Federal Ministry
for Economic Affairs
and Energy

Energiewende
Switch to the Future

The Energy of the Future

8th Monitoring Report on the Energy Transition – Reporting Years 2018 and 2019

bmwi.de

Imprint

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

Status
February 2021

This publication is available for download only.

Design
PRpetuum GmbH, 80801 Munich

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Central messages of the 8th Monitoring Report

The Federal Government is pursuing ambitious goals with its energy transition. It is a process that will ultimately enable Germany to shape its energy supply in a sustainable manner and create new potential for value creation in Germany's commercial and industrial sectors. In this respect, cost efficiency, security and environmental compatibility are and will remain the guiding criteria for its energy supply.

The energy transition is not a national solo effort. It is in fact firmly embedded in European energy policy and is happening on a global scale. This means that, to be successful, the energy transition must also be seen in global and holistic terms. As far as the measures being implemented are concerned, the Federal Government is relying on market processes to move forward with the energy transition in a technology-neutral and cost-effective manner in line with specified targets.

Generally speaking, the European Union (EU) as a whole is on track to achieve its energy and climate targets for 2020. In terms of greenhouse gas reductions, for example, the sectors covered by the European Emissions Trading Scheme (EU ETS) and the non-ETS sectors at EU level have already met their respective emission reduction targets of 21% and 10% respectively. At EU level, the Clean Energy for All Europeans legislative package in particular has successfully determined the direction the energy transition is to take in Europe and in Germany. The package entered into force in 2019 and sets ambitious targets for 2030 and beyond. The Green Deal proposed by the European Commission at the end of 2019 is intended to make Europe the first climate-neutral continent by 2050, while strengthening competitiveness at the same time.

The share of renewable energy sources in gross electricity consumption had already reached a level of 42.0% in 2019. After the target of at least 35% laid down in the Renewable Energy Sources Act (EEG) 2012 had already been surpassed in 2017, the EEG 2017 target corridor of 40 to 45% for 2025 was subsequently reached in 2019. The prime driver of electricity generation from renewables was wind energy, with onshore wind energy at around 52% accounting for more than half of the total renewable electricity generated in 2019. The strong growth in both wind and PV generation of electricity in 2018 and 2019 resulted in renewables overtaking coal-fired electricity generation in particular as Germany's main energy source.

Primary energy consumption was down by 2.6% in 2019 compared with the previous year. As a result, energy consumption in Germany dropped to its lowest level since the early 1970s. Further improvements in energy efficiency and shifts in the energy mix also contributed towards this development. Despite the average annual reductions of 1% achieved to date since 2008, the savings target set for 2020 (minus 20%) will no longer be met. In view of the medium to long-

term energy and climate targets, the Energy Efficiency Strategy 2050 (EffSTRA) was adopted in 2019. This strategy not only sets an energy efficiency target for 2030, but also bundles and specifies the measures required to achieve this target in demand sectors in an updated National Action Plan on Energy Efficiency (NAPE 2.0).

Final energy consumption in the buildings sector was up 4.2% in 2019 compared with the previous year. Since 2008, it has decreased by an average of 1% per year. This means it will not be possible to achieve the 2020 savings target (minus 20%). The long-term modernisation strategy for public and private buildings was adopted in 2020. It includes a roadmap for the national building stock with indicators and indicative milestones for achieving the long-term energy and climate targets and identifies ways and incentives to renovate the national building stock.

The heat transition in the buildings and industry sectors is an important element of the energy transition. Quite apart from energy efficiency and the direct use of renewables, electricity generated from renewable sources, neighbourhood approaches, the use of waste heat, green gas and biomass, plus heat and electricity storage, will also play a significant role in the heat transition when used in heat pumps, for example, or in the production of green hydrogen.

Final energy consumption in transport continued to move counter to the 2020 savings target (minus 10%) in 2019, increasing by 1.1% compared with the previous year and 7.2% compared with the 2005 baseline. Significant further efforts are needed to reverse the trend as soon as possible. The electrification of vehicle drive systems or the use of alternative fuels and a stronger focus on public transport and rail transport will contribute to reducing greenhouse gases emitted in the transport sector.

Greenhouse gas emissions were down 5.4% in 2019 compared with the previous year, and 35.1% compared with the 1990 reference year. The Covid-19 pandemic will further reinforce the positive trend of recent years towards achieving the 2020 target (a reduction of at least 40% from 1990 levels).

The Coal Phase-out Act, which entered into force for the most part on 14 August 2020, essentially implements the energy policy recommendations made by the Commission on Growth, Structural Change and Employment (KWSB) in 2019. Among other things, it contains provisions to reduce and ultimately eliminate hard coal and lignite-fired electricity generation by 2038 at the latest. Germany's power supply is nevertheless secure, despite the phase-out of nuclear energy and coal-fired electricity generation. The energy demand in Germany is covered at all times, providing the country with a high level of security of supply. The pan-European electricity market also makes a significant contribution to this, thus guaranteeing this high level of

security. The Coal Phase-out Act is supplemented by the Structural Support for Coal Regions Act, the aim of which being to put the structural policy recommendations of the KWSB for sustainable and forward-looking structural development into practice in those regions affected by the coal phase-out.

The affordability of energy for private households and the economy is one of the guiding criteria in the implementation of the energy transition. Electricity in particular must remain affordable for all final consumers and competitive for German industry. That is why the Federal Government is striving to make the energy transition as cost-effective as possible, reducing the EEG surcharge from 6.88 to 6.79 ct/kWh in 2018, for example, with a further reduction to 6.41 ct/kWh in 2019. In 2020, it amounted to 6.76 ct/kWh. Revenue from national CO_2 pricing and subsidies from the economic stimulus and future package will reduce the EEG surcharge to 6.5 ct/kWh in 2021 and to 6.0 ct/kWh in 2022. Electricity prices for household customers remained almost constant in 2018 and increased by 3.2% in 2019. For industrial customers not covered by relief schemes, electricity prices rose by 2.7% in 2018 and 4.4% in 2019. This was primarily due to higher procurement and distribution costs, which are market-driven and beyond government control.

Final consumers spent more overall on final energy in 2019 than in the previous year. However, as a share of economic output, final energy expenditure was down year-on-year. At 6.5%, it had even reached its lowest level since 2002, as the increase in energy consumption was more than offset by the rise in nominal gross domestic product.

