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and Energy

Energie wende
Switch to the Future

Sixth "Energy Transition" Monitoring Report

The Energy of the Future

Reporting Year 2016 – Summary –

Imprint

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Central messages from the Sixth Monitoring Report

The German energy transition is embedded in the European energy transition, which has set ambitious goals for 2030 and beyond. In particular, the package of measures titled “Clean Energy for All Europeans” will provide a new European legislative framework for clean energy. The integrated National Energy and Climate Plans to be created by EU Member States will provide information on how they plan to achieve their respective national energy and climate goals for 2030, and thereby contribute to corresponding goals of the Energy Union. The facts and figures presented in this report regarding Germany’s progress toward fulfilling several specific 2020 goals indicate the seriousness of this challenge. The coalition agreement between the CDU, CSU and SPD paves the way for implementing the necessary framework.

On the positive side, almost one out of every three kilowatt hours was produced with renewable energies, which provided 31.6% of gross electricity consumed in 2016. This increase continued in 2017. At the same time, the 2017 Renewable Energy Sources Act introduced a paradigm shift toward competitive subsidies, leading to substantially more cost-efficient development of renewable energies.

However, primary energy consumption in 2016 increased by 1.4% compared with 2015. Strong economic growth and relatively cool weather were factors. The measures proposed by the National Action Plan on Energy Efficiency (NAPE) and the energy policy resolutions of 1 July 2015 have been instigated and are starting to show results. However, annual energy savings of 0.8% on average since 2008 are not sufficient to reach the target set for 2020 (20% reduction). Overall, there is a great need to take action to achieve the reduction target as quickly as possible.

Energy consumption in buildings in 2016 increased by 4.3% compared with 2015. Since 2008, this figure has declined by an average of around 0.8% annually. In order to achieve 20% savings by 2020, consumption would have to decline five times this amount in the five remaining years. Here, too, much work must be done to reach the target as quickly as possible.

Final energy consumption in the transport sector continued to run counter to the goals of the Energy Concept, increasing by around 2.9% compared with the previous year and around 4.2% compared to 2005. It is expected that the 2020 Goal (10% reduction) will not be reached until around 2030 under the present circumstances. Considerable additional efforts will be required to turn this trend around as soon as possible.

Greenhouse gas emissions increased slightly in 2016, but have dropped by 27.3% overall compared with 1990 levels. The Federal Government will continue to implement the 2020 Climate Action Programme, assess its effects on lowering emissions, and determine what additional action should be taken in order to reach the climate protection goal for 2020 set forth in the coalition agreement between the CDU, CSU and SPD (40% less greenhouse gases compared with 1990).

Germany's electricity supply is secure. There is enough energy to cover demand in Germany at all times, guaranteeing a high level supply security. The European electricity market also contributes to this security. Germany is also at the forefront – also by international standards – with supply quality consistently at a very high level.

Cost efficiency is one of the main criteria for optimal implementation of the energy transition. In light of this, efforts have been made to slow down the electricity cost dynamics of previous years appreciably. Whereas electricity prices increased in 2016 by an average of 2.4% for household customers, prices in 2017 were approximately at the level of the previous year. For industrial customers not covered by special compensation arrangements, electricity prices fell by 4.0% in 2016.

Final consumer expenditures for final energy consumption dropped in 2016 from €215 billion to €212 billion. The share of final consumer expenditures in nominal GDP declined on the previous year from 7.1% to 6.7%. The share of electricity costs in GDP declined to the lowest level since 2010. In 2016, energy costs from the use of imported primary fossil fuels were down on the previous year, falling from €54.8 billion to €45.9 billion. This was mainly a result of lower prices on the global commodity markets, which again fell substantially over the previous year.

If the energy transition is to be successful, renewable energies and electricity grid capacity must be better synchronized right down to the regional level, grid expansion must be accelerated and existing grids must be modernized and optimized. The grid expansion measures that have been agreed must be implemented without delay. Just as important is implementing the projects under the Federal Requirements Planning Act as quickly as possible. This process has entered the next phase, as federal planning has commenced for the big extra-high voltage, direct current transmission lines SuedLink and SuedOstLink in 2017, and for A-Nord in early 2018.

The energy transition is part of a macroeconomic modernisation strategy that will trigger extensive investments in the German economy. Innovative business models offer big opportunities in this process. The energy transition is beneficial in opening up new opportunities for innovation and new market potential. Digitisation of the energy transition also has an impact. Many German companies profit from trade in new and innovative energy technologies. In 2016, exports of renewable energy installations and components amounted to almost €12 billion. International energy collaboration efforts are gaining in importance, because they facilitate political discussions and underpin economic activities.

1 Monitoring the energy transition

The Energy for the Future monitoring process tracks progress towards goals and checks the implementation of measures of the transition of the energy system with a view to establishing a secure, economic and environmentally friendly energy supply; the German energy transition is embedded in the European energy transition and its ambitious goals. The monitoring process provides the basis for making adjustments, 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 comprising several years of data propose measures to remove obstructions and reach the targets.

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

This Sixth Monitoring Report documents the status of the energy transition in 2016, and assesses the progress made toward reaching the goals. 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.

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).

In addition, the Federal Government has also been reporting on current greenhouse gas emission trends since 2015 in annual climate reports. These reports provide 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. National goals are based on the ambitious goals set at the EU level. The triple objective of security of supply, affordability and environmental compatibility remains the guiding principle for Germany's energy policy, as is evidenced by the coalition agreement between the CDU, CSU and SPD.

The Monitoring Report reviews the quantitative targets set by the energy transition as well as additional goals and policies of the energy transition.

Table: Goals at the European and international level

Europe International	Creating a reliable European and international framework for more climate protection, renewables and energy efficiency

Table: Quantitative targets of the energy transition and status quo (2016)

	2016	2020	2030	2040	2050
Greenhouse gas emissions					
Greenhouse gas emissions (compared with 1990)	-27.3%*	at least -40%	at least -55%	at least -70%	largely greenhouse-gas-neutral -80% to -95%
Renewable energy					
Share of gross final energy consumption	14.8%	18%	30%	45%	60%
Share of gross electricity consumption	31.6%	at least 35%**	at least 50% Renewable Energy Sources Act 2017: 40-45% by 2025**	at least 65% Renewable Energy Sources Act 2017: 55-60% by 2035	at least 80%
Share of heat consumption	13.2%	14%			
Efficiency and consumption					
Primary energy consumption (compared with 2008)	-6.5%	-20% →			-50%
Final energy productivity (2008-2050)	1.1% per year (08-16)	2.1% per year (2008-2050)			
Gross electricity consumption (compared with 2008)	-3.6%	-10% →			-25%
Primary energy consumption in buildings (compared with 2008)	-18.3%	→			-80%
Heat consumption in buildings (compared with 2008)	-6.3%	-20%			
Final energy consumption in the transport sector (compared with 2005)	4.2%	-10% →			-40%

Source: In-house data from the Federal Ministry for Economic Affairs and Energy, March 2018
* Provisional figure for 2016
** The Coalition Agreement between the CDU, CSU and SPD provides for additional expansion of renewable energy that is effective, efficient, synchronized with energy grids and increasingly competitive. With these requirements in place, the goal is a 65%-share of renewables by 2030; any corresponding adjustments will be made. Special tenders in the area of wind and solar energy aim to help reach the 2020 climate protection goal. The challenge is to better synchronise renewables and grid capacity expansion.

Table: Targets and policies affecting the energy transition

Security of supply	Efficiently 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.
Environmental aspects	Creating an energy supply system that is environmentally compatible and protects natural habitat.
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.
Research **Innovation**	Fostering forward-looking innovations for the restructuring of the energy supply.
Investment **Growth** **Jobs**	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, 3/2018

Energy transition monitoring is based on publicly accessible and verifiable data. The process is carried out using selected indicators which visualise progress made in the energy transition over time. These indicators are informed, wherever possible, by official and publicly accessible data. The Energy Statistics Act is the national legal basis for official energy statistics.

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 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.

3 The energy transition in the European and international context

Where do we stand?

European energy policy: The EU is generally on target for 2020. Despite progress in renewable energy sources, Germany needs additional effort, in particular in reducing greenhouse gas emissions and primary and final energy consumption, in order to comply with its obligations regarding 2020 goals for individual EU Member States.

The European electricity market is reality, and contributes substantially to a secure energy supply. Diverse collaboration formats strengthen trade and exchange of electricity between Germany and its neighbours. Bilateral agreements have addressed specific issues regarding cross-border energy trade with Denmark and Austria.

Introduced in 2005, the European Union Greenhouse Gas Emissions Trading System (ETS) comprises emissions of around 12,000 plants and installations of the energy sector and energy-intensive industry, as well as emissions from intra-European aviation in the 28 Member States of the EU and Norway, Iceland and Liechtenstein. The reduction target for ETS areas was once again fulfilled ahead of schedule. In 2016 ETS sectors (not including European air transport) lowered their emissions by 2.9% over the previous year, leading to a 26% overall drop in emissions since 2005 – from 2,375 million tonnes to a total of 1,750 million tonnes of CO_2 equivalent.

Climate protection in sectors not included in emissions trading: Even the non-ETS sectors (especially buildings, non-aviation transport, agriculture and waste) make a decisive contribution. In 2016, emissions from these sectors was already 13% lower than 2005, yet the trend in the past few years has indicated a rise, due to low oil prices and weather-related heating needs. However, it is expected that the EU will reach its goal of a decrease of 10% in non-ETS sectors by 2020.

International energy policy: The global energy transition is making progress across the board toward lower-emission energy supplies. According to the IEA, around 40% of USD 718 billion in total investments in the electricity supply

Table: Overview of major EU 2020 and 2030 targets

	2016	2020 targets	2030 targets (according to informal trialogue agreements)	Comments
GHG reduction (from 1990)	23%	at least 20%	at least 40%	binding
GHG reduction in the ETS area (from 2005)1	26%	21%	43%	binding
GHG reduction in non-ETS sectors (from 2005)[1]				
• for all of the EU	13.3%[2]	10%	30%	binding
• for Germany	4.9%[2]	14%	38%	binding
Renewables percentage				
• of gross final energy consumption at the EU level	17%	20%	32%	binding
in Germany	14.8%	18%	no country-specific targets	binding
• in the heating/cooling sector	13.2%		Increase of 1.1 percentage points annually (waste heat and waste cooling included: 1.3 percentage points annually)	indicative
• in the transport sector	7.1% (EU) 6.9% (Germany)	10%	14%	no sector targets, rather commitment to introduce a certain percentage to the market
Reduction of energy consumption				
• at the EU level	10% reduction in primary energy consumption from 2005	by 20%[3] (= 13% drop in primary energy consumption from 2005)	by 32.5%[3]	no information
• in the individual EU Member States		indicative national contributions to reaching targets	indicative national contributions to reaching targets	indicative
		additional energy savings 1.5% annually	additional real final energy savings of 0.8% annually	binding
Interconnection in EU Member States	2017 in Germany: 9%	10%	15%[4]	indicative
Electricity trading/exchange		Make overall system more efficient and increase security of supply		

Source: Federal Ministry for Economic Affairs and Energy, 2/2018.
1 See Chapter 3.2 in the full version of the Monitoring Report
2 Preliminary targets; Status in all of the EU: 09/2017; Status in Germany: 01/2018; whereby the 2005 baseline year emissions according to the EEA are calculated as follows: 2005 baseline year emissions = absolute 2020 target/(1 + % of the 2020 target)
3 compared with the trend in the reference figures for 2020 or 2030 (according to the PRIMES 2007 Model for the European Commission)
4 Additional thresholds make this figure more specific

sector went to renewable energy sources and expansion of electric grids, and only slightly more than 16% went to fossil energy generation.

