehicles is to accelerate the market entry of LNG in heavy-duty freight transport. The purpose of the platform is to coordinate actors on both the demand and the supply side to resolve the "chicken and egg dilemma" of sufficient demand for LNG and appropriate supply of LNG at filling stations.
72.	Charging Infrastructure Ordinance I and II	The aim is to establish uniform standards for the EV charging infrastructure. I: Decision of October 2015 contains charger plug standards and minimum requirements for the development and operation of public-access charging points for electric vehicles. II: Aims to standardise authentication and payment at charging stations.
73.	2014 EU Directive on the Deployment of Alternative Fuels Infrastructure	The aim of the EU Directive is the pan-European deployment of an appropriate interoperable refilling and charging infrastructure for the different alternative fuels. Member States are required to submit National Policy Frameworks by 18 November 2016 that describe the baseline situation, define goals to ramp-up the infrastructure and underpin these goals with specific measures. The European Commission will submit a report on the assessment of the National Policy Frameworks and their cohesion at Union level to the European Parliament and the European Council by 18 November 2017. Each Member State will submit a report on the implementation of their individual National Policy Framework to the European Commission by 18 November 2019 and every three years thereinafter.
74.	Funding guidelines for "Electric Vehicle Charging Infrastructure in Germany"	The aim is the development of a nationwide charging infrastructure with 15,000 charging stations across the country. A total of €300 million will be mobilised for the funding programme which runs from 2017 to 2020.
75.	Hydrogen infrastructure development (H2 Mobility project)	The aim is to develop 400 hydrogen filling stations in Germany by 2025 (in accordance with the National Policy Framework as part of the implementation of the EU Directive on the Deployment of Alternative Fuels Infrastructure (AFID)). The first 100 filling stations will be built irrespective of vehicle uptake, while further expansion thereafter will be based on the number of vehicles on German roads. The first 50 hydrogen filling stations are part-funded by the Federal Government.
76.	National Policy Framework for the deployment of alternative fuels infrastructure	The National Policy Framework adopted by the Federal Cabinet comprises the charging infrastructure for electric vehicles, the infrastructure for the supply of natural gas (CNG and LNG) and the infrastructure for the supply of hydrogen to vehicles powered by fuel cells. It forms part of the implementation of EU Directive 2014/94/EC. The National Policy Framework sets goals for publicly accessible refilling and charging infrastructures and underpins these goals with specific measures, which must be implemented by the Federal Government (in conjunction with industry where applicable) in order to reach the goals. The National Policy Framework is a "learning strategy" and will be reviewed regularly and adapted where necessary throughout the course of the implementation of the EU Directive. The Federal Ministry of Transport and Digital Infrastructure will set up an ongoing monitoring procedure to this end. Under the provisions of the EU Directive, a report on the state of infrastructure development must be submitted to the European Commission after three years. The Federal Government communicated the National Policy Framework to the European Commission in November.
77.	Promotion of intermodal transport through the expansion and new construction of transhipment terminals	The Federal Government promotes intermodal transport by providing grants towards the cost of constructing transhipment terminals. For Deutsche Bahn terminals, this is done through the Act on the Expansion of Federal Railways, and through a funding guideline of the Federal Ministry of Transport and Digital Infrastructure for private terminals. The aim of efforts to promote intermodal transport is to transfer freight transport in standardised loading units from road to rail and waterways. The funding guideline for private intermodal transhipment terminals provides support for up to 80% of eligible costs for the upgrading and construction of terminals. Following a decision by the Federal Cabinet, a spending review of the programme of financial assistance to private undertakings was conducted in 2015/2016. Within this context, it was agreed to relax rules surrounding guarantees for repayment obligations to the Federal Government. The Federal Ministry of Transport and Digital Infrastructure updated the funding guideline and submitted it to the European Commission for approval. Subject to approval, the new guideline will apply from January 1, 2017.
78.	2020 National Cycling Plan	The promotion of bicycle transport is a common objective of the Federal Government, the *Länder* and municipalities. Federal funding for non-investment innovative projects amounted to €3.2 million in 2016. Further to this, cycle paths also received €98 million in funding by way of federal trunk roads. An additional €1.2 million were also provided for the improvement of paths along federal waterways. Equal amounts are set out in the 2017 budget. In addition, around €1.3 billion are provided each year from the federal budget for the improvement of municipal transport conditions, inter alia (known as "unbundling funds"). This level of funding will continue through to 2019 and the funds can also go towards the development of the cycling infrastructure.
79.	Initiative for Digital Connectivity in Public Passenger Transport	The Initiative started in early 2015. At its core is a dialog and stakeholder process with representatives of the *Länder*, transport authorities, municipalities, transport companies and associations, industry and consumer associations. Together, relevant actors and decision-makers developed a roadmap outlining areas where there is a need for action, as well as the necessary steps and responsibilities, which was adopted in June 2016. The Federal Ministry of Transport and Digital Infrastructure makes a financial contribution towards the implementation of the roadmap. A total of €16 million are available in the Future Investment Programme in the years 2016 through 2018.