For the energy transition to succeed, renewable energy sources and power grid capacities must be synchronised to an even better extent and grid expansion accelerated. In 2019, forward-looking internal auditing was introduced and the Act to Accelerate the Power Grid Expansion (NABEG revision) was passed. The revised version simplifies and accelerates planning and approval procedures for new construction, reinforcement and optimisation of grids by partially waiving federal sectoral planning, strengthening the notification procedure and creating the potential for forward-looking planning by laying empty pipes.

Sector coupling, digitisation and energy research are further keys to a successful energy transition. The economically efficient integration of the electricity, heating and transport sectors is contributing more and more now to decarbonisation and increased energy efficiency, as well as making the energy system more flexible. In a complex system with numerous, heterogeneous players on the supply and demand sides, digitisation enables intelligent networking and thus greater control of generation and consumption.

In view of the key role played by energy research in achieving a successful energy transition, research and development each received funding amounting to over €1 billion in 2018 and 2019. In this respect, energy research is becoming increasingly system-driven. A new focus is on technology and innovation transfer by means of regulatory sandboxes for the energy transition, which were launched in 2020 and also included a hydrogen project.

The energy transition is a modernisation strategy that is triggering extensive investments in Germany's economy – especially in the energy-efficient modernisation of buildings, the power supply and the switch to electric mobility. The energy transition will thus provide impetus for more growth and employment in Germany. It will also help to create innovation and new market potential, and in this way will offer tremendous opportunities for innovative business models. The digitisation of the energy transition will also make a major contribution to such efforts. Specific industrial sectors and business models are currently facing structural change, which is where the Federal Government comes in to provide support.

Even under the difficult conditions currently being experienced during the Covid-19 pandemic, the Federal Government remains on track with its energy transition. Additional impetus for growth and innovation in the economy, for example, is coming from the energy policy elements of the Economic Stimulus and Future Technologies Package launched in June 2020 (e.g. as a result of the National Hydrogen Strategy, the expansion of project-based research and the extension of the CO_2 building modernisation programme).

Many German companies will benefit from doing business in new, innovative energy technologies. In 2018, for example, systems and components for the use of renewable energy sources worth some €10.5 billion were exported. The rise in global demand for mature renewable energy systems and energy efficiency technologies will improve opportunities even further. International energy partnerships that fund policy dialogue and support business activities will also become increasingly important.

1. Introduction

The Energy of the Future monitoring process tracks the extent to which the goals of the energy transition are being achieved with a view to setting up an economic, secure and environmentally compatible energy supply and the measures which are being implemented to this end. The German energy transition with its ambitious goals is embedded in the European energy transition (see Chapters 2 and 3). The monitoring process provides the basis for making whatever adjustments are necessary. It focuses on three main tasks:

Overview: The monitoring process provides a fact-based overview of the progress being made in implementing the energy transition. For this purpose, the enormous amount of energy-related statistical information available is condensed and processed to provide a number of selected parameters (indicators).

Evaluation: Based on the current status, the annual monitoring reports assess the extent to which the targets set out in the Federal Government's Energy Concept have been achieved and what impact the measures are having. In the event of any foreseeable failure to meet targets, consolidated progress reports based on a multi-year data basis suggest what measures are to be implemented at three-year intervals to remove obstacles and achieve the targets.

Outlook: The monitoring process also focuses on the foreseeable further development of key indicators. To this end, progress reports that are published every three years provide an indication of reliable trends. Measures mentioned in the report that have not yet been implemented will be implemented at a later date on the basis of the budgetary and financial principles of the Federal Ministries currently in force, subject to the availability of the budget funds required.

The core element of the monitoring process is the annual monitoring report, which provides new facts on the energy transition. The current 8th Monitoring Report documents the status of the energy transition for 2018 and 2019 and evaluates the progress made towards achieving the 2020 targets.

Embedded in the European and international context (Chapter 3), Part I summarises the current progress towards implementing the quantitative targets of the energy transition in the following areas:

- Progress in the expansion of renewable energy sources (Chapter 4)
- Development of energy consumption and energy efficiency (Chapter 5) with a focus on three action areas: electricity, heating and transport
- Energy policy targets and measures in the buildings sector (Chapter 6) and in the transport sector (Chapter 7)
- Development of greenhouse gas emissions (Chapter 8)

Part II focuses on additional targets and policies affecting the energy transition:

- Development of the power plant fleet in terms of security of supply, especially in light of the phase-out of nuclear power and coal-fired generation (Chapter 9)
- Affordability of energy for private households and businesses (Chapter 10)
- Environmental compatibility of the energy supply system (Chapter 11)
- Grid infrastructure (Chapter 12)
- Sector coupling and digitisation of the energy transition (Chapter 13)
- Energy research and innovation (Chapter 14)
- Effects of the energy transition on investments, growth and employment (Chapter 15)

At the end of the report, a tabular overview describes the implementation status of the corresponding measures (Chapter 16). Additional indexes provide details of the sources and references included in the report, in addition to the abbreviations used.

A commission of independent energy experts oversees the monitoring process. Based on scientific evidence, the members of the commission subsequently give their opinions on the Federal Government's monitoring and progress reports. Prof. Dr. Andreas Löschel (University of Münster) is the chair of the commission. The other members are Prof. Dr. Veronika Grimm (University of Erlangen-Nuremberg), Prof. Dr. Barbara Lenz (German Aerospace Center) and Prof. Dr. Frithjof Staiß (Centre for Solar Energy and Hydrogen Research Baden-Württemberg). 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 will help to boost public acceptance. The Federal Government publishes key data on the energy transition in reports that appear on a regular basis. Dialogue with the commission of experts on the Energy of the Future monitoring process and the high-level energy transition platforms that focus on the electricity market, energy efficiency, buildings, energy grids and research and innovation encourage discussion and the sharing of ideas and opinions with representatives from the Länder, the business community, society and academia. This ultimately can lead to the development of common solutions and strategies for the main action areas of the energy transition.

2. Objectives of the energy transition and monitoring indicators

With the energy transition, Germany is gradually converting its energy supply from fossil and nuclear energy sources to renewable energy sources. The course mapped out for the energy transition – and thus the basis for monitoring its progress – is the Federal Government's Energy Concept, supplementary decisions taken by the Bundestag, in addition to European requirements. The national targets are in line with the ambitious targets adopted at EU level. The energy policy target triad of affordability, security of supply and environmental compatibility remains the central guiding principle of Germany's energy policy.