The Paris Convention on Climate Change that entered into force in November 2016 provides the overall framework for the global energy transition. The convention has been signed by 178 of the 197 countries, including the EU and Germany. The convention requires all contracting states to make national climate protection contributions (NDCs: Nationally Determined Contributions). The Federal Government provides assistance to ensure rapid implementation of NDCs worldwide.

Germany is an important partner for many countries in developing the international energy transition. There is strong interest all over the globe in German expertise and technology, for example in adapting the legal framework or integrating renewables into a secure supply system.

What is new?

European energy policy: In November 2016 the European Commission introduced an extensive legislative package titled "Clean Energy for All Europeans" that aims to reshape the European energy framework by 2030. Central elements include recommendations for a governance system for the Energy Union (Governance Regulation), for a new EU electricity market design (Electricity Market Directive, Electricity Market Regulation, ACER Regulation and Risk Preparedness Regulation) and for reworking the directives for renewables, energy efficiency and buildings. Negotiations are expected to be completed during 2018.

The integrated National Energy and Climate Plans (NECP) form the core of the governance regulation. The loose agreement of the trialogue calls upon each Member State to submit a draft National Energy and Climate Plan to the European Commission by the end of 2018, and to submit the final plan for the years 2021-2030 by the end of 2019. These drafts will set out their national energy and climate targets along with strategies and measures they are planning to adopt in order to reach these targets.

More effective price signals should further strengthen the ETS. The ETS reform that entered into force in April 2018 will balance the limited offer of certificates with international competitiveness of the European industry.

International Energy policy: At the G20 summit held in July 2017 in Hamburg under German presidency the heads of state and government – without the USA – resolved a G20 Action Plan on Climate and Energy for

Growth. In this plan the countries express their commitment to implement without restriction the Paris Agreement and the goals of the Agenda 2030 on sustainable development, as well as to efficiently transform energy systems. This is an important signal, because the G20 countries are responsible for about 80% of global primary energy consumption, and even more than 80% of all CO_2 emissions.

Central measures in the area of European energy policy specifically include:

- Regulation on Governance of the Energy Union
- Amendment of the EU Renewable Energy Directive
- Amendment of the Energy Efficiency Directive
- Amendment of the Energy Performance of Buildings Directive
- Initiative on "Speeding-up the Conversion of Buildings to Clean Energy"
- revising the EU energy label
- Risk Preparedness Regulation
- Amendment of the Security of Gas Supply Regulation
- cross-border grid expansion
- Commission Communication on Protecting Europe's Critical Energy and Transport Infrastructure
- Commission Communication on an interconnection target for 2030
- regional partnerships
- Revised Cross-Border Renewable Energy Ordinance (GEEV)
- energy congestion management on the Austria-German border
- Electricity Market Regulation
- Electricity Market Directive
- ACER Regulation
- Regulation on determining a guideline on electricity balancing
- Amendment of the Internal Gas Market Directive
- Tallinn e-Energy Declaration
- Energy Diplomacy Action Plan

Central measures in the area of climate change mitigation in European emissions trading and outside of this area specifically include:

- Market stability reserve in the EU ETS
- reform of the ETS for the period 2021-2030
- moving allowances that were held back into the market stability reserve
- linking the EU ETS with the Swiss emissions trading system
- Effort Sharing Regulation
- Strategy for low-emission mobility
- Mobility package "Europe on the Move"
- Second mobility package for regulating CO_2 emissions of passenger cars and light commercial vehicles

Central measures of international energy policy specifically include:

- G20 Action Plan on Climate and Energy for Growth
- 23rd World Climate Conference (COP 23)
- IEA/IRENA Study: Perspectives for the Energy Transition – Investment Needs for a Low-Carbon Energy System carried out under the auspices of the German G20 presidency
- deepening existing bilateral energy partnerships and creating new ones (recently with Mexico, United Arab Emirates and Australia)
- Berlin Energy Transition Dialogue
- Energy Export Initiative
- Travelling exhibition: "Energiewende – Germany's Energy Transition"

4 Renewable energy

Where do we stand?

The share of renewables in total energy consumption is rising across the board. In 2016, the gross final energy provided by renewable sources amounted to 385.6 TWh, thereby covering 14.8% of total gross final energy consumption. This represents a slight increase over the previous year of 0.1 percentage points.

The share of renewables in gross final electricity consumption has risen by more than half (5.6 percentage points) since 2008. Overall, the share of renewables across all three sectors has even trebled since 2000. This positive development has primarily been driven by the increase in renewable generation in the electricity sector. The share

of renewables in the heating sector went up slightly, and the share of renewables in the transport sector has been slowly declining since 2008. A difference of 3.2 percentage points must be closed to reach the 18% target by 2020. This target 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.

At 189.7 TWh, electricity generated from renewable sources was only slightly over the previous year (2015: 188.8 TWh). Despite a sizeable increase in installed capacity, weather factors stymied a corresponding increase in electricity generated with renewables, which was 31.6% of gross electricity consumption (2015: 31.5%). The share of renewable energy in the electricity sector has more than doubled since 2008. The Federal Government has achieved a great deal in its efforts to secure, affordable and environmentally-friendly energy supply system. The share of renewables in gross electricity consumption in 2017 grew to 36.2% – the strongest rise within one year – thereby already exceeding the 2020 goal (35%) in 2017.

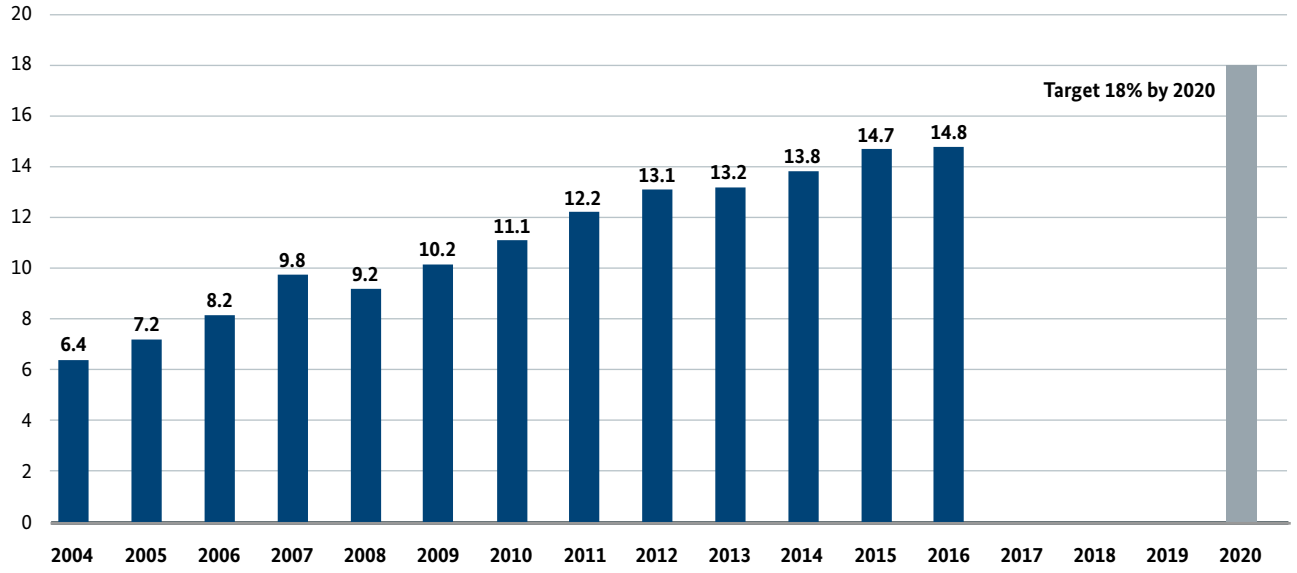
Usage of renewable energies for generating heat increased in 2016, due in part to relatively cool temperatures compared to the previous year. In 2016, approximately 13.2% (about 163.7 TWh) of final energy consumption for heat and cooling was covered by renewable energy sources – in 2015 this figure was also 13%, at 155.5 TWh.

The share of renewables in the total energy mix for the transport sector was down over the previous year, at 33.6 TWh or 5.2% (2015: 5.3%). The share of biofuels in total final energy consumption stood at 4.6% in 2016, and the renewable share of the electricity consumed by rail and road transport vehicles at 0.6%.

The EEG surcharge in 2018 is 6.792 ct/kWh. This is a slight decrease of 0.09 ct/kWh over the previous year. The surcharge has ranged between 6.2 and 6.9 ct/kWh since 2014. Previous to that, it climbed drastically (from 3.59 ct/kWh in 2012 to 6.24 ct/kWh in 2014). 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

Diagram:	**Meeting the target for renewable energy and gross final energy consumption**
2020 target	Renewables will cover 18% of gross final energy consumption
Status in 2016	14,8%

Share of gross final energy consumption in %

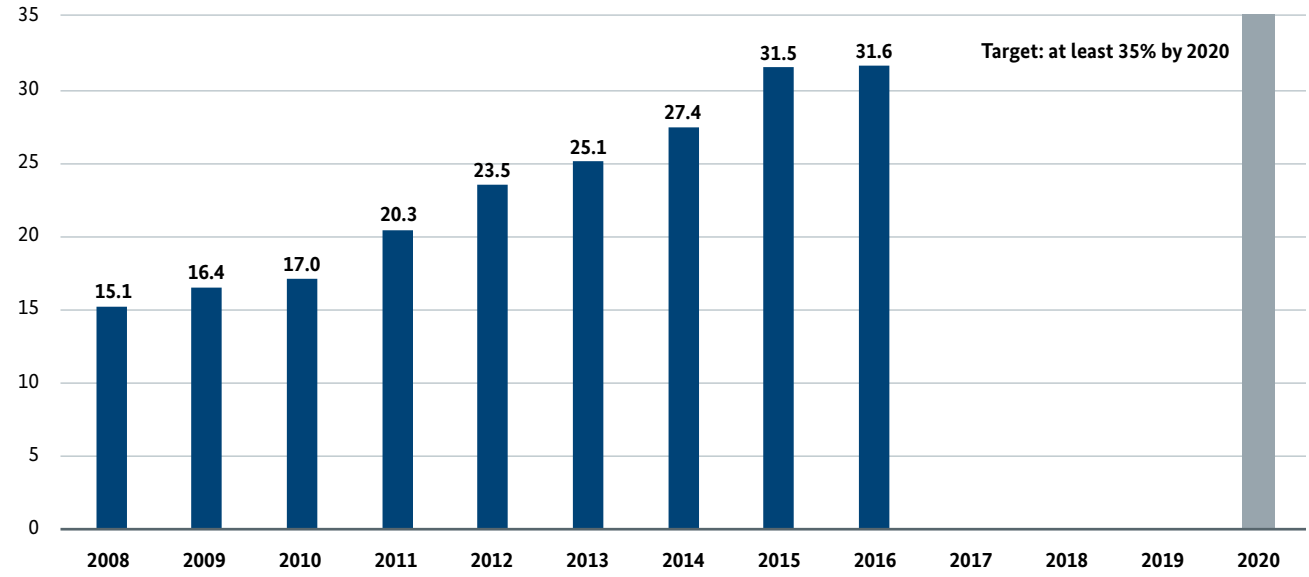


Source: AGEE-Stat 02/2018

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

Diagram:	Meeting the target for renewable energy and gross electricity consumption
2020 target	Renewable energy will provide at least 35% of gross electricity consumption
Status in 2016	31,6%

Share of gross electricity consumption



Source: AGEE-Stat 02/2018

Trend	●●●●●
Measure	Renewable Energy Sources Act

legitimate expectations and the protection of vested interests. New installations require much lower feed-in tariffs, which will substantially reduce the load on the EEG surcharge in the long run.