	Instrument	State of implementation
80.	Federal Transport Infrastructure Plan	Goals: Maintenance and replacement ahead of expansion and construction, elimination of congestion on main routes, strengthening of the more climate-friendly modes of transport. Scope/status: The 2030 Federal Transport Infrastructure Plan was adopted in the Cabinet in August 2016. The infrastructure expansion legislation adopted by the Bundestag forms the basis for the financing and realisation of infrastructure expansion and construction projects. Facts and figures: Over €270 billion in total are earmarked for maintenance and replacement measures and for road, rail and waterway infrastructure expansion and construction projects.
81.	Promotion of hydrogen-based mobility in rail transport as part of the NIP	The world's first-ever hydrogen-powered train was unveiled in September 2016. In the state of Lower Saxony, 14 hydrogen trains are to be introduced on non-electrified routes between 2018 and 2020, thereby replacing diesel locomotives. A total of 50 trains are to be rolled out in the passenger transport sector by 2021. In this way, the aim is to take advantage of the synergies from the development of hydrogen-based on-road mobility, particularly with regard to the production, transportation and provision of the fuel.
82.	Further development of the HGV toll/adaptation of the European Infrastructure Costs Directive	The HGV toll system is to be developed further to make freight transport more climate-friendly. The aim is to scale the HGV toll depending on the energy consumption of the vehicles in a manner that is revenue neutral. This will first require an amendment to European Infrastructure Costs Directive 1999/62/EC at the EU level which defines the legal framework for Member States to levy tolls. Directive 1999/62/EC currently does not contain any provisions for a toll scale based on vehicle energy efficiency categories.
83.	Strengthening of rail freight transport	The aim is to intensify the expansion of rail transport. To this end, far higher investment in the expansion of the rail infrastructure will be facilitated between 2016 and 2018 with funds from the Future Investment Programme. Besides the implementation of projects under the requirements plan, the measures of the Second Immediate Action Programme for Seaport Hinterland Transport, which are designed to increase capacity, will be implemented starting in 2015 and through to 2020. The financing agreement for a first tranche of the Second Immediate Action Programme for Seaport Hinterland Transport has been concluded, while measures for a second tranche are currently being reviewed. Negotiations are currently underway regarding the financing arrangements for the electrification of transport routes. Rail freight transport is also strengthened through federal support for private intermodal transhipment terminals (cf. No. 77) and for private sidings. Irrespective of whether freight is transported in standardised loading units, the Regulation for the Construction and Expansion of Private Sidings helps to shift freight traffic from road to rail and also to reduce emissions. Under the provisions of the Regulation, grants towards the cost of construction are given to private undertakings for up to 50% of eligible costs. The Federal Government has revised the Regulation and submitted it to the European Commission for approval. Subject to approval, the new Regulation should enter into force at the earliest possible date.
84.	Strengthening waterways as a mode of transport	The Regulation on Contributions to Waterway Transport Enterprises for the Sustainable Modernisation of Inland Waterway Vessels of 21 July 2015 replaces the funding guideline for lower-emission engines. The federal funding guideline for private transhipment facilities also applies to facilities to transfer to waterways.
85.	Strengthening of regional economic cycles	Preparations are underway for the allocation of a preliminary Federal Government study on regional economic cycles. The aim of the study is to provide a preparatory analysis that will be the basis for the creation of guidelines for local authorities.
86.	Strengthening of local public passenger transport	The Federal Government and the *Länder* have agreed to increase state subsidies for local and regional passenger services (regionalisation funds) to €8.2 in 2016 and increase this amount by 1.8% annually in the following years. In addition, the Federal Government and the *Länder* have agreed to continue the financial assistance based on the federal programme under the Local Authority Transport Infrastructure Financing Act beyond 2019 without any cuts in funding. The *Länder* are to receive compensation for the discontinuation of unbundling funding within the framework of general payments from VAT tax revenue.
87.	Strengthening of the cycling and pedestrian infrastructure	Further development of the cycling infrastructure and linking the bicycle transport system to other modes of transport via investment, non-investment and communication measures. Improvement of framework conditions. Current invitation for projects under the National Cycling Plan for the 2016 funding year with a focus on electric mobility as well as cycling and space.
	Chapter 7: Greenhouse gas emissions	
88.	2020 Climate Action Programme	The Federal Government adopted the 2020 Climate Action Programme in December 2014. Comprising over 100 individual measures, this Climate Action Programme seeks to close the climate change mitigation gap, which was previously identified, and achieve the climate goal set for 2020, i.e. reduce greenhouse gas emissions in Germany by at least 40% from 1990 levels.
89.	2050 Climate Action Plan	The Federal Government adopted the 2050 Climate Action Plan in November 2016. It describes fundamental principles and provides orientation for delivery on the global goals set out in the Paris Agreement. For the first time, it defines target corridors for emissions reduction in individual sectors by 2030. These will undergo a comprehensive impact assessment and then be discussed with the social partners. If necessary, adjustments can be made to the sectoral targets in 2018.