EU goals are described in detail in Chapter 3. The reduction of greenhouse emissions in Germany is anchored in a European framework. The EU had committed itself to reducing emissions by 20% by 2020 compared with 1990. Key instruments for this included the European Emissions Trading System for the industrial, energy and intra-European aviation sectors, in addition to effort sharing in the other sectors. Whereas the target for the EU ETS sectors is not allocated to Member States, the reduction target for non-ETS sectors is broken down into national targets for each individual Member State in accordance with the EU Effort Sharing Decision. Accordingly, Germany had committed itself to reducing its emissions in these sectors by 14% by 2020, compared with 2005 (see Chapter 3).

Table 2.1: Targets at European and international level

EUROPE INTERNATIONAL	To create a reliable European and international framework for more climate protection, renewables and energy efficiency.

Part I of the Monitoring Report examines the quantitative targets of the energy transition. As Table 2.2 shows, these targets extend through to 2050, with some milestones set for 2020, 2030 and 2040.

Table 2.2: Quantitative targets of the energy transition and the current status (2018, 2019)

	2018	2019	2020	2030	2040	2050
GREENHOUSE GAS EMISSIONS						
Greenhouse gas emissions (compared with 1990)*	-31.5%	-35.1%	at least -40%	at least -55%		Greenhouse gas neutrality
RENEWABLE ENERGY						
Share of gross final energy consumption	16.8%	17.4%	18%	30%	45%	60%
Share of gross electricity consumption	37.8%	42.0%	at least 35%	65%**		***
Share of heat consumption	14.8%	14.7%	14%			
EFFICIENCY AND CONSUMPTION						
Primary energy consumption (compared with 2008)	-8.7%	-11.1%	-20%	-30% →		-50%
Final energy productivity (2008 – 2050)	1.6% per year	1.4% per year	2.1% per year			
Gross electricity consumption (compared with 2008)	-4.2%	-6.9%	-10% →			-25%
Non-renewable primary energy consumption in buildings (i.e. primary energy demand) (compared with 2008)	-26.0%	-23.6% →		-55%		
Heat consumption in buildings (compared with 2008)	-14.4%	-10.9%	-20%			
Final energy consumption in transport (compared with 2005)	6.1%	7.2%	-10% →			-40%

Source: In-house data from the BMWi, September 2020

* The targets indicated for 2020, 2030, 2040 and 2050 represent Germany's currently existing, political greenhouse gas reduction targets.

** Target specified in the Climate Action Programme 2030 and the Renewable Energy Sources Act 2021. The prerequisite for this is an additional targeted, efficient, grid-synchronised and increasingly market-driven expansion of renewable energy sources in the years ahead, for which further expansion of the electricity grids is a key requirement.

*** In accordance with the Federal Government's draft law of September 2020, the EEG 2021 stipulates that all electricity generated and consumed in Germany is to be generated in a greenhouse gas-neutral manner before the year 2050.

Conversion factors used for the uniform assessment of energy sources when calculating primary energy consumption

In accordance with international convention, primary energy sources are calculated in the energy balance using the so-called efficiency rate method, which replaced the substitution method in 1995. For energy conversion using the efficiency rate method, a physical efficiency rate is assigned to energy sources that have no calorific value. For hydropower, wind energy and photovoltaics, this is 100% (equivalent to the calorific value of the electrical energy generated), and for nuclear energy it is 33%. For the import balance, which is recorded in the energy balance at the primary energy consumption level, an efficiency of 100% is also assumed. Use of the efficiency rate method is standard international practice and is required for comparison with other countries.

Part II of the Monitoring Report focuses on additional targets and policies affecting the energy transition. In some cases, no quantitative targets have been approved for these areas, which means that qualitative targets are also the main focus in such cases (see Table 2.3). There is much discussion in public and scientific communities about the extent to which the goals for security of supply and affordability, in particular, can be quantified and the achievement of the goals verified using meaningful key indicators (see EWK (2017)). As a matter of principle, any approaches that make the current implementation status of the energy transition visible in the required degree of multidimensionality are to be welcomed. However, no sufficient consensus has yet been reached in the debate on quantifying the specified goals. As a result, and for other reasons as well, Part II of the report examines the specified goals further, not on the basis of a single indicator, or a key indicator, but using a variety of indicators, which, when viewed together, provide a fairly accurate picture of the progress made in achieving these goals, considering the complexity of the issues. For example, the research project commissioned by the BMWi entitled “Definition and Monitoring of the Security of Supply in European Electricity Markets” defines indicators and threshold values deemed appropriate for the measurement and assessment of the security of supply in the electricity market (see Chapter 9).

Table 2.3: Additional targets and policies affecting the energy transition

SECURITY OF SUPPLY	To cover the energy demand in Germany efficiently at all times.
NUCLEAR ENERGY PHASE-OUT	To shut down the last nuclear power plants at the end of 2022.
COAL PHASE-OUT	To phase out coal-fired electricity generation in Germany by 2038 at the latest in a socially balanced, predictable and economically viable manner.
AFFORDABILITY COMPETITIVENESS	To maintain the affordability of energy and to ensure Germany's competitiveness.
ENVIRONMENTAL COMPATIBILITY	To make the energy supply compatible with the environment, the climate and the nature throughout the entire life cycle.
GRID EXPANSION	To expand and modernise grids to meet demand.
SECTOR COUPLING DIGITISATION	To unlock the potential of efficient sector coupling and digitisation for a successful energy transition.
RESEARCH INNOVATION	To foster forward-looking innovations for the transformation of the energy supply.
INVESTMENTS GROWTH EMPLOYMENT	To retain and create jobs in Germany and to lay the foundations for sustainable prosperity and quality of life.