What is new?

The Renewable Energy Sources Act is the central instrument for steering the expansion of renewable energy. The Act has undergone continuous development since its introduction in 2000 – with amendments to the Act in 2004, 2009 and 2012, various photovoltaic revisions and the Renewable Energy Sources Act 2014 – as well as the most recent revision, the Renewable Energy Sources Act 2017.

- 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. 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 Renewable Energy Sources Act 2017 created a paradigm shift in renewable energy funding towards more competition and greater cost efficiency. The most important renewable energy sources – onshore and offshore wind energy, large photovoltaic systems and biomass – are now required to compete in auctions, where only the cheapest offers are awarded contracts. This is the end of a phase of technology support with fixed subsidies – although hydropower, geothermal energy and small PV roof systems still have fixed feed-in tariffs.

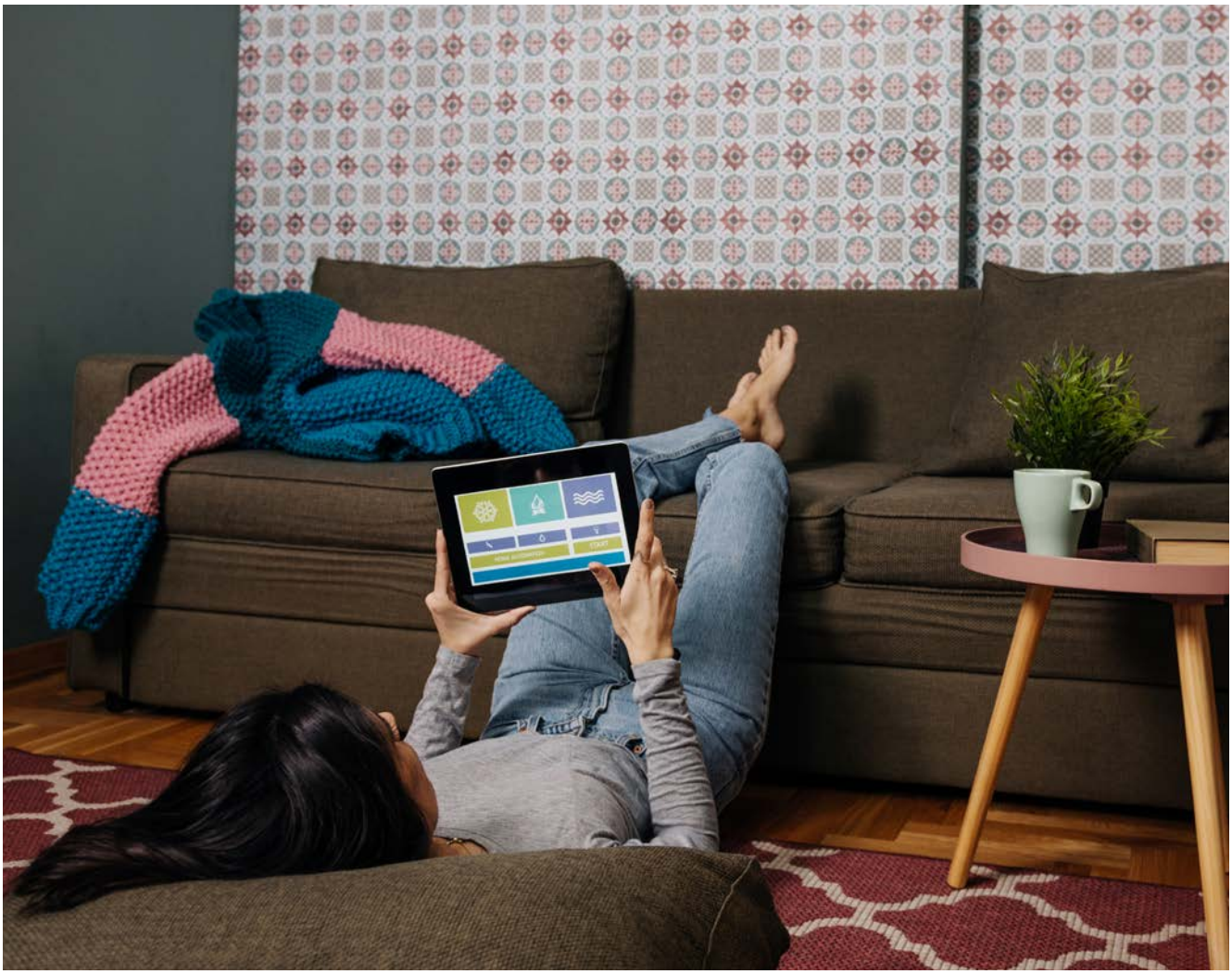
Owing to the EEG reforms in 2014 and 2017, it was possible to limit the increase in the EEG surcharge and at the same time, to promote renewable energy expansion. It has therefore been possible to slow down the cost dynamics of previous years appreciably. At the same time, the share of renewable energy sources in electricity consumption grew more rapidly than ever before – from 25% in 2013 to around 36% in 2017. There has not been an increase of 11% in any parliamentary term since the EEG became law.

The Coalition Agreement between the CDU, CSU and SPD provides for additional expansion of renewable energy that is effective, efficient, synchronized with energy grids and increasingly competitive. With these requirements in place, the goal is a 65%-share of renewables by 2030; any corresponding adjustments will be made. Special auctions for wind and solar energy aim to help reach the 2020 climate protection goal. The challenge is to better synchronise renewables and grid capacity expansion.

Central measures concerning renewables in the electricity, heating and transport sectors specifically include:

- Renewable Energy Sources Act 2017
- Act to Revise the EEG 2017
- Landlord-to-Tenant Electricity Act
- 2015 Revision of the Market Incentive Programme
- harmonised regulatory system for the heating market
- measures regarding electric mobility/biofuels/rail transport
- promotion of heat pumps
- low-temperature heat networks with seasonal thermal energy storage

5 Energy consumption and energy efficiency



Where do we stand?

Primary energy consumption rose in 2016 compared with the year before. In 2016, primary energy consumption stood at 13,451 PJ, up 1.4% on the previous year. Compared with the reference year (2008), primary energy consumption in Germany had dropped by 6.5% in total in 2016. Primary energy consumption has dropped by 0.8% annually since 2008. In order to reach the 2020 reduction target, consumption would have to be reduced by 3.8% annually from now on – the reduction rate would have to increase by a factor of almost five. Overall, there is a great need take action to achieve the savings target as quickly as possible.

Between 2008 and 2016, final energy productivity increased by 1.1% on average each year, which clearly falls short of the target of an annual increase of 2.1%. Final energy productivity would have to increase by an average of 4.2% annually in the four years between the reporting year 2016 and 2020 to achieve the pre-determined target set by the Energy Concept.

Gross electricity consumption stayed fairly constant in 2016 compared to the previous year. Gross electricity consumption refers to the volume of electricity consumed in Germany. In 2016, this figure was around 597 TWh.

Between 2008 and 2016, gross electricity consumption declined by around 3.6%, an average decline of about 0.5% annually. In order to reach the 10% reduction goal by 2020, electricity consumption would have to go down by an average of 1.7% annually from 2016 to 2020.

Diagram:	Meeting the primary energy consumption target
2020 target	20% reduction in primary energy consumption (compared with 2008)
Status in 2016	-6,5%

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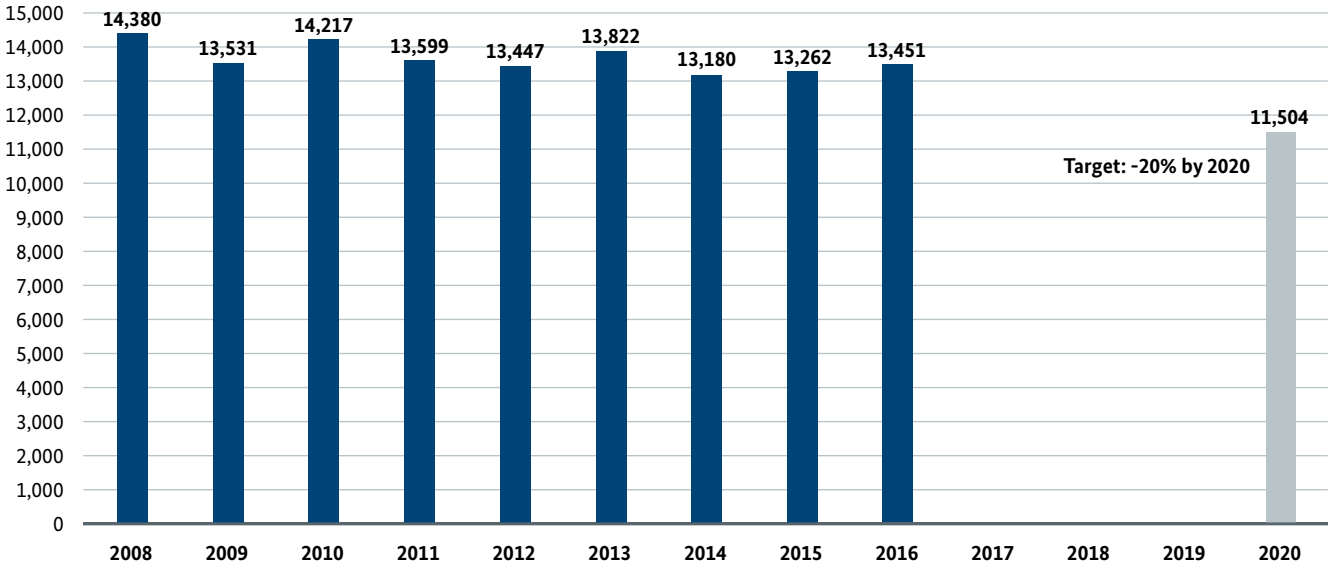


Source: Working Group on Energy Balances, 8/2017

Trend	●●○○○
Measures	National Action Plan on Energy Efficiency and other existing energy efficiency programmes

What is new?

With its Green Paper on Energy Efficiency, the Federal Government has launched consultative processes that look to promote energy efficiency policies. The next step is to develop an efficiency strategy for the Federal Government. The "Efficiency First" principle is to be established as the guiding principle for energy policy.

With the National Action Plan on Energy Efficiency (NAPE), the Federal Government in 2014 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.

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

To do this, NAPE defines cross-sector measures designed to reduce energy consumption. The goal was to utilise NAPE measures to boost energy efficiency to save 390-460 PJ of energy in total primary energy by 2020.

The measures proposed by NAPE and the energy policy resolution of 1 July 2015 have already been introduced and are starting to show results. The tax incentive proposed by NAPE for building refurbishment could not be implemented because no agreement was reached with the

Länder. As a substitute, the Federal Energy Efficiency Incentive Programme (incentives in the buildings sector) was provided with 42.5% funding, the portion of Federal financing intended for the original tax incentive.

In 2016 all of the programmes for which there is data have achieved a reduction of about 11 million tonnes of CO_2, which is about 140 PJ of primary energy savings. These comprise both new savings from efficiency measures carried out in 2016, as well as savings in 2016 resulting from earlier energy-efficiency work (this is called the NAPE logic). A direct comparison with projected effects of NAPE is not possible because in some cases they reflect the increased funding of only some of the programmes. This applies in particular to the CO_2 building renovation programme. Table 8.1 of the full version of the Monitoring Report shows the effects of NAPE measures projected for the period to 2020.