90.	"Nature Conservation and the Energy Transition" centre of expertise	Headquartered in Berlin, the Nature Conservation and the Energy Transition centre of expertise commenced operations on 1 July 2016.

	Instrument	State of implementation
	Chapter 8: Power plants and security of supply	
91.	Electricity Market Act	The Electricity Market Act was adopted by the Cabinet in November 2015, and the legislative procedures were completed in July 2016. The aim is the continued development of the electricity market into an electricity market 2.0, specifically: 1) Strengthening of existing market mechanisms, 2) Removal of barriers to access for providers of demand side management measures, 3) More efficient grid planning, 4) Increased monitoring of security of supply, 5) More transparency in the electricity market, 6) Introduction of a capacity reserve established separately from the electricity market and 7) Creation of a security standby reserve.
92.	Amended Combined Heat and Power Act (December 2015)	Targeted support of particularly low-carbon generation using gas-fired CHP and flexibilisation of CHP plants; new CHP support system approved by the European Commission in October 2016. Financial support volume doubled to €1.5 billion per year.
93.	Draft Act on the Redistribution of Responsibility for Nuclear Waste Management	The aim is to guarantee the financing of the decommissioning and dismantling of nuclear power plants and the disposal of radioactive waste. Operators of nuclear plants will continue to be responsible for the management and reserve-backed financing of plant decommissioning and dismantling. The Federal Government will be responsible for interim and final storage in the future, with the help of a company-financed fund. To this end, nuclear power-plant operators will transfer €17.389 billion to a fund established under public law. In addition, they can opt to pay an additional risk surcharge of 35.47%, which will transfer any subsequent liability for cost and interest-related risks completely to the state.
94.	Commission for the storage of high-level radioactive waste (Final Repository Commission)	The Commission presented its final report on 5 July 2016. In the search for a final repository, it is in favour of a multi-stage, transparent and science-based process, which is open as to the outcome, and defines selection criteria to identify the best possible site for the final repository.
95.	Establishment of a central market master data register	Starting in 2017, the central market master data register will merge the master data of all the plants in grid-bound energy supply in Germany's electricity and gas market, and the master data of market stakeholders, to create a single online database.
96.	Monitoring of security of supply in Europe	The aim is to improve the system of monitoring the security of supply and consider supply security from a multi-country perspective. Furthermore, in addition to conventional and renewable generation units, regulators should also take flexibility options, such as demand side management, into consideration in the future. The process launched by the Federal Ministry for Economic Affairs and Energy builds on the work of the regional "Pentalateral Energy Forum". The study into "Security of supply in Germany and its neighbours" has been published and contains proposals regarding a transnational approach to monitoring and assessment. Declaration of the Pentalateral Energy Forum (Germany, Austria, the Netherlands, Belgium, Luxembourg, France, Switzerland) on cross-border collaboration regarding security of supply issues and monitoring in June 2015.
97.	Electricity Market Platform	The Electricity Market Platform provides a forum to discuss current issues regarding the continued development of the electricity market 2.0 with relevant stakeholders. The platform plenum has met on multiple occasions since July 2014, most recently on 20 September 2016 together with the Energy Grids Platform.
98.	Programme to promote PV battery storage systems	The aim is to strengthen measures to serve the system and deliver more cost reduction in storage technologies. The programme supports investment in battery storage units that are installed in connection with a PV installation and connected to the electricity grid. Funding amounts to €30 million for the period 2016 to 2018.
	Chapter 9: Affordable energy and a level playing field	
99.	Renewable Energy Sources Act 2017	See Chapter 3
100.	Ordinance on the Transparent Itemisation of State-imposed or Regulated Price Components in the Basic Supply of Electricity and Gas	With the Ordinance, the Federal Government increased transparency for consumers, thereby making it easier to compare rates.
101.	National Action Plan on Energy Efficiency	See Chapter 4
102.	"Germany Makes it Efficient" awareness-raising campaign	See Chapter 4
103.	Special compensation arrangements in the Renewable Energy Sources Act	The aim is to ensure that electro-intensive businesses and rail operators that compete internationally are not put at a disadvantage due to the higher electricity costs as a result of the EEG surcharge, and that jobs are therefore not lost. In 2015, 2,111 businesses in the manufacturing industry with an electricity consumption of 95 TWh received privileges under the special compensation arrangements. Total relief, including rail operators, amounted to €4.8 billion.

	Instrument	State of implementation
104.	Reductions in the surcharge under the CHP Act (CHP surcharge)	The aim is to ensure that German businesses are not put at a disadvantage in relation to international competitors, and that jobs are therefore not lost, as a result of the promotion of combined heat and power in Germany. Certain highly electro-intensive businesses and rail operators pay a lower CHP surcharge. According to the forecast data of the transmission system operators, a lower CHP surcharge was paid for 206 TWh in 2015, as the final consumers drew over one GWh of electricity. In addition, the CHP surcharge was limited for an additional 87 TWh as this energy could be assigned to electro-intensive businesses. Total relief amounted to €493 million. This system is being reorganised with effect from 2016 and the rules for special compensation arrangements under the Renewable Energy Sources Act will also apply under the CHP Act.