Source: In-house data from the BMWi

2.1 Target architecture for the energy transition

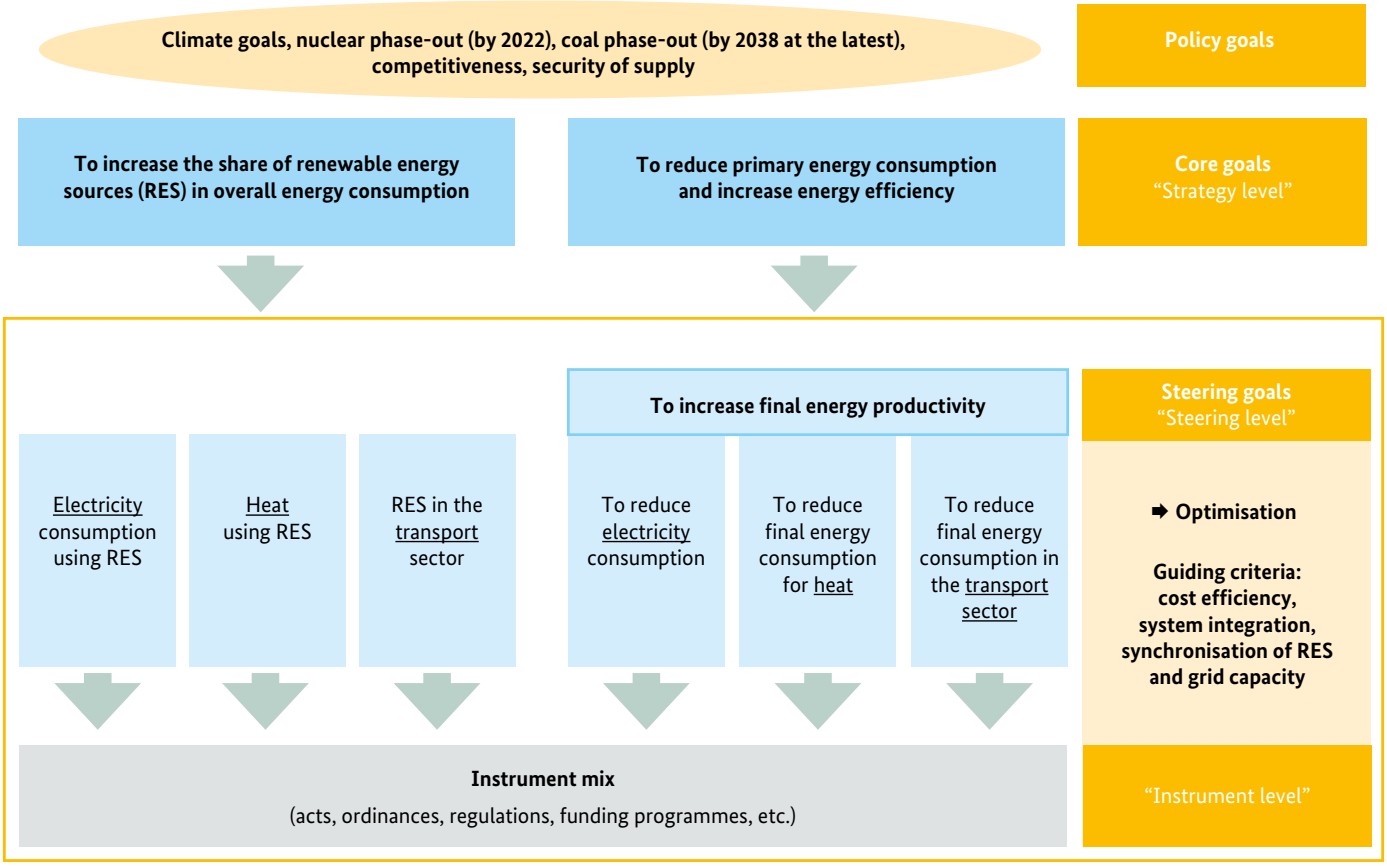
The target architecture structures the individual targets of the energy transition. With the First Progress Report on the Energy Transition, a target architecture for the energy transition was approved by the Federal Cabinet (see Diagram 2.1). This target architecture structures and prioritises the individual targets of the Energy Concept, while making a distinction between a number of different target levels:

The **policy goals** provide the framework for the transformation of the energy supply. They include:

- the climate targets, including a 40% reduction in greenhouse gas emissions by 2020 and further reductions in the decades thereafter,
- phasing out nuclear power for electricity generation by 2022,
- phasing out hard coal and lignite-fired electricity generation by 2038 at the latest, and
- ensuring competitiveness and security of supply.

The **core targets** describe the key strategies of the Energy Concept that will drive the energy transition forward. These are the expansion of renewable energy sources and the reduction of primary energy consumption, i.e. increasing energy efficiency. Both of these core targets are

Diagram 2.1: Structure of the goals of the Energy Concept



Source: In-house data from the BMWi

defined in specific terms by means of **steering targets** for the three action areas: electricity, heating and transport. The focus of the target architecture is on visualising the interaction of the individual levels and targets. The quantitative targets for 2020 and beyond are given in Table 2.2. The steering targets and **associated measures** are coordinated in such a way that the overarching goals can be achieved as reliably and as cost-effectively as possible using an integrated approach. This optimisation task also includes improved synchronisation of renewable energy sources and grid capacities (see Chapters 4 and 12).

2.2 Indicators and evaluation scheme

Monitoring of the energy transition is based on publicly accessible and verifiable data. It is carried out using selected parameters (indicators) that display the progress made in implementing the energy transition over time. Wherever possible, they are based on official and publicly accessible data. The national legal basis for official energy statistics is the Energy Statistics Act (EnStatG), which was amended in 2017 to adapt the law to the current circumstances. The official data from the reporting year 2018 onwards have been collected on the basis of the amended law. The indicators used are listed in Table 2.4 and are assigned to the various subject areas.

A points system is used to evaluate progress towards the quantitative goals of the energy transition. The progress of the indicators is initially updated linearly from 2008 onwards. Based on the percentage deviations of the updated values from the target values in 2020, points are calculated for this report as follows: 5 points are given if the target value on the basis of the update has been achieved 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 is more than 60%.

The values given in the report generally reflect the data status that was available in September 2020. Data on the Energy of the Future monitoring process is publicly available on the website of the BMWi. Reporting years are 2018 and, based on preliminary figures, as far as possible 2019. With this report, the Federal Government is simultaneously fulfilling its reporting obligations under Section 63 (1) of the Energy Industry Act (EnWG), Section 98 of the Renewable Energy Sources Act (EEG), and Section 24 of the Core Energy Market Data Register Ordinance (MaStRV), as well as under the National Action Plan on Energy Efficiency (NAPE) and the Energy Efficiency Strategy for Buildings (ESG).