Table: Effects of NAPE in 2016 that have been quantified up to now

NAPE measures 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	Primary energy savings (in PJ)	CO_2 savings (cumulated in kilo tonnes of CO_2 equivalent)
	2016	2016
NAPE measures (only those with quantifiable primary energy savings in 2016)		
CO_2-Building Modernisation Programme: residential buildings	101	7,683
CO_2-Building Modernisation Programme: non-residential buildings	not specified	466
Energy Efficiency Incentive Programme (APEE), measures carried out by KfW (Reconstruction Loan Corporation) and BAFA	2	142
National Efficiency Label for old heating systems	0.02	133
Market Incentive Programme on Promoting Measures for Use of Renewable Energy in the Heating Market (MAP)	1	792
KfW Energy efficiency improvement Programme for Production Facilities and Processes	16	475
Energy Efficient Networks Initiative	1	36
Mandatory energy audits for non-SMEs	4	264
SME Energy Transition and Climate Action Initiative	1	37
Energy-efficient and Climate-smart Production Processes	3	183
National Top Runner Initiative (NTRI)	0.2	not specified
STEP up! „STromEffizienzPotenziale nutzen“ (Utilize energy efficiency potential)	0.1	6
Funding guidelines for energy management systems	1	67
Energy consulting	5	325
Programmes on the basis of decisions made 1 July 2015		
Heating optimisation	0.03	2
Funding for horizontal technologies	6	359
Waste heat	0.78	52
Total effect	**140**	**11,022**

Source: Federal Ministry for Economic Affairs and Energy, 5/2018.

6 Buildings

Where do we stand?

Final energy consumption in buildings, hereinafter also referred to as heating energy demand, rose in 2016, reaching 3,235 PJ, an increase of 4.3% over 2015. This increase was largely due to the relatively cold temperatures compared to the previous year, leading to increased heating demand.

Even if heating demand in the previous three years increased again, it has decreased by 6.3% overall since 2008. This means that heating energy demand fell annually by around 0.8% on average during this period. To reach the target of cutting heating energy demand by 20% by 2020 compared to the 2008 baseline, heating demand would have to drop on average 3.9% annually between 2016 and 2020 – five times faster than previously.

Primary energy consumption of buildings was 3.2% lower in 2016 than in the previous year. Primary energy consumption has already decreased by over 18% since 2008. This is equivalent to an average annual reduction of 2.5%. This is a clear indication that Germany is on the right track to reducing primary energy consumption.

What is new?

Numerous programs for the buildings sector were expanded in 2016 – some under the Energy Efficiency Strategy for Buildings (ESG) – and new measures were initiated. For example, the Energy Efficiency Incentive Programme (APEE) includes a “Heating and Cooling Package” funding

component, a new subsidy for efficient combination solutions. Also new is the "Programme for Promotion of Heating Optimisation Using High-Efficiency Pumps and Hydraulic Balancing" (HZO) aimed at low-threshold, "smaller" efficiency measures – a logical addition to the existing funding landscape that could provide an incentive to take additional efficiency measures. Another funding initiative introduced in April 2016 with the title "Energy-efficient Buildings 2050 - Innovative Projects for a Virtually Climate-neutral Building Stock in 2050" provides assistance and support for innovative solutions and technologies, with the aim to broaden their impact. To use the benefits of digitisation in the area of energy efficiency, the Federal Ministry for Economic Affairs and Energy started the Energy Savings Meters pilot programme in May 2016. To satisfy the high demand and avoid a discontinuation of this program, the budget has already been doubled. In addition, the Heating Networks 4.0 funding programme was initiated in July 2017 as a systematic assistance programme for the heating infrastructure, which encompasses not only stand-alone technologies and components, but also entire systems. The ESG was also incorporated into the Climate Friendly Building and Housing Strategy, part of the Federal Government's 2050 Climate Action Plan.

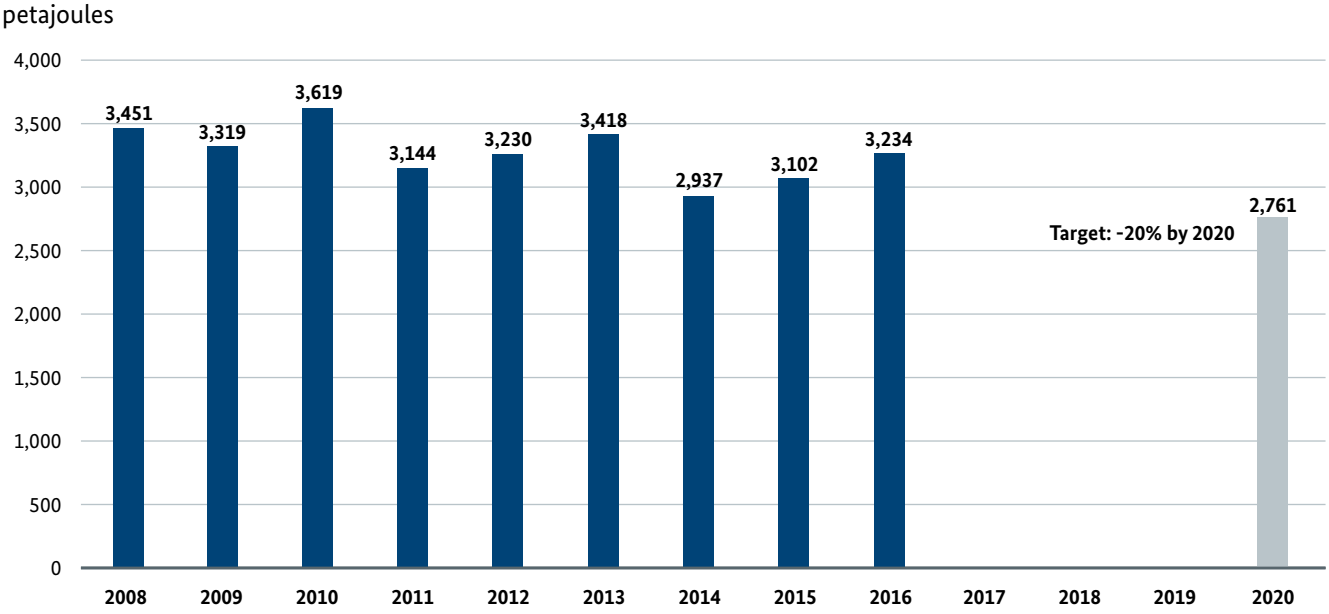
The CO_2 Building Modernisation Programme, the Market Incentive Programme for Renewable Energies in the Heat Market (MAP) and the Market Incentive Programme for Renewable Energies (APEE) were very successful in 2016. These programmes were extensively utilised in 2016. The KfW programmes for energy-efficient construction and retrofitting – part of the CO_2 building renovation programme – are still in high demand.

Energy consulting programmes are important components of the Federal energy efficiency and climate policies. Professional energy consultation can unleash potential for efficiency and savings, as well as clarify the costs of implementation and how to finance such measures or apply for funding. At the same time, energy consulting empowers energy consumers to develop their own knowledge and helps them avoid imprudent investments.

Central measures in the buildings sector are found in the table in Chapter 5.

Diagram: Meeting the target for heating energy demand

2020 target	20% reduction in heating energy demand (compared with 2008)
Status in 2016	-6,3%



Source: Working Group on Energy Balances, 11/2017

Trend	●●●○○
Measures	National Action Plan on Energy Efficiency, Efficiency Strategy for Buildings and Climate Action Programme

7 Transport

Where do we stand?

Final energy consumption in the transport sector increased in 2016. Taking all modes of transport together, final energy consumption in the transport sector stood at 2,696 PJ in 2016, up 2.9% on the previous year. The transport sector therefore accounted for roughly 29% of total final energy consumption in Germany.

Final energy consumption in the transport sector has increased by a total of 4.2% compared against the baseline year, 2005. Final energy consumption in the transport sector has therefore increased annually by around 0.4% on average since 2005, and by as much as 0.9% annually since 2010. In light of this, considerable additional efforts will be required to turn this trend around as soon as possible. In order to drive down the final energy consumption in the transport sector by 10% by 2020, this figure would have to drop by a total of 13.7% compared to 2016 in the coming four years, and annually by an average of 3.6%. This is improbable.

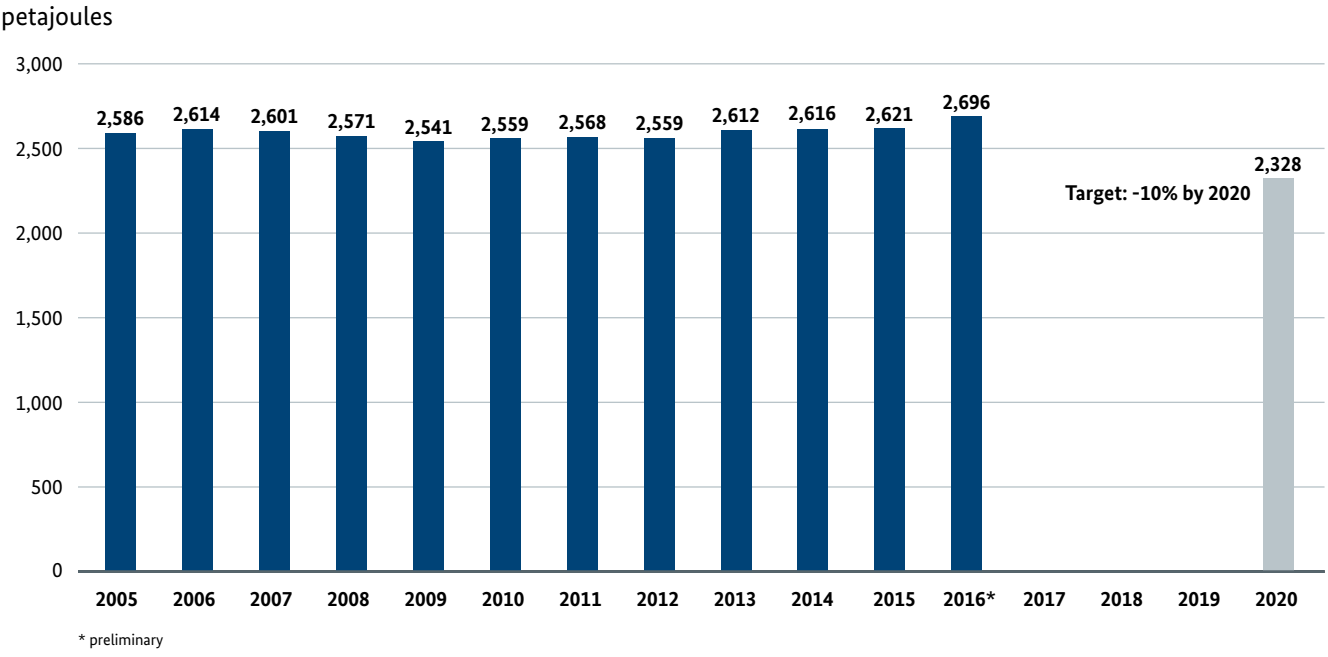
The number of electric drive vehicles is increasing rapidly, but the market share is still small. Around 62,500 battery-powered 3-wheel-plus vehicles were registered in 2016, around 21,000 of which were externally chargeable hybrid electric vehicles. However, their market share remained at less than 0.8% of new passenger car registrations. In addition to 3-wheel-plus electric drive vehicles, increasing numbers of two-wheel electric vehicles, such as pedelecs and e-bikes, can be seen on German roads.

What is new?

A reversal of the trend in the transport sector, with 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 not offset growing energy consumption in the transport sector resulting from the significant increase in the volume of traffic. With the Mobility and Fuel 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 designed to further reduce final energy consumption in the transport sector. 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, as well as the potential of digital solutions.