105.	Electricity price compensation	The aim is to prevent manufacturing from moving offshore. Since the start of the third trading period, certain businesses can apply for compensation for the costs incurred under the EU ETS. In 2015, assistance was approved for 928 industrial plants, as a result of which assistance amounting to €186 million was disbursed.
106.	Relief in the Energy Tax Act and Electricity Tax Act	The aim is to ensure that German businesses are not put at a disadvantage in relation to international competitors, and that jobs are therefore not lost, as a result of excessively high energy costs. Further to this, tax relief is granted for environmentally friendly electricity use (e.g. local public transport, CHP plants), subject to certain conditions. Energy tax relief amounted to €925 million in 2015, while electricity tax relief amounted to €3.57 billion.
107.	CO_2 allowance price and free allocation, in some cases, in the EU emissions trading system	See Chapter 12
	Chapter 10: Grid infrastructure	
108.	Revision of the Incentive Regulation Ordinance	The aim is to improve investment conditions for distribution grids and strengthen incentives for efficiency, while keeping the costs for consumers to a minimum and increasing transparency. Revenue caps are set for the transmission system operators (TSOs) for each year of the 5-year regulation period. New publication obligations render the decisions of the regulation authorities and the costs and revenues of the TSOs more transparent.
109.	Act to Amend Provisions of the Law Governing Power Line Construction	The goal is to increase acceptance for grid expansion, and accelerate the expansion of the grid as a result.
110.	Act on the Digitisation of the Energy Transition	See Chapter 11
111.	Continued development of the monitoring of German grid expansion projects	The Federal Network Agency's quarterly monitoring system was refined with effect from the first quarter of 2016 to contain a separate summary report for projects under the Energy Line Expansion Act, projects under the Federal Requirements Planning Act (43) and for offshore projects.
112.	Further development of the Ordinance on Agreements Concerning Interruptible Loads	Ensure grid stability and therefore security of supply by procuring and using interruptible loads. The revised version of the Ordinance entered into force on 1 October 2016. The European Commission has confirmed that it complies with European rules on state aid. On average, 944 MW of interruptible capacity was available in 2015 of which 398 MW were immediately interruptible loads.
113.	Energy Grids Platform	The increasing share of renewable energy in the electricity mix also puts demands on the grid infrastructure. To have efficient, smart grids in Germany and Europe, the power grids need to be expanded and modernised. For this reason, the Federal Ministry for Economic Affairs and Energy launched the permanent Energy Grids Platform in February 2011. In this platform, key stakeholders – grid operators, federal and *Land* institutions, and associations – continuously work together to devise solutions for grid expansion and the modernisation of the power grids.
114.	"Civil Dialogue on the Power Grid" initiative	The "Civil Dialogue on the Power Grid" initiative promoted by the Federal Ministry for Economic Affairs and Energy since 2015 holds diverse local events and provides online information about its services and participation formats. It has ten citizens' advice centres nationwide.
	Chapter 11: Integrated development of the energy system	
115.	"Electricity 2030" discussion paper of the Federal Ministry for Economic Affairs and Energy	In its discussion paper, the Federal Ministry for Economic Affairs and Energy discusses twelve long-term trends for a low-cost, secure and climate-friendly power supply. The Federal Ministry for Economic Affairs and Energy launched a public consultative process with the publication of the discussion paper. In addition, the discussion paper is also discussed with the relevant stakeholders within the context of the Electricity Market Platform and the Energy Grids Platform set up by the Federal Ministry for Economic Affairs and Energy.
116.	Electric mobility premium/ eco-bonus	See Chapter 6
117.	Promotion of heat pumps	In addition to supporting other renewable heating technologies, the funding guideline for the Market Incentive Programme also promotes electric-powered air-to-water heat pumps as well as water-to-water and brine-to-water heat pumps in the existing building stock. Support was granted for around 16,000 heat pumps through the Market Incentive Programme in 2015. Basic support amounts to at least €1,300 for installations with air as the heat source, and at least €4,000 for installations with geothermal energy or water as the heat source.
118.	Promotion of innovative CHP systems under the CHP Act	Innovation pilot scheme designed to gather practical experience with innovative CHP systems. Further development of CHP toward future-oriented systems for particularly energy-efficient, low-GHG cogeneration and heat supply in the heating system. Funding will be determined through a competitive auction process. The details of the auction system are currently being prepared.

	Instrument	State of implementation
119.	Act on the Digitisation of the Energy Transition	The Act on the Digitisation of the Energy Transition creates the technical framework for demand side and generation management measures and therefore for more flexibility in the power grid. With smart meter systems, the Act introduces a technology that can be used for numerous applications of the smart grid.