Table 2.4: Indicators

The energy transition in the European and international context	• EU targets 2020/2030 • Physical flows of electricity • Emissions trading in the EU ETS • Effort sharing in non-ETS area • Global CO_2 emissions • Global installed renewable capacity • Global investment in renewable energy sources and energy efficiency
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 by technology • Sum total of EEG surcharge plus electricity prices on the exchange
Energy consumption and energy efficiency	• Primary energy consumption • Primary and final energy productivity • Gross electricity consumption
Buildings and heat transition	• 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 transport • Specific final energy consumption of the transport sector • Number of electric vehicles with more than two wheels • Number of vehicles with more than two wheels powered by fuel cells and natural gas • Shift to rail transport • Shift to local 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
Power plants and security of supply	• Installed capacity of power generation plants • Distribution of power plant capacity across the Länder • CHP, including electricity generation • Conventional generation capacities: new construction and decommissioning • Capacity of pumped storage power stations • Nuclear phase-out roadmap • SAIDI • Conventional power plants currently under construction • Country comparison of power outage duration
Affordable energy and fair competition	• Final consumer expenditure on energy and as a share of GDP • Macroeconomic energy expenditure • Energy expenditure of private households • Electricity prices of private households • Energy costs for industry • Electricity prices on the exchange • Electricity prices of non-privileged industrial enterprises • Oil and gas prices • Energy prices compared with other countries
Environmental compatibility of the energy supply system	• Environmental monitoring of the energy transition
Grid infrastructure	• Projects under the Power Grid Expansion Act (EnLAG) and Federal Requirement Planning • Grid investments • Grid fees • Costs for ancillary services
Sector coupling and digitisation of the energy transition	• Number and electricity consumption of heat pumps • Number and electricity consumption of electric vehicles • Efficient heat networks • Innovative combined heat and power (CHP) systems • Digitisation barometer, including Smart Meter Gateway certification
Energy research and innovations	• Industry expenditure on R&D • Federal research expenditure in the Energy Research Programme • Project funding using EU funds • Patents • Market uptake of innovative technologies in energy consumption
Investments, growth and employment	• Investments in renewable energy sources and energy efficiency • Investments in grids and electricity supply • Primary fossil fuels saved as a result of using renewable energy sources • Energy imports saved as a result of expanding renewable energy sources and improving energy efficiency • Number of people employed in the energy industry • Number of people employed in the renewable energy sector

Source: In-house data from the BMWi

3. Energy transition in the European and international context

Where do we stand?

The EU is basically on track to achieve its energy and climate targets for 2020. In terms of greenhouse gas reductions, the sectors covered by the European Emissions Trading System (EU ETS) and the non-ETS sectors at the EU level have already exceeded their respective targets of 21% and 10% reductions in emissions.

Germany will need to make a particularly strong effort to reduce greenhouse gas emissions in the non-ETS sectors, as well as primary and final energy consumption in order to meet its commitments under the 2020 targets for individual EU Member States.

The "Clean Energy for All Europeans" legislative package is reshaping the European energy framework and is also of tremendous strategic importance for national energy and climate policies.

With the revised directives for energy efficiency and renewable energy sources, the EU has set itself ambitious targets for the expansion of energy efficiency (at least 32.5% by 2030) and renewable energy sources (at least 32% by 2030). For the first time, specific targets for the expansion of renewable energy sources in the heating and cooling sector and in the transport sector will now apply at EU level also. The European legal framework in the electricity sector and numerous forms of collaboration are strengthening electricity trade and exchange with neighbouring countries and are thus contributing to a high level of security of supply.

The expansion of renewables and improvements in energy efficiency are making rapid progress around the world, and interest in international collaboration with Germany remains high. The key driver of global development is China.

What is new?

On 17 September 2020, the European Commission published the so-called Climate Target Plan, which proposes an increase in the EU GHG reduction target by 2030 from its current level of -40 to at least -55% compared with 1990. This target was adopted by the European Council in December 2020, and it has been submitted to the Climate Change Secretariat as the European Union's new contribution to the Paris Agreement. As a supplement to the so-called Climate Target Plan, the European Commission presented its so-called "impact assessment" on the 2030 climate target increase in September 2020.

In its work programme for 2021, the European Commission has announced legislative proposals to adapt climate and energy legislation to the new target level. In connection with the Climate Target Plan, new measures are also under discussion that will affect various sectors of the economy, including industry, the energy sector, agriculture, transport, the buildings sector, foreign trade and finance, especially through a possible expansion of EU emissions trading to additional sectors and energy taxation.

The Federal Government submitted its final National Energy and Climate Plan (NECP) to the European Commission in June 2020 and published it (BMWi (2020h)). The plan outlines Germany's energy and climate policy and makes clear how Germany will contribute, in particular, to the EU's targets for renewable energy and energy efficiency and for reducing greenhouse gas emissions by 2030. Additionally, in September 2020, the European Commission published the aggregated evaluation of the Member States' NECPs and assessed the contributions of the EU Member States to achieving the EU's 2030 energy targets. According to this, the Member States are on track to achieve the EU target for the expansion of renewable energy sources for 2030 (EU target: at least 32%; NECP evaluation: 33.7%). In contrast, according to the information in the 27 NECPs, the EU target for increasing energy efficiency for 2030 has not yet been met (EU target: at least 32.5%; NECP evaluation: 29.5%). Since the NECPs only provide information on the plans submitted by the Member States, the actual achievement of the targets in the NECP progress report remains to be monitored and awaited. In addition, a statement on the State of the Energy Union was published as part of the European Commission's Communication on 14 October 2020, which included recommendations by the European Commission for each EU member state as to what energy and climate policy measures they should implement with a view to rebuilding their economies following the Covid-19 pandemic.

In December 2019, Commission President Ursula von der Leyen published the Green Deal, which aims to make Europe the first climate-neutral continent by 2050. The associated structural change is to be cushioned in particularly affected regions and sectors with the aid of the Just Transition Mechanism. The EU's greenhouse gas neutrality target by 2050 is to be enshrined in the European Climate Act, for which the European Commission presented a proposal in March 2020.