Future mobility will be sustainable, interconnected and increasingly energy efficient – particularly rail transport –

Diagram:	**Meeting the target for final energy consumption in the transport sector**
2020 target	10% reduction in final energy consumption (compared with 2005)
Status in 2016	4,2%



Source: Working Group on Energy Balances, 9/2017

Trend	● ○ ○ ○ ○
Measures	Consumption/Efficiency/Climate change mitigation, Electric mobility/Alternative fuels/Refilling and charging infrastructure, Shift to environmentally-friendly modes of transport

but also passenger car traffic. Alternatively-fuelled vehicles are the key to sustainable and climate-neutral mobility in the long term. E-mobility is a major focus of activities. The priority now is to speed up the development of a market for such technologies. The number of electric cars (without hybrids) has increased more than tenfold overall since 2010. They are either battery-powered or use fuel cells that convert hydrogen into electric power in the vehicle. The goal is to make Germany a leading market and provider for electric mobility and thereby entice the entire value-added chain to set up business here. The eco-bonus will be provided up to 2019 at the most for promoting sales of electrically operated vehicles. A total of €600 million has been set aside for this programme.

Central measures in the transport sector specifically include:

- **Consumption, efficiency and climate change mitigation:**
  - continued development of the 2013 Mobility and Fuel Strategy (MKS)
  - new World Harmonised Light Vehicle Test Procedure (WLTP)
  - Strategy for Automated and Connected Driving
  - Eighth Act amending the Road Traffic Act
  - Action plan to create ethic rules for self-driving computers
  - Reform of the EU Regulations on Reducing CO_2 Emissions of New Passenger Cars and Light Commercial Vehicles
  - EU Regulation on Monitoring and Reporting of CO_2 Emissions as well as Fuel Consumption of New Heavy-duty Vehicles
  - EU Regulation on binding annual emission reductions by Member States from 2021 to 2030 (Effort Sharing Regulation)
  - climate action law
  - creation of a commission and drafting a strategy for the “Future of Affordable and Sustainable Mobility”

- **Electric mobility – alternative fuels – refilling and charging infrastructure:**
  - Electric Mobility Market Incentive Package
  - “Local Electric Mobility” funding programme
  - Charging Station Ordinance I, II and III
  - Regulations on Minimum Technical Requirements for the Safe and Interoperable Deployment and Operation of Publicly Accessible Electric Vehicle Recharging Points
  - Charging Infrastructure Financial Assistance Programme
  - “Renewable and Mobile” funding programme
  - Second Act amending the Energy Tax Act and the Electricity Tax Act
  - Round Table on Gas-based Mobility
  - Maritime Technologies of the Next Generation R&D programme
  - Taskforce on LNG in heavy-duty vehicles
  - H_2 Mobility project
  - Clean Air 2017-2020 immediate action programme
- **Switching to more environmentally-friendly modes of transport:**
  - Promotion of investment in rail infrastructure
  - 2020 National Cycling Plan (NRVP)
  - 2030 Federal Transport Infrastructure Plan (BVWP)
  - Clean Air 2017-2020 immediate action programme
  - Federal programme: Hydrogen and Fuel Cell Technology 2016-2026 – from market preparation to competitive manufacturing processes
  - funding for intermodal transport
  - shifting city/metropolitan traffic to rail – improving air quality in cities

8 Greenhouse gas emissions and environmental impacts

Where do we stand?

According to 2016 estimates of the Federal Environment Agency, total greenhouse gas emissions in Germany have fallen by 27.3%, or a total of 342 million tonnes of CO_2-equivalent, since 1990. The increase since 2015 is about 3 million tonnes.

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. Emissions in the transport sector went up the most, with an increase of 4 million tonnes over 2015, or 2.5%. The increase in transport emissions is primarily due to the fact that road haulage increased by 2.8% and passenger car traffic by 2%. Private households were affected by the relatively cool weather and also leap day. Temperature trends and the corresponding higher demand for heating led to an increase in emissions of households and other small consumers of 3.5 million tonnes (+4.1%). The greenhouse gas emissions of the energy sector dropped by 1.4%.

Weather conditions, low commodity prices and a high electricity export surplus had a major bearing on the climate footprint for 2016. 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 2016. 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.

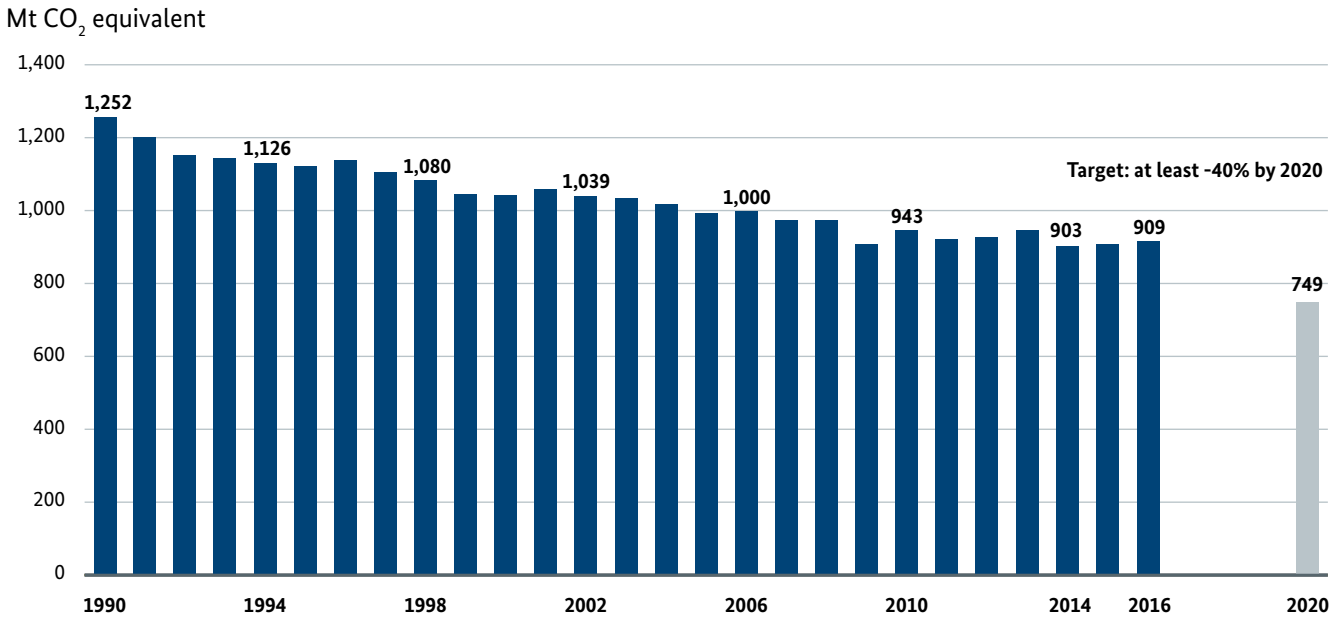
Replacing fossil fuels with renewables is a key factor in reaching climate goals. Total emissions of around 160 million tonnes of CO_2 equivalent were avoided in 2016, benchmarked against a reference system without renewable energy and with the same demand. The GHG emissions saved correspond to the emissions generated by the road traffic sector in 2016. The electricity supply sector accounted for emissions of 119 million tonnes of CO_2 equivalent. The use of renewable energy sources in the heating sector reduced emissions by 34 million tonnes of CO_2 equivalent, and the use of biogenic fuels, by 7 million tonnes.

What is new?

The 2020 Climate Action Programme is the central instrument to make up the difference between current figures and 2020 targets identified in the 2013 Projection Report. The Action Programme is designed to contribute between 62 and 78 million tonnes of CO_2 equivalent toward reaching the climate change target. This aggregate contribution is based on contributions from more than 110 individual measures.

The quantification to assess the impact of measures to reduce emissions, as illustrated in the 2017 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. It shows that the measures of the Action Plan are effective, and that a substantial contribution can be expected toward reaching the climate change

Diagram:	**Meeting the target for greenhouse gas emissions in Germany**
2020 target	Reduction in greenhouse gas emissions of at least 40% (compared with 1990)
Status in 2016	-27,3%



Source: Working Group on Energy Balances, Federal Environment Agency 12/2017

Trend	●●●○○
Measure	2020 Climate Action Programme

goal as quickly as possible. However, the current assessment also shows that the total projected effect of the individual measures in the amount of 40 to 52 million tonnes of CO_2 equivalent for 2020 ranges below the figure for 2014. This estimate is however subject to uncertainties regarding assumptions and effects. In particular, there is often no empirical basis for quantification of newly introduced measures. For this reason, the Federal Government does not espouse evaluating the individual contributions of the measures. Furthermore, there are additional ongoing and planned studies that will be taken into account in future assessments. The Federal Government will continue to implement these measures and evaluate their effects on lowering emissions. However, it is not likely that the measures will deliver the desired reductions by 2020. According to a current study of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, the programs implemented up to now can be expected to reduce greenhouse gas emissions by around 32% compared with 1990. This would create a gap of about 8 percentage points.

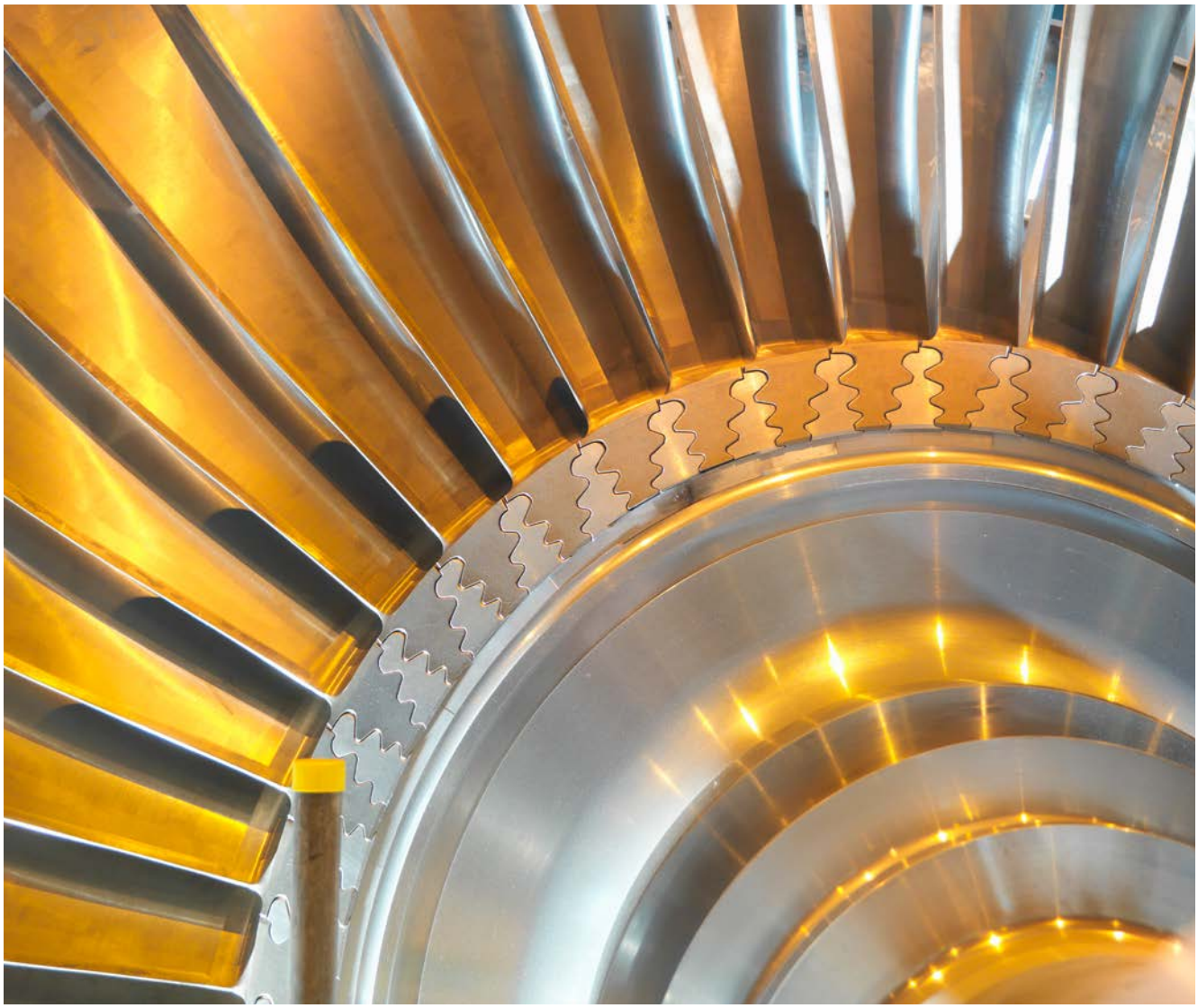
The 2050 Climate Action Plan adopted by the Federal Government in November 2016 is based on the outcome of the 21st Framework Convention on Climate Change and is being implemented as a modernisation strategy on three levels: It develops concrete guiding principles for the individual action areas for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

The Federal Government set up the "Growth, Structural change and Jobs Commission" in June 2018, which is tasked with presenting specific recommendations on the topics specified in the resolution which created this commission. One important task is to draft a programme of action with the focus on the areas specified in the resolution.