120.	Smart Energy Showcases – Digital Agenda for the Energy Transition (SINTEG)	The aim of the funding programme is to establish large-scale showcase regions to develop and demonstrate secure processes and technologies, which are ready for the mass market, designed to intelligently link generation, the grid and consumption, as well as new approaches for reliable grid operation given increasing shares of intermittent electricity generation from wind and solar sources. A funding competition was held to select five showcase regions that are due to commence in late 2016/early 2017. The Federal Ministry for Economic Affairs and Energy will provide a total of up to €230 million in funding to the showcase regions which have over 200 participating companies and other stakeholders. The participating businesses plan to invest an additional €370 million approximately.
121.	Energy Savings Meter pilot programme	Since May 2016, the programme has been promoting pilot projects run by businesses that want to trial and demonstrate digital solutions and new business models at the site of a third-party with the aim to save energy and switch grid load in line with the needs of the grid. Funding is paid for each verifiable kWh of energy saved ("energy savings meter"). The measure was launched in May 2016. Funds amounting to €29 million in total are available for the period 2016–2020.
122.	Digital Agenda 2014–2017	The aim of the Federal Government's Digital Agenda 2014–2017 is to force the pace on digital change in business and society, including in the energy sector.
	Chapter 12: The energy transition in the European and international context	
123.	2030 Framework for climate and energy	The goals are to be implemented through specific legislative acts in the individual sectors (ETS reform, effort sharing in areas outside the emissions trading scheme, inclusion of LULUCF in the climate framework, amended Energy Efficiency Directive, and Renewable Energy Directive). Corresponding proposals are currently being developed by the Commission or are being negotiated with the EU Member States.
124.	Governance of the Energy Union	Establish integrated, national energy and climate plans for the 2021–2030 period. Set up a pan-European system to monitor progress towards the goals of the Energy Union and sustainable financing structures in favour of low-carbon technologies. The Commission is expected to put forward a legislative proposal at the end of November 2016.
125.	EU Regulation on national contributions to GHG reduction for areas outside the ETS for 2021–2030	The proposal for a corresponding EU Regulation is currently being discussed in the European Council and the EU Parliament.
126.	New Directive for the Expansion of Renewables post-2020	Public consultation hosted by the Commission at the start of 2016. The Commission's legislative proposal has been announced for the end of November 2016.
127.	New post-2020 Energy Efficiency Directive	The new Energy Efficiency Directive addresses the actual percentage target for EU efficiency for 2030 and the binding nature of this target. In so doing, it sets the framework (e.g. annual reduction targets) and additional sector-specific measures (e.g. energy audit in larger companies and rate of building modernisation in the buildings sector).
128.	Cross-border grid expansion	Additional grid expansion projects must be implemented and ongoing projects completed to also reach the European 10% interconnection goal in 2020. German grid expansion plans comprise ten interconnector projects to further expand numerous interconnection points with our neighbours. The majority of the projects are in the approval or construction phase.
129.	Commission Communication concerning a 15% electricity interconnection target for 2030	The European Council underlined the importance of cross-border interconnector capacity for the internal electricity market in October 2014 and confirmed the 15% interconnection target for 2030 which had been proposed by the European Commission.
130.	Regional partnerships	Flow-based coupling of the day-ahead markets was introduced in the Pentalateral Energy Forum in May 2015. Further to this, the Pentalateral Energy Forum also published Europe's first regional generation adequacy report in March 2015. In the Baltic Energy Market Interconnection Plan (BEMIP), the further development of regional electricity markets and a more regional approach to security of supply were also agreed on the basis of a new policy declaration.
131.	Electricity neighbours	The Joint Declaration was signed by Germany and its "electricity neighbours" in June 2015. The exchange of information and ideas to flexibilise the electricity markets was stepped up further on this basis in 2015 and 2016. In this context, the electricity neighbours have identified various barriers that stand in the way of greater flexibility and pinpointed initial measures to remove such barriers.
132.	Regional cooperation in renewable energy/opening up the Renewable Energy Sources Act	Cooperation with Denmark for ground-mounted PV installations was signed in July 2016 on the basis of the Renewable Energy Sources Act 2014 (pilot opening). Cooperation with another Member State in the area of ground-mounted PV installations is planned in early 2017. In this regard, work is currently underway on the opening of auctions under the Renewable Energy Sources Act 2017 (auctions for 5% of the annual capacity to be installed will be open to installations from other European countries).
133.	Legislative package concerning the electricity market design, capacity mechanisms, regional aspects	Commission Communication in July 2015 and opinions of the Member States submitted by October 2015. Legislative package announced for the end of November 2016.
134.	Understanding with the European Commission regarding the energy package	In summer 2016, the Federal Ministry for Economic Affairs and Energy held intensive talks with the European Commission on the drafting of the details of energy legislation to ensure that it complies with European rules on state aid. This concerns the Act to Promote Combined Heat and Power (CHP Act) as well as the Electricity Market Act and the Renewable Energy Sources Act 2017, for instance. In the talks, both sides reached an understanding as to how this can be addressed in a manner that complies with state aid rules.