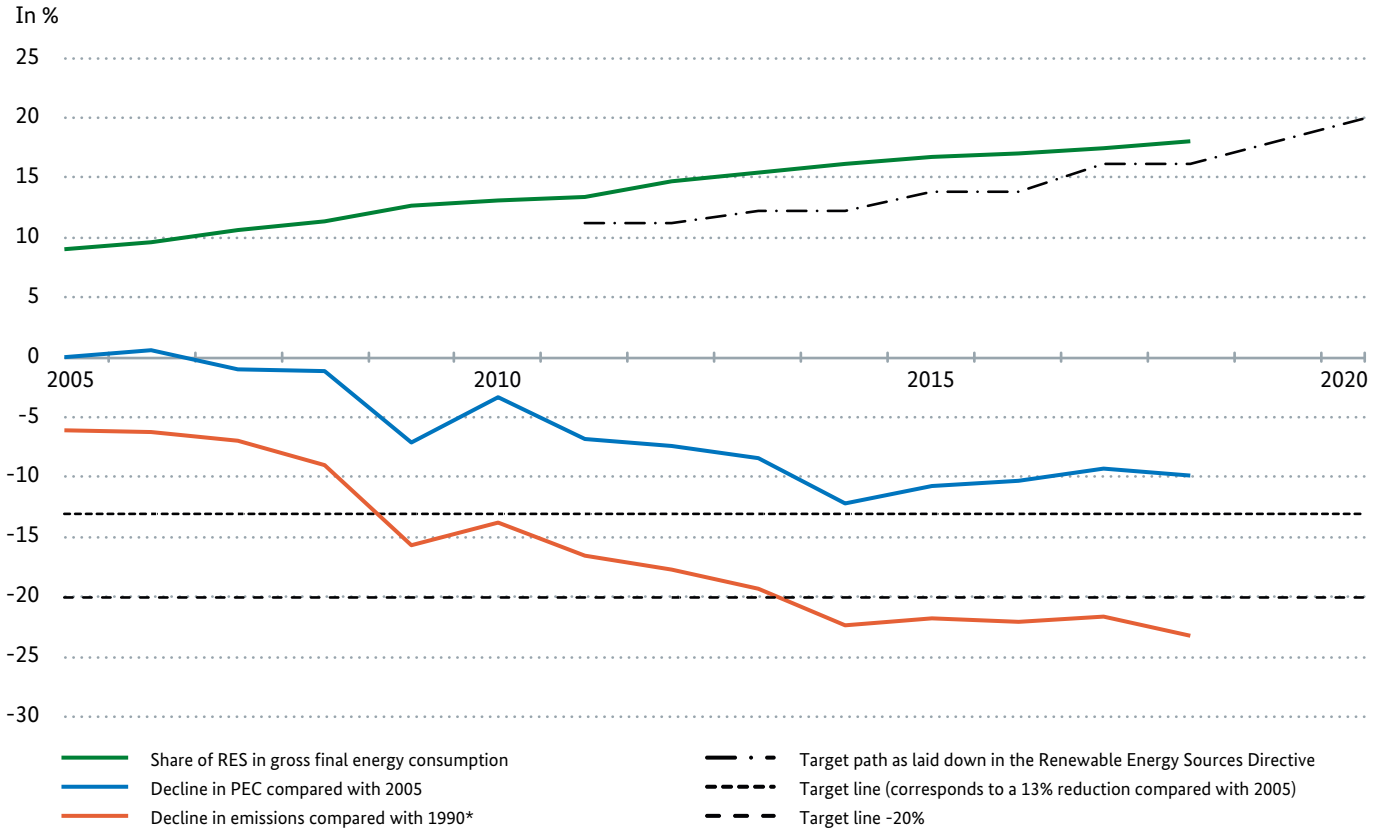
EUROPE INTERNATIONAL	To create a reliable European and international framework for more climate protection, renewables and energy efficiency.

3.1 European energy and climate policy

In terms of the goals to reduce GHG emissions by 20% (compared with 1990), to achieve a 20% share of renewable energy sources in the energy supply and a 20% reduction in primary energy consumption (compared with a baseline), the EU is either close to reaching or has already reached its targets ahead of its schedule in some areas (see Diagram 3.1). However, there is hardly any time left to close the gaps that still remain. This means there is still a need for action, particularly with regard to energy savings.

In the case of greenhouse gas reductions, the picture is positive. In 2018, emissions fell by around 2.1% compared with the previous year, even though the EU economy continued to grow. As a result, emissions were a good 23% lower than in 1990, according to preliminary data from the European Environment Agency (EEA). They thus exceeded the 20% target the EU had agreed to under the Framework Convention on Climate Change of the Kyoto Protocol. The only sector where emissions have increased since 1990 is transport, which accounts for a quarter of all greenhouse gas emissions across the EU.

Diagram 3.1: EU28* progress regarding 20-20-20 targets



Source: Eurostat 09/2020 (Renewables and primary energy consumption figures; primary energy consumption without non-energy consumption); EEA 09/2020 (Emissions figures; without LULUCF, but with indirect CO_2 and with international aviation); in-house calculations

* The United Kingdom officially left the EU on 31 January 2020. As the data given here are for the 2018 reporting year, the EU28 aggregate (i.e. including the United Kingdom) has nevertheless been used.

The EU-wide share of renewable energy sources in gross final energy consumption is no longer very far from the 20% mark. In 2018, it was around 18% across the EU and thus made a significant contribution to the decarbonisation of the energy system in Europe. Accordingly, a clear majority of the 23 Member States had exceeded their national indicative target paths set under the Renewable Energy Directive; no less than 12 Member States have already reached or even exceeded their 2020 targets. Germany also met its indicative target path under the Renewable Energy Directive, which calls for a 13.7% share of renewables in gross final energy consumption as an average level for 2017 and 2018. In fact, Germany had already achieved 16.5% in 2018 (calculated using EU methods). This brings Germany closer to its 2020 target of 18% for renewables as a share of gross final energy consumption. It is not certain, however, that the target will be achieved. This is also evident from the fact that in 2018 Germany narrowly missed its national target path under the National Renewable Energy Action Plan. This target path is more ambitious than the one in the Renewable Energy Directive and specifies a target of 16.7% for 2018 and 17.7% for 2019. In the event that Germany fails to meet its 2020 renewables target, it faces infringement proceedings with financial sanctions.

In the EU as a whole, further efforts are needed in transport to meet the sectoral 10% target for 2020 for the use of renewable energy sources. In 2018, a share of just over 8% was achieved. Renewable energies accounted for around one-third of gross electricity consumption across the EU in 2018 – with a rising trend. Wind energy is currently the largest contributor.