Central measures of climate change mitigation specifically include:

- Measures for reaching the 40% target
- The 2050 Climate Action Plan and the planned 2030 Programme of Measures

9 Power plants and security of supply



Where do we stand?

Germany's electricity supply is secure. There is enough energy to cover demand in Germany at all times, guaranteeing a high level of supply security.

Installed renewable capacity showed strong growth again in 2016. Overall, the net nominal capacity of power generation installations connected to the German grid increased by roughly 68 GW in total between 2008 and 2016. In 2016, the nominal capacity of electricity generation plants based on renewable energy amounted to 105 GW, up 7% on the previous year. The share of nominal capacity from renewables increased in 2016 to roughly 49% of total power plant capacity.

Combined heat and power (CHP) is an important component of the energy transition, and plays a special role in conventional electricity generation and local heating supply. The goal of the Combined Heat and Power Act (CHPA) is to expand CHP. This act therefore envisions expanding power generation to 110 TWh in 2020 and 120 TWh in 2025. In fact, CHP electricity generation was already at 117.1 TWh in 2016 – an increase of 11% over the previous year. Heat generation grew by about 5% to 224.1 TWh, meaning that the 2020 goal was achieved four years early, and was even exceeded. The goal for 2025 will most likely also be achieved.

The energy supply is also secure for the electricity grid. The duration of power interruption at the distribution grid level has remained at a consistently low level, even under international standards. Each year, the Federal Network Agency publishes the "System Average Interruption Duration Index" (SAIDI), which reports on the average outage duration per connected final consumer at the distribution grid level. The index stood at 12.80 minutes in 2016, close to the previous year's level. Viewed over the long term, the interruption duration has been continually shrinking.

What is new?

In the period 2017-2020 the existing overcapacity in conventional power plant capacity will probably be reduced somewhat. The total capacity of conventional power generation plants hardly changed over the previous year, but a slight decrease in black coal energy was balanced out with an increase in gas. According to the Federal Network Agency, new conventional power plant capacity added during this time will amount to around 2.3 GW of net nominal capacity nationwide. On the other hand, 4.5 GW of conventional power plant capacity will be shut down, primarily in the area of nuclear energy.

By October 2019, 13% of lignite capacity will be put on security standby. Under the 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 by 2020. This reduction is an important contribution to climate change mitigation.

Supply security will also be ensured at the European level. The German electricity market is closely connected to the electricity markets of its "energy neighbours", meaning its geographical neighbours as well as Sweden, and in the future, Norway. By taking advantage of smoothing effects across a large area, particularly in the event of peak loads and the feed-in of renewable energy, less energy overall will be required than would be in an isolated energy market without efficient connections to neighbouring countries.

The funding for long-term costs of nuclear shutdown are available – solving one of the major challenges arising from the nuclear phase-out. On 3 July 2017 German nuclear power plant operators paid a total of €24.1 billion to Bundesbank acounts of the fund for financing nuclear waste disposal. This ends their responsibility for nuclear waste disposal in the area of interim and final storage. The responsibility for management and financing of interim and final storage was transferred to the Federal Government as soon as all payments were received. However, the companies still have complete responsibility for decommissioning and dismantling of nuclear power plants, as well as for properly packaging radioactive waste and for the financing of these activities. Combining operational obligations with financial responsibility for the operators is regulated by the Draft Act on the Redistribution of Responsibility for Nuclear Waste Management that entered into force in June 2017.

Central measures in the area of supply security and power plants specifically include:

- Electricity Market Act
- Amendment to the Electricity Network Access Ordinance (StromNZV)
- SMARD (the new electricity market platform)
- Capacity Reserve Ordinance
- Amended Combined Heat and Power Act (December 2015 and 2016)
- Combined Heat and Power Auction Ordinance
- Act on the Redistribution of Responsibility for Nuclear Waste Management
- Commission for the storage of high-level radioactive waste (Final Repository Commission)
- Act Modernising the Repository Site Selection Act and other Legislation
- Establishment of a central market master data register
- Act amending the Security of Gas Supply Regulation (EU) 2017/1938

10 Affordable energy and a level playing field

Where do we stand?

The Federal Government sees cost efficiency as one of the main criteria for optimal implementation of the energy transition. The EEG surcharge cost dynamics of previous years slowed appreciably, thanks to various amendments to the EEG.

Final consumer expenditures for final energy consumption dropped in 2016 from €215 billion to €212 billion. This was primarily attributable to the continued sharp decline in the prices for oil and natural gas on international markets.

Final consumer expenditures for electricity went down in 2016, from €75.3 billion in 2015 to €74.1 billion. This reduction of 1.6% is attributable to market-driven components of electricity prices. On the other hand, expenditures related to government-induced and regulated electricity price components showed an increase. Taken as a share of GDP, electricity expenditures decreased in 2016 by around 4.7%, the lowest level since 2010. In 2016, the share of nominal GDP comprising final consumer expenditures for electricity was at 2.4%, compared to 2.5% in 2015.

Private household spending on energy dropped in 2016. On average, an individual household spent about €2,681 on energy in 2016, a drop of 2.4% over the previous year. Spending on fuel dropped the most, by 5.9%. Households spent 1.6% less on average on lighting than in the previous year, yet heating costs remained about the same. By con-

trast, average spending on process heat, used for example for cooking, went up by around 2.4%.

Electricity prices went up in 2016. On the reference date in April 2016, households paid 29.80 ct/kWh on average compared with 29.11 ct/kWh the year before, an increase of 2.4%.

German industry spent approximately the same amount on energy as in the previous year. Energy is an important cost factor for industry and therefore has a bearing on the ability of industry to compete with other countries. Industry spent a total of €36 billion on energy, as in the previous year. Lower prices made up for the 1.3% increase in consumption. Prices on the global energy commodity markets dropped strongly once again.

What is new?

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 prevent manufacturers from 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 in the long term.

Regulations preventing carbon leakage help reconcile the competitiveness of German industry with climate change mitigation requirements. It is already a fact that the German economy produces more but has less greenhouse gas emissions. 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 also needed at the global level, to limit greenhouse gas emissions that could otherwise be shifted to countries with possibly lower climate change mitigation standards.

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

- The Renewable Energy Sources Act 2017 adopted in early 2017 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.
- The Network Charges Modernisation Act entered into force in July 2017, and also helps to regulate the gradual removal of the costs incurred from avoided grid fees. Between 2017 and 2018, the costs for avoided grid charges in electricity distribution systems sank overall by more than €1 billion, which resulted in a corresponding cost savings for energy consumers. Both measures can help to significantly reduce costs to the final consumer that arise from operating, modernising and expanding the electricity grid.
- Other measures: The efficient use of energy and energy conservation will be the basis for lower energy expenditures 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
  - Efficiency Strategy for Buildings (ESG)

Central measures in establishing a level playing field specifically include:

- EEG Special equilisation scheme and special compensation arrangements for self-supply
- reductions in the CHP surcharge
- relief provided by the Energy Tax Act and Electricity Tax Act, e.g. energy tax cap
- partial free allocation in the EU emissions trading system
- relief from grid charges

11 Environmental compatibility of the energy supply system

Where do we stand?

It is essential not only to prove that greenhouse gases are going down, but also to ensure that any environmental impacts or effects on human health or the environment attributable to the energy transition are identified early on. If, for, example, less fossil fuels are burned and Germany phases out nuclear energy, environmental pollution will be greatly reduced, thereby lowering health risks. On the other hand, it is important to ensure that the continued expansion of renewable energy and other technological developments do not result in greater negative – or especially serious – impacts on health and the environment.

The energy industry is responsible for a large portion of air pollution in Germany. In addition to greenhouse gases, air pollutants in particular are released in all sectors in which fossil fuels and biogenics are burned. As an example, in 2015 the energy sector was responsible for a major portion of nitrogen oxide emissions (about 25%), sulphur dioxide emissions (over 60%), particulate matter (PM2.5, almost 9%) and mercury emissions (about 65%). These pollutants are not only harmful to the environment but also have an adverse effect on human health.

The demand for natural resources and where energy plants are located are factors for any type of energy generation – due both to climate change mitigation and environmental considerations and to economic efficiency. With highly efficient use of resources and sustainable land use, the energy transition can be a model for climate change mitigation. Efficient use of resources requires resource-efficient planning, production and operation of plants as well as mostly closed resource loops. If natural resources must be

imported, it is also essential that international environmental and social standards are complied with during raw material extraction and to increase transparency of resource supply chains. A greater emphasis on using power from renewable energy sources at the stage of raw material extraction as well as in manufacturing plant components will reduce even further the climate and environmental impact of energy produced with renewables.

Efforts to protect biodiversity and basic resources required by nature and humans make the energy transformation much more acceptable to the public. In general, it is apparent that structural change in the energy sector brings about completely new effects on the environment – influencing the appearance of the landscape, the ecosystem and biodiversity. At the same time, reduced use of conventional fuels lowers the burden on nature.

Energy sector emissions also affect human health. For example, nitrogen oxide (NO_2) is a byproduct of combustion plants and combustion engines that is harmful to respiratory passages and makes other pollutants even more irritating, which may lead to respiratory or cardiovascular disease. Particulate matter is also harmful to human health.

Not only emissions, but also noise pollution can have negative effects on human and animal health. Being exposed to consistently high decibel ranges can lead to health issues. In order to properly assess the effects of the energy system, it is important to take noise pollution into consideration.

What is new?

The first step for monitoring the effects of the energy transition on the environment and human health is to establish a quality evaluation tool for the effects and changes in the environment accompanying the energy transition. Comparable times series – like those for the development of greenhouse gases – are not yet available for assessing the environmental compatibility of the energy system. For this reason, the Federal Environment Agency has commissioned a study in order to close this data gap. Other research projects are currently being developed for the Federal Agency for Nature Conservation. The pressing issue is to determine the impact of expanding renewables and the energy grid on nature and the landscape. Another focus of research is also developing means for avoiding conflicts between nature conservancy and renewables expansion. The Federal Office for Radiation Protection is running a research programme on radiation protection in conjunction with expansion of renewable energy.