	Instrument	State of implementation
135.	Reform of the European emissions trading system - introduction of a market stability reserve (MSR)	The market stability reserve will start operation in 2019. From this time onward, the supply of allowances in the emissions trading market will be adapted on the basis of a surplus analysis which is performed annually. If the total number of allowances in circulation (TNAC) is too high, the amount of allowances available for auction will be reduced by moving allowances into the reserve, and if the TNAC is too low more allowances will be released from the reserve. 900 million allowances backloaded between 2014 and 2016 will be transferred directly to the market stability reserve, as will allowances that were not auctioned between 2013 and 2020.
136.	ETS legal framework 2021-2030	The proposed directive is currently being discussed at the European level. It includes rules for determining the emissions cap, the reduction factor and the division of the amounts into amounts for auction and amounts for free allocation. It also contains detailed rules for the free allocation of allowances to industrial facilities.
137.	Effort sharing decision (ESD) regarding national GHG emission reduction targets for sectors outside the scope of the ETS by 2020	The goal is to have a 10% EU-wide reduction of GHG emissions by 2020 compared with 2005 levels. The national targets for GHG reduction are in the range from -20% to +20%. With the national policies and measures currently in place, 23 Member States are likely to meet their 2020 targets. The remaining 5 Member States can probably reach the targets with additional measures or by transferring emissions budgets from other Member States.
138.	EU draft regulation on national GHG reduction targets for sectors outside the scope of the ETS for the period 2021-2030 (Effort Sharing Regulation, ESR)	The goal is for Member States (MS) to share the emissions reduction effort to reach the EU climate target for 2030. The MS contribution is in the range from 0 to -40%. The proposal of 20 July 2016 put forward by the EU Commission concerning an EU Regulation is currently being discussed in the Council and the EU Parliament.
139.	Land Use, Land-Use Change and Forestry Regulation (LULUCF)	Greenhouse gas emissions and removals from land use, land-use change and forestry are to be incorporated into the 2030 EU climate framework. The proposal of 20 July 2016 put forward by the EU Commission is currently being discussed in the Council and the EU Parliament.
140.	Berlin Energy Transition Dialogue 2016	At the first international energy transition conference after the Paris Agreement, the central question was how the energy sector can and should contribute to reaching the Paris climate goals.
141.	Energy Export Initiative	This Federal Government initiative focuses on technical solutions in the field of renewable energy, energy efficiency, storage technologies and smart grids.
142.	G20 energy cooperation under the German G20 presidency in 2017	When it holds the G20 presidency in 2017, Germany will focus G20 energy cooperation on addressing how the energy sector will develop following the adoption of the 2015 Paris Convention.
	Chapter 13: Energy research and innovation	
143.	Sixth Federal Government Energy Research Programme	A total of €3.4 billion will be provided to fund R&D in the period 2013-2016, with €863 million budgeted for 2015. Currently, the development of the programmes under energy research policy is scientifically supported by analytical studies conducted within the framework of strategic flagship projects.
144.	Horizon 2020 / Research and Innovation Framework Programme	“Horizon 2020”, the European research and innovation framework programme, commenced in 2014. Around €5.9 billion are allocated for the 2014-2020 funding period for “safe, clean and efficient energy” in the area of non-nuclear energy research.
145.	Energy transition - Research and Innovation platform (R&I platform)	Plenary sessions of the R&I platform have been held twice annually since early 2015. The platform acts as an advisory panel that engages in dialogue with national stakeholders in the Federal Government, *Länder*, the business sector and the scientific community on the strategic direction of energy research policy. The platform brings together and coordinates the long-term research networks. The aim is to accelerate the market rollout of new energy technologies by forging stronger connections between research activities and stakeholders in Germany. The initial results of the strategic flagship projects for the further development of energy research policy will be presented in the spring session on 2 May 2017.
146.	Energy Transition Research Forum	Since 2013, key players from the *Länder*, the business community, academia and civil society have been meeting in the Energy Transition Research Forum twice a year in plenary sessions and group leader sessions. The Forum provides science-based policy advice, is involved in the effective coordination and long-term direction of energy research and develops conclusions for research policy with a view to structures, instruments and topics in the future. The energy transition Copernicus projects will be presented at the spring sessions in 2017.
147.	Funding initiative “Energy Transition Copernicus Projects”	Using the basic research pending in the first phase of funding provided by the Federal Ministry of Education and Research, the aim is to create the basis for a technologically outstanding and economically competitive energy system which also enjoys the greatest possible level of public acceptance. The first funding phase of the projects is set for three years, and planned funding is up to €120 million.
148.	“Carbon2Chem” research project	The aim of this project involving a high-level consortium from industry and the scientific community is to convert smelting gas from steel production into base chemicals using renewable energy. Valuable chemical primary products for fuels, plastics or fertilizers that replace fossil fuels are produced from blast furnace gas. Thanks to the project, 10% of annual CO2 emissions from German industrial processes can be used commercially. The Federal Ministry of Education and Research will make more than €62 million available for this project in the next four years.