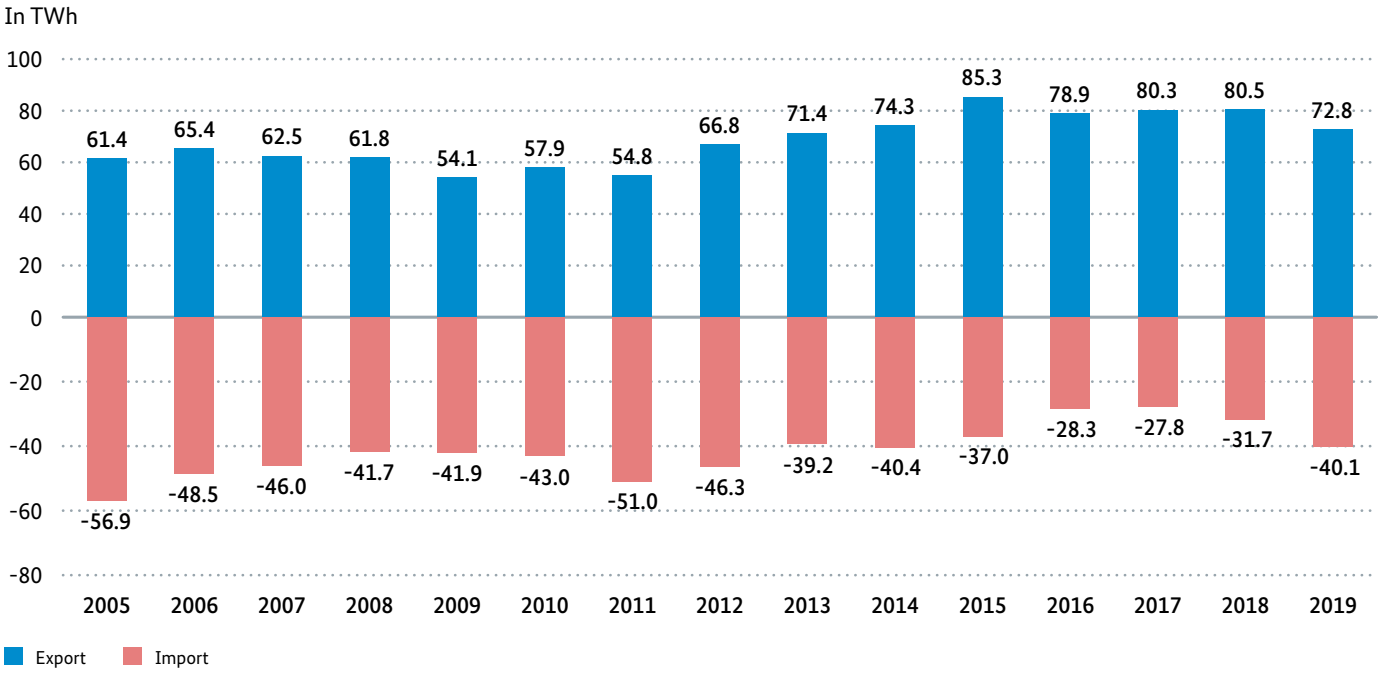
In terms of energy efficiency, the trend towards a rise in energy consumption that had been observed in the EU since 2015 did not continue in 2018. The reason for this was the comparatively warm winter of 2018 and measures implemented by the Member States to reduce consumption. Overall, primary energy consumption across the EU was down 0.7% compared with 2017. The period from 2005 to 2018 saw a decline of almost 10%, in spite of the fact that EU-wide primary energy consumption in 2018 was 64.97 EJ, which was still around 4.6% above the 2020 target (less than 62.09 EJ). This means that the amount still to be saved is roughly equivalent to the primary energy consumption of the Netherlands and Luxembourg combined in 2018. Unlike primary energy consumption, however, final energy consumption increased slightly in 2018 compared with the previous year and was 3.5% above the target (less than 45.47 EJ). This means that an amount at least equal to the combined final energy consumption of Belgium and Cyprus in 2018 would still need to be saved between 2018 and 2020 to meet the target. The increase can be attributed primarily to both the transport (increase in transport activity with a decrease in fuel efficiency due to the increasing market share of SUVs) and industry (increase in economic activity) sectors. In view of this situation, additional efforts may be needed to ensure that the EU reaches its 2020 energy efficiency targets. It must be borne in mind, however, that the Covid-19 pandemic and the associated reductions in consumption in 2020 have not yet been included in these findings.

With regard to the security of the energy supply, the EU believes a more coordinated approach will be needed in future. To meet its energy needs,

the EU is more than 58% dependent on imports from non-EU countries. This dependency is particularly acute for oil and gas. Net imports, for example, accounted for some 87% of the total gross inland consumption (EU-28) of crude oil and petroleum products in 2018, and 77% in the case of natural gas. The largest share of these (net) imports of both oil and gas came from Russia (roughly two-fifths in each case). As a result of Brexit, which is not yet included in these figures, this dependency will increase even further. In the gas sector, as is the case with electricity, the EU is relying on increased cross-border cooperation and support from Member States in order to provide security of supply.

The European electricity market is a fact. It makes a significant contribution to the security of supply. It makes more competition possible on the energy markets and thus funds affordable electricity prices for consumers in the EU Member States. In the European electricity market, Germany trades electricity with its neighbours at all times, which means that large-scale balancing effects can be used much more effectively: in June 2018, for example, the European cross-border intraday trading platform was launched to link up the electricity trading markets of Germany, France, Austria, Belgium, Denmark, Estonia, Finland, Lithuania, Latvia, Norway, the Netherlands, Portugal, Spain, and Sweden. In a second step, the intraday

Diagram 3.2: Physical flows of electricity in cross-border capacities



Source: AGEB 04/2020

energy trading markets of Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania and Slovenia were added at the end of November 2019. The project enables continuous cross-border intraday trading between the participating countries and offers market participants the opportunity to access foreign capacity to manage shortfalls or surpluses in their balancing groups at short notice. This can reduce costs significantly. Germany's physical electricity exchange with its European electricity neighbours has long been in excess of 100 TWh, with Germany's electricity exchange balance with other countries reaching an all-time high of almost 53 TWh in 2017, and then declining again quite significantly to slightly less than 33 TWh in 2019 (see Diagram 3.2).

In 2019, the comprehensive legislative Clean Energy for All Europeans package entered into force. The package forms the basis of the European energy transition and reshapes the European energy framework as far as 2030. Key elements include the new regulations for an Energy Union governance system (EU Regulation on the Governance System of the Energy Union and Climate Action, the so-called Governance Regulation) and for a new EU electricity market design (Electricity Market Directive, Electricity Market Regulation, ACER Regulation and Risk Provision Regulation), in addition to the revision of the Renewables, Energy Efficiency and Buildings Directives. The Federal Government is currently working on transposing the EU requirements into national law.