The results of this study will be used to systematically develop a new environmental monitoring process for the energy transition. The focus should be on effects of the energy transition – the energy system and its transformation – in the areas of

- soil, air and water
- natural resources and land use
- nature and the landscape
- human health

This is an ongoing process.

The central measures in the area of environmental compatibility of the energy transition specifically include:

- German Resource Efficiency Programme II
- the first Nitrogen Report of the Federal Government
- environmental monitoring of the expansion of renewable energy in the area of electricity
- BGZ Gesellschaft für Zwischenlagerung mbH, a federally-owned company for interim storage of nuclear waste
- Prohibition on unconventional fracking for extracting natural gas and oil

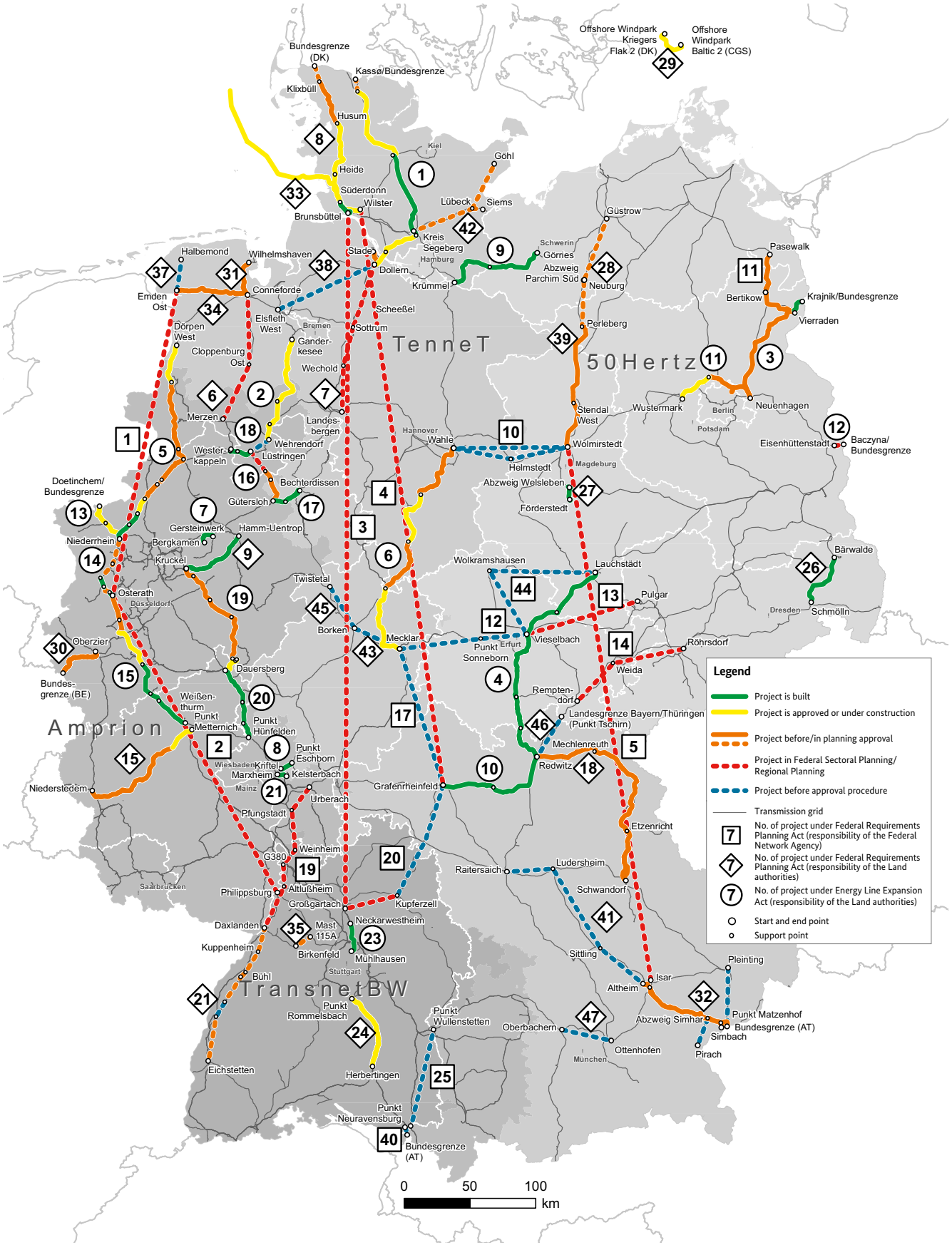
12 Grid infrastructure

Where do we stand?

The grid expansion measures that have been agreed must be implemented without delay. Around 40% of the Energy Line Expansion Act projects had been implemented by the end of the first quarter of 2018. More than half of the projects have already been approved, however. The Thüringer Strombrücke (Thuringia electricity network) went online completely in September 2017. It is also just as important to implement the projects proposed by the Federal Requirements Planning Act as quickly as possible. This process has entered the next phase, as federal planning has commenced for SuedLink and SuedOstLink in 2017 and for A-Nord in early 2018, three big extra-high voltage, direct current transmission lines.

The public is closely involved in the grid expansion planning process. This applies to 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 to the public.

Projects under the Energy Line Expansion Act and the Federal Requirements Planning Act



Source: Federal Network Agency, 3/2018.
Note: Graphic representation of the state of development of line expansion projects under the Energy Line Expansion Act and the Federal Requirements Planning Act as of 31 March 2018. 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.

The expansion of the power grids requires greater investment. Grid operator investments in German power grids and expenditures on maintenance increased to a total of €9.6 billion in 2016. Inter alia, this comprises costs for financing underground cabling, which is funded through grid-use charges and borne by end users. Most of the investment in the transmission grid – about €2.1 billion – went to new grid construction and grid reinforcements. Further to this, €366 million were spent on grid maintenance and repair. At the distribution grid level, grid operators invested around €3.7 billion in the expansion and €3.5 billion in the maintenance and repair of the infrastructure.

In terms of grid stability and quality, reliability of the grid infrastructure in Germany remains at a very high level. The costs of ancillary services increased slightly in 2016. The share of ancillary service expenses that can be attributed to congestion in the power grid (especially redispatch, feed-in management and grid reserve) increased slightly from €1.0 billion in 2015 to €1.2 billion in 2016.

What is new?

The costs of grid expansion and operations are distributed more fairly. The Network Charges Modernisation Act (NEMoG) that entered into force in July 2017 aims to harmonise grid-use charges in Germany by 2023 and to gradually remove regional differences. In addition, the costs incurred from avoided grid fees will be gradually removed. The slow removal will lead to a moderation of distribution grid costs and thereby help stabilise energy prices.

Power distribution grids increasingly face new tasks. Feed-in to the distribution grid is increasing, because over 90% of installed capacity from renewable energy installations are connect to it, and more and more energy consumers are also electricity producers. Because the distribution grids are not designed for such electricity feed-in, however, there is increased need for investment. The improvement of electric mobility will present new challenges to the expansion of the power distribution grids. Smart grids must be developed to meet this need, with smart connections between grids, and between grids and electricity generation and consumption. To this end, the Bundestag adopted the Act on the Digitisation of the Energy Transition in July 2016. The SINTEG funding program was started at the end of 2016, with a total of five showcase regions that try out innovative processes, technologies and business models for consumers, storage and grid operators.

Utilise the potential offered by optimising the existing grid

In order to reduce costs of network congestion problems in the transmission grid, in early 2017 the Federal Ministry for Economic Affairs and Energy launched a comprehensive stakeholder process together with the Federal Network Agency, the German Energy Agency, BET Aachen, associations and companies, and worked out an action plan. The work group developed seven measures in addition to expanding the grid that should lower economic costs and improve utilisation of the electricity grid in the short term. This includes optimal grid monitoring and structural improvements to five sections of the transmission grid, especially installation and upgrade of high voltage transmission lines. These measures should be implemented by 2023. The stakeholders involved expect to achieve a significant reduction of costs in net network congestion management by implementing these measures. The transmission grid operators assess this savings potential at more than €200 million annually.

Central measures in the field of grid infrastructure specifically include:

- Network Charges Modernisation Act (NEMoG)
- revision of the Incentive Regulation Ordinance
- Act to Amend Provisions of the Law Governing Power Line Construction
- continued development of the monitoring of German grid expansion projects
- further development of the Ordinance on Agreements Concerning Interruptible Loads
- Electricity Market Act
- Act on the Digitisation of the Energy Transition

13 Integrated development of the energy system

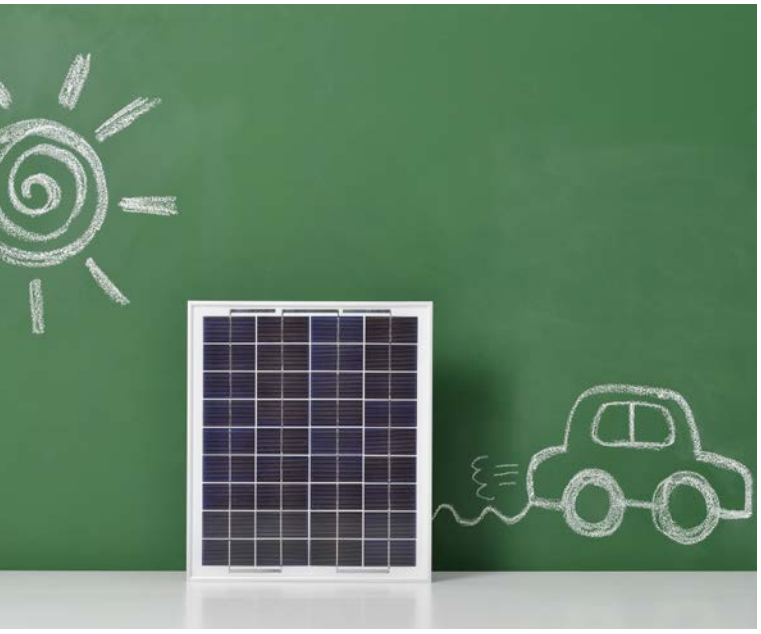
Where do we stand?

The economically efficient integration of the electricity, heating and transport sectors contributes increasingly to decarbonisation, greater efficiency and a more flexible energy system. The importance of heat pumps for heat generation has increased dramatically. 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 the efficient use of renewable electricity (sector coupling).

Digitisation links the energy sector with modern information and communication technology. Digitisation uses innovative, customer-friendly business models to create new potential for efficiency improvements and for integrating renewable energy. Data protection and data security are a high priority in this process.

What is new?

The integrated development of the energy system will drive forward coupling of the energy, transport and buildings sectors as well as industry, in combination with storage technologies. Municipal utilities and distribution system operators have a key role by virtue of their connections to utility companies and consumers and with local public transport. The goal is to design a framework such that development of various energy infrastructures – including existing gas and heating infrastructures for sector coupling – is coordinated and cost efficient. Alongside this, flexible infrastructures also play a central role.