149.	“Energy Systems of the Future” Academies’ project	120 representatives from German science academies develop systemic policy options for the area of basic research with a focus on the energy system of the future, and in doing so provide a scientifically sound basis for society-wide debates on issues that are of medium- to long-term relevance to a successful energy transition. In addition to questions about technological feasibility, the project also addresses economic and legal issues, as well as aspects regarding the efficient use of resources and public acceptance.

	Instrument	State of implementation
150.	"Sustainable Power Grids" research initiative	The joint initiative of the Federal Ministry for Economic Affairs and Energy and Federal Ministry of Education and Research aims to create the necessary technological framework for the future transmission and distribution of electricity for a reliable, affordable and environmentally friendly power supply system. Support of €150 million has been granted to around 300 projects since 2014.
151.	"Solar Construction/Energy-efficient Cities" funding initiative	See Chapter 5
152.	National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP)	Under the joint initiative of the Federal Ministry for Economic Affairs and Energy, the Federal Ministry of Transport and Digital Infrastructure, the Federal Ministry of Education and Research and the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety as well as industry and the scientific community, which is designed to speed up technology development and the process of producing marketable products based on these technologies, around €1.4 billion are available in the period 2007-2016 to fund more than 200 research projects.
153.	Programme collaboration: Energy Transition Research Alliance at the German Federation of Industrial Research Associations (AiF)	Joint initiative of industrial collective research and the Federal Ministry for Economic Affairs and Energy to specifically strengthen the innovative capacity of non-research-focussed SMEs in developing energy solutions. The first projects started at the end of 2016. An additional €18 million in funding will be available from 2016.
154.	"Renewable Resources" funding programme	Initiative of the Federal Ministry of Food and Agriculture for the promotion of research, development and demonstration projects in the use of renewable resources as a material and for energy purposes. €61 million are available in 2016. Another €24.6 million will come from the Energy and Climate Fund for bioenergy projects.
155.	"Biomass Energy Use" funding programme	This programme aims at research and development work, with a practical orientation, on forward-looking technologies and the optimisation of processes which enable the efficient, economic and sustainable use of bioenergy and help contribute to security of supply. The programme was launched in 2009 and reorganised in 2015.
156.	Promotion of storage systems	Research initiative: A joint initiative of the Federal Ministry for Economic Affairs and Energy and the Federal Ministry of Education and Research to support research and development projects ranging from basic R&D work to application-oriented demonstration projects has provided €200 million in support to around 250 projects since 2012. A status seminar was held with roughly 200 participants in April 2015. Funding programme for decentralised battery storage systems: The funding programme for decentralised battery storage systems commenced on 1 May 2013 and ran until 31 December 2015. The programme was relaunched with a new framework on 1 March 2016. Support is given to investment in battery storage systems which are operated in conjunction with PV installations in a manner which serves the system.
157.	Support in the area of electric mobility - "Electric mobility - Positioning along the value chain" (ELECTRO POWER II)	The Federal Government provides over €200 in funding annually to support research into, and the development of, important key technologies in the area of electric mobility. The funding competition "ELECTRO POWER II: Electric mobility - positioning along the value chain" is part of a comprehensive package of measures designed to implement the goals adopted in 2009 in the National Development Plan for Electric Mobility.
158.	Environmental Innovation Programme	The Environmental Innovation Programme supports demonstration projects where innovative technologies that protect the environment are implemented on a large scale for the first time.
159.	WIPANO – "Knowledge and Technology Transfer via Patents and Standards"	With regard to the promotion of patenting, WIPANO covers some of the costs for patent advice, consulting a patent attorney or for filing a patent. The measure is in place from 1 January 2016-31 December 2019 with a budget of €23 million. Businesses, third-level institutes, universities and non-university research centres are eligible to apply.
160.	Promotion of stationary fuel cell heating as part of the Energy Efficiency Incentive Programme	Support is granted for the installation of fuel cell systems with a capacity of between 0.25 kWel and 5 kWel in residential buildings if the fuel cell is incorporated into the building's heating and power supply system. Both new buildings and energy retrofits in existing buildings are eligible for support. Support is provided in the form of a grant and can be combined with funding under the CHP Act. A total of €150 million is available annually in the period 2016-2018 for investment support measures under the Energy Efficiency Incentive Programme (heating package, ventilation package and fuel cells).
161.	Hydrogen and Fuel Cell Technology Government Programme for the 2016-2026 funding period	With the goal of establishing marketable products on the market, the Federal Government will support activities and measures across all ministries in the areas of "Research and Development" and "Market Activation" within the framework of the NIP through to 2026. Industry investment plans will be supported by public-sector funding in this context. The funding budget amounts to around €1.4 billion for the 2016-2026 period.
162.	Renewed funding for horizontal technologies	The aim of the funding is to drive investment in selected technologies to increase energy efficiency and thereby decrease annual CO_2 emissions.

If measures described in the table above are also measures under the 2020 Climate Action Programme, detailed information on their state of implementation is provided in the annual climate reports issued by the Federal Government.