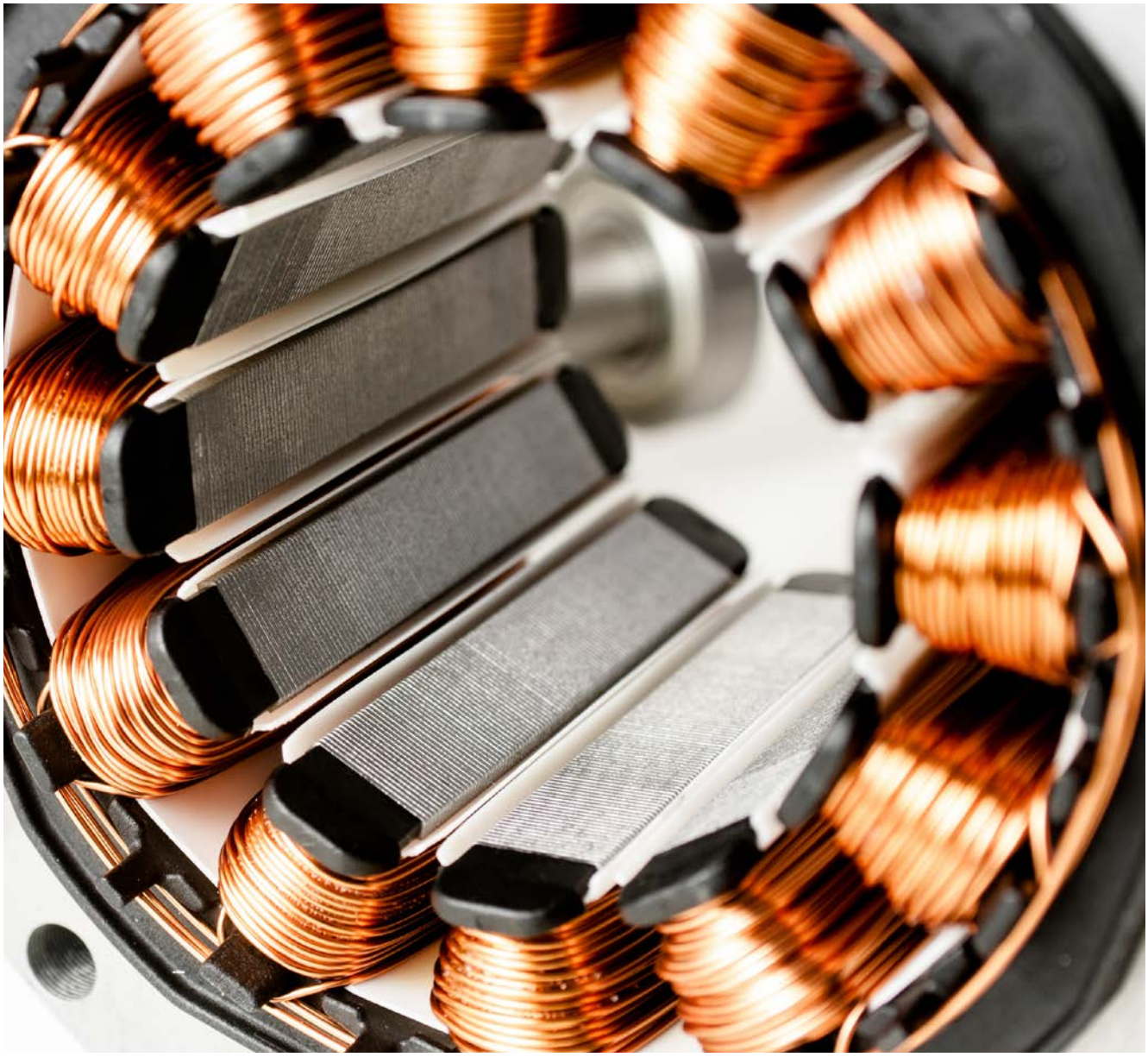
The digitisation of the energy transition has begun. With the Act on the Digitisation of the Energy Transition and the SINTEG programme (Smart Energy Showcases - Digital Agenda for the Energy Transition), the Federal Government has taken important steps towards defining the framework for digitisation in the power sector. Work on this path to smart grids, smart meters and smart homes must be rigorously continued. Applications in these areas benefit from a communication platform modelled on the principle "Data Protection and IT Security By Design". This platform includes transparent rules for data communication. The Federal Ministry for Economic Affairs and Energy and the Federal Office for Information Security are developing standards for a smart meter gateway for the aforementioned areas. Work plans will be part of a "Standardisation Strategy Roadmap for Cross-sector Digitisation in accordance with the GDEW" (Global Distribution Express Worldwide). This will also benefit businesses outside of the energy sector.

The results of consultations on the Green Paper on Energy Efficiency and on the Electricity 2030 discussion paper of the Federal Ministry for Economic Affairs and Energy also demonstrate how digitisation can contribute to the success of the energy transition and reaching energy policy goals. To assist in the digitisation process, it is especially important to utilise the potential that the GDEW provides for creating smart grids for an affordable energy supply. Innovative business models will be tested in model regions and results compiled to determine how to adapt the legal framework (SINTEG programme: Smart Energy Showcases – Digital Agenda for the Energy Transition). This should help integrate flexible utilities and consumers into the distribution network.

Central measures specifically include:

- **Sector coupling:**
  - Electric mobility eco-bonus
  - promotion of heat pumps
  - low-temperature heat networks with seasonal thermal energy storage
  - promotion of innovative CHP systems in the CHP Act
- **Digitisation of the energy transition:**
  - Act on the Digitisation of the Energy Transition (GDEW)
  - "Digitisation of the Energy Transition: Barometer and Main Topics" project
  - Standardisation Strategy Roadmap for Cross-sector Digitisation in accordance with the GDEW (Global Distribution Express Worldwide)
  - SINTEG programme
  - Energy Savings Meters pilot programme
  - enhancing federal funding programmes for market introduction of the climate-friendly smart Efficiency Plus Building Standard, because these buildings of the future will take on an additional function of "smart energy managers" (network and notification of energy use in and around a house and in the neighbourhood)

14 Energy research and innovation



Where do we stand?

Business investment in research and development for innovative energy technologies continued to increase in 2016. Within the framework of publicly funded energy research projects alone, businesses invested around €155 million in the development of innovative energy technologies in 2016. 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.

The Federal Government again increased the budget for energy research in 2016. From 2013 to 2016, the Federal Government provided a total of about €3.6 billion to promote the research and development of modern energy technologies. In 2016, €876 million was spent on the Sixth Energy Research Programme. This corresponds to an increase of 1.5% over last year, nearly doubling the amount in ten years. Funding for energy research is in high demand, and is popular with companies and research institutes. In 2016, 92% of the funding set aside was paid out. About three-

fourths of the annual budget went to energy efficiency and renewable energy. The annual Federal report on energy research gives a comprehensive overview of all major developments.

"Horizon 2020", the European research and innovation framework programme, is given high priority in Germany. Of the projects approved, some 14% of this European funding will go to Germany.

Energy storage is becoming increasingly important as the share of renewable energy in the energy supply continues to grow. The Federal Government has invested around €184 million since 2011 in various storage technologies for the energy transition. It is developing customised funding activities as part of its Seventh Energy Research Programme, and supports a large range of storage technologies with its projects.

What is new?

Energy research will become even more important going forward. Medium-term financial planning will provide for €1.105 billion for project funding in 2020. Also in the European context, Germany will continue to 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 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. Interministerial 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 in the energy transition using electricity-based fuels.

Innovative and highly efficient energy technologies are essential requirements for a secure, economical and climate-friendly energy supply. Only through increased R&D can the German economy continue to maintain a leading position in technology and competitiveness. The coalition agreement between the CDU, CSU and the SPD provides in particular for specific funding for energy research on industry processes that are low in CO_2 emissions or on CO_2 closed cycles.

Central measures in the field of energy research specifically include:

- consultation on the Seventh Energy Research Programme
- Energy transition - Research and Innovation platform (R&I platform)
- Energy research networks
- "Energy transition in the Transport Sector" research initiative
- "Energy-efficient Buildings 2050" funding initiative
- "Solar Construction/Energy-efficient Cities" funding initiative
- "Sustainable Power Grids" research initiative
- "Energy Storage" research initiative
- National Hydrogen and Fuel Cell Technology Innovation Programme (NIP 2) for the 2016 to 2026 funding period
- Copernicus projects
- "Energy Systems of the Future" Academies' project
- Energy Transition Research Forum
- "Biomass Energy Use" funding programme
- "Renewable Resources" funding programme
- Programme collaboration: Energy Transition Research Alliance at the German Federation of Industrial Research Associations (AiF)
- "Carbon2Chem" research initiative
- "Mobility2Grid" and "Flexible Electrical Networks" research campuses

Central measures for the promotion of market introduction of innovative technologies specifically include:

- promotion of stationary fuel cell heating as part of the Energy Efficiency Incentive Programme
- Hydrogen and Fuel Cell Technology Government Programme for the 2016-2026 funding period
- Additional examples of innovation funding: Energy Efficiency Incentive Programme; Strategy for Automated and Connected Driving; Electric Mobility Showcase; "PV battery storage systems" funding programme

15 Investment, growth and jobs

Where do we stand?

The energy transition in Germany is part of a macroeconomic modernisation strategy to open up new market potential and to provide tangible impetus for growth and jobs with billions of ongoing investment. Investments are key to discovering growth and employment possibilities in the German economy and also remaining competitive in the future.

Spending on improving the energy performance of buildings is an important factor for reforms in energy supply. According to the German Institute for Economic Research (DIW) and the Institute of Economic Structures Research (GWS), €42.5 billion were spent in 2016 on this, compared with €39 billion in 2015. Building energy retrofitting is a main focus of measures to increase energy efficiency.

Investments in construction of installations using renewables once again increased slightly in 2016. At around €15.2 billion, they were above the 2015 level but below that of previous years. Investments were made especially in electricity generation, but also to a small degree in generating heat from renewable sources. The moderate growth in investment that brings about relatively significant increases in capacity shows that costs for capacity expansion per installation are going down.

The energy transition has led to a moderate increase in macroeconomic price levels. GWS and Prognos 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 (since 2005, on average 0.1 percentage points). This development is also understood in the context of overall low inflation in Germany.

Germany currently covers around two-thirds of its energy needs through energy imports. This greatly exposes the German economy to often volatile global market prices. The prices of these fossil fuels have declined considerably in recent years, thereby relieving the burden on consumers to some extent. Nevertheless, an important goal is to loosen the dependence on individual suppliers.

The demand for imports of fossil fuels would have been higher in the absence of renewable energy and energy efficiency efforts. According to GWS, the estimated dampening effect of renewables and energy efficiency on the demand for imports of fossil fuels in 2016 is calculated at €16.1 billion. This means specifically that businesses and households had relatively lower expenditures for energy, savings which were put into personal savings or consumption, or increased corporate profits.

The job impact of the energy transition affects both the energy sector in the stricter sense and industries that supply the energy sector with goods. These two areas must be considered together. Each individual area requires workers. The expansion of renewables and investments in energy efficiency sharpens the focus on the fact that increased demand for capital goods in these areas also leads to an increase in manufacturing and jobs in industries outside of the actual energy sector.

Direct employment in the energy industry in Germany has remained stable, and areas related to renewables are growing in importance. Employment over all areas (adjusted for the overlap with renewables) was at about 218,000 in 2016. Added to this are jobs for operation and maintenance of renewable energy installations – 76,000 in 2016 – and 69,000 for production of biomass and biofuels. Overall, the energy sector employed around 360,000 individuals, which corresponds closely to employment trends observed since 2000 by DLR, DIW and GWS. Renewable energy has become an important economic factor, which is evident from the employment figures. Expansion of renewable energies provided around 339,000 jobs in 2016. In 2016, 10,000 more jobs were created in renewables compared to 2015; the leader is the wind energy sector. Investments in building energy retrofitting employed almost one-half million people.

What is new?

In 2016 a number of regulations were adopted to make planning feasible and to create a stable framework for investments in the energy system. This includes the EEG 2017, the Electricity Market Act, the Digitisation of the Energy Transition Act (GDEW) and the Revision of the Incentive Regulation Ordinance.

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