The measures are implemented under the applicable budgetary and financial planning principles of the ministries (including positions and permanent posts) subject to the availability of the necessary budget funds.

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The figures in the graphics and additional information on the "Energy of the Future" monitoring process can be found on the website of the Federal Ministry for Economic Affairs and Energy (www.bmwi.de/DE/Themen/Energie/Energiewende/monitoring-prozess.html).

List of abbreviations

AA	Federal Foreign Office
AGEB	Working Group on Energy Balances
AGEE-Stat	Working Group on Renewable Energy Statistics
AiF	German Federation of Industrial Research Associations
AMR	Automatic Meter Reading
BAFA	Federal Office for Economic Affairs and Export Control
BBPlG	Federal Requirements Planning Act
BBSR	Federal Institute for Research on Building, Urban Affairs and Spatial Development
BLE	Federal Office for Agriculture and Food
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMWi	Federal Ministry for Economic Affairs and Energy
BMZ	Federal Ministry for Economic Cooperation and Development
bn.	Billion
BNetzA	Federal Network Agency for Electricity, Gas, Telecommunications, Post and Rail
BSI	Federal Office for Information Security
BVWP	Federal Transport Infrastructure Plan
CCS	Carbon Capture and Storage
CCU	Carbon Capture and Use
CEEE	Central-Eastern European Electricity Forum
CEER	Council of European Energy Regulators
CLM	Clean Energy Ministerial
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2-eq.	Carbon dioxide equivalent
COORETEC	CO_2 reduction technologies
COP21	21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change
COM	European Commission
ct	Cent
dena	German Energy Agency
DIW	German Institute of Economic Research
DLR	German Aerospace Centre
DPMA	German Patent and Trademark Office
DSO	Distribution system operator
EEA	European Environment Agency
EED	Energy Efficiency Directive
EEG	Renewable Energy Sources Act
EEX	European Energy Exchange
ECF	Energy and Climate Fund
EHV-DC	Extra-high Voltage, Direct Current
EnLAG	Energy Line Expansion Act
ESD	Effort Sharing Decision
ESR	Effort Sharing Regulation
ETCS	European Train Control System
ETS	Emissions Trading System
EU	European Union
EUA	European Emission Allowance
EV	Electric Vehicle
EWI	Institute of Energy Economics at the University of Cologne
Fh ISI	Fraunhofer Institute for Systems and Innovation Research
FNR	Agency for Renewable Resources
GDP	Gross domestic product
GHG	Greenhouse gas
GWS	Institute of Economic Structures Research
HDV	Heavy duty vehicles
HGV	Heavy goods vehicles
IAEW	Institute of Power Systems and Power Economics, RWTH Aachen
IASS	Institute for Advanced Sustainability Studies
ICAO	International Civil Aviation Organization
ICCT	International Council on Clean Transportation
IEA	International Energy Agency
IFAM	Fraunhofer Institute for Manufacturing Technology and Advanced Materials
ifeu	Institute for Energy and Environmental Research, Heidelberg
ICT	Information and Communication Technology
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IREES	Institute for Resource Efficiency and Energy Strategies
IRENA	International Renewable Energy Agency
ITD	Institute for Transportation Design

KFK	Commission to Review the Financing for the Phase-out of Nuclear Energy
KfW	Reconstruction Loan Corporation, Germany's state-owned development bank
km	Kilometre
KNE	"Nature Conservation and the Energy Transition" centre for expertise
KPI	Key performance indicator
kW	Kilowatt
LBEG	Lower Saxony State Office for Mining, Energy and Geology
LNG	Liquefied natural gas
LULUCF	Land Use, Land-use Change and Forestry
m	Million
MSR	Market Stability Reserve
MWV	German Petroleum Industry Association
NAPE	National Action Plan on Energy Efficiency
NIP	National Innovation Programme for Hydrogen and Fuel Cell Technology
NIR	National Inventory Report to UNFCCC
NPE	National Platform for Electric Mobility
NOW	National Organisation for Hydrogen and Fuel Cell Technology
PJ	Petajoule
Pkm	Passenger Kilometre
PV	Photovoltaic
R&D	Research and Development
REN21	Renewable Energy Policy Network for the 21st Century
RES	Renewable energy
SAIDI	System Average Interruption Index
SINTEG	Smart Energy Showcases – Digital Agenda for the Energy Transition
SME	Small and medium-sized enterprises
StBA	Federal Statistical Office
t	Tonne
TCP	Technology Collaboration Programme of the IEA
TCS	Trade, commerce and services
tkm	Tonne-kilometre
TNAC	Total Number of Allowances in Circulation
TSO	Transmission system operator
TWh	Terawatt hour
UBA	Federal Environment Agency
UEC	Unit energy costs
UNFCCC	UN Framework Convention on Climate Change
WLTP	World Harmonised Light Vehicle Test Procedure
ZEW	Centre for European Economic Research
ZSW	Centre for Solar Energy and Hydrogen Research Baden-Württemberg

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