The following targets are to be achieved at EU level by 2030:

- To reduce greenhouse gas emissions by at least 55 percent (compared with 1990). The target was adopted by the European Council in December 2020 (instead of the one adopted in 2014 – at least -40%), in line with the European Commission's proposal under the so-called Climate Target Plan.
- To achieve a share of renewable energy sources of at least 32 percent of gross final energy consumption through voluntary national target contributions. The amended Renewable Energy Directive (RED II) also provides for measures to increase the share of renewable energy sources in the individual sectors. For example, EU Member States are obliged to aim for an increase in the share of renewable energy sources in the heating and cooling sector by 1.1 percentage points per year from 2021, or 1.3 percentage points if waste heat and cooling are included (however, waste heat and cooling can only be included to a maximum share of 40 percent). In transport, an obligation was introduced for the distributors of fuels to increase their share of renewable fuels to at least 14 percent by 2030. The production of biofuels based on edible plants is to be frozen at the 2020 production level. In contrast, a share of at least 3.5 percent in 2030 has been stipulated for modern biofuels obtained from non-edible plants.
- To achieve a reduction in primary energy consumption of at least 32.5 percent (compared with the energy consumption forecast for 2030 in 2007).

As a result of Brexit, slight adjustments have now been made to the target framework. In accordance with the Governance Regulation, i.e. the amended Energy Efficiency Directive, an adjustment to the absolute EU efficiency targets that result from the required reduction in energy consumption of at least 32.5% was approved in 2019. This is a purely technical recalculation for the EU-27, with no change to either the target or the underlying model basis. The EU renewables targets for 2020 and 2030 are expected to be somewhat easier to achieve overall following Brexit, as the UK's share of renewables is currently below the EU average and total EU energy consumption will subsequently be reduced as a result of Brexit. However, according to the Renewable Energy Directive, this would have no impact on the binding national targets for 2020.

A key factor when setting up an integrated electricity market is to have interconnectors between the various electricity markets. For this reason, the EU regulation on the governance system includes the target of a higher degree of interconnection between Member States. By 2030, there are to be enough cross-border transmission lines in each member state to meet the criteria required by the regulation. For example, the differences in wholesale prices between the Member States must not be too high and the transmission capacity of the interconnectors must not fall below a certain share of the peak load and the installed renewable generation capacity. Member States are obliged to report regularly on the level of interconnection.

Germany already operates interconnectors with all neighbouring countries and will significantly increase its interconnector capacity. This means that Germany will reach the European 2030 target for the degree of interconnection if the interconnectors provided for in the Energy Line Expansion Act and the Federal Requirements Plan Act are in operation by that time as planned. Accordingly, Germany will build more than 10 additional major transmission lines to its neighbours, increasing its cross-border transmission capacity by more than 50% by 2030 compared to 2019.

There is no final agreement as yet on the future post-Brexit relationship of the UK and the EU with regard to the electricity market. Without further agreements, the UK would initially be treated like a third country after the end of the transition period. Many rules, for example on the allocation of cross-border capacities, would no longer apply.

Table 3.1: Overview of key EU targets 2020 and 2030

	Actual values 2018	2020 targets	2030 targets	Comments
GHG reduction (compared with 1990)	23%	at least 20%	at least 55%	To be made binding by EU climate law (together with regulation in EU law of the 2050 target: climate neutrality).
GHG reduction in the non-ETS sector (compared with 2005)[1]	29%	21%	43%	binding
GHG reduction in the non-ETS sector (compared with 2005)[1]				
• for EU total	11.3%[2]	10%	30%	binding
• for Germany	7.7%[2]	14%	38%	binding
RE share				
• of gross final energy consumption at EU level	18%	20%	at least 32%	binding
• in Germany	16.5%[3]	18%	no country-specific targets, but national target contributions that must add up to the binding EU target (according to energy concept of BReg and NECP 30%)	binding
• in the heating/cooling sector	21% (EU) 13.6% (Germany)		according to RED II: increase of 1.1 percentage points per year (if waste heat and cooling are taken into account: 1.3 percentage points per year)	indicative
• in the transport sector	8.0% (EU) 7.9% (Germany) (incl. double counting for biofuels from waste, residues and from lignocellulose)	10% (incl. double counting for biofuels from waste, residues and from lignocellulose)	at least 14% (incl. fourfold crediting of electricity in road transport; 1.5fold crediting in rail transport; nationally definable double crediting of biofuels from residues as well as other regulations) with a maximum of 7% first-generation biofuels.	no sectoral target, but obligation to introduce a distributor quota
Reduction in energy consumption				
• at EU level	9.8% decrease in primary energy consumption (PEC) compared with 2005	by 20%[4] (corresponds to 13% decrease in PEC compared with 2005)	by at least 32.5%[3]	indicative for 2020, binding for 2030
• in the individual EU Member States	Germany's PEC is 5% above the indicative national target for 2020	indicative national targets	no country-specific targets, but national target contributions that must add up to the binding EU target (according to EffSTRA and NECP: 30% compared with 2008)	indicative
		In addition, cumulative final energy savings of 1.5% per year	in addition, cumulative final energy savings of 0.8% per year	binding
Interconnectivity in the EU Member States	In Germany (2017): 9%[6]	10%	15%[5]	binding
Electricity trading/exchange		Making the overall system more efficient and increasing security of supply		

Source: BMWi

1) see Chapter 3.2
2) provisional values; status for EU as a whole; status for Germany; the 2005 base year emissions according to EEA are calculated as follows: 2005 base-year emissions = absolute 2020 target/(1+ % of 2020 target)
3) according to the requirements of EU Directive 2009/28/EC
4) compared with the reference development for 2020 or 2030 (according to the Primes 2007 model for the European Commission)
5) in specific terms through additional threshold values
6) according to EU Communication COM (2017) 718 final

The core of the Governance Regulation consists of the Integrated National Energy and Climate Plans (NECP). They can help to achieve greater convergence of national policies. Each Member State was required to submit a draft NECP to the European Commission by the end of 2018. The final plan for the years 2021 to 2030 had to be submitted by the end of 2019. In the NECP, the EU Member States set out targets and measures for energy and climate policy up to the year 2030. The plans are intended to be comparable with each other and include, in particular, the national contributions of the Member States to the EU-2030 targets for renewable energy and energy efficiency. Overall, all five dimensions of the Energy Union are reflected in the NECP (decarbonisation, with the two sub-dimensions of greenhouse gas reduction and renewable energy, energy efficiency, security of energy supply, internal energy market, and research, innovation and competitiveness). The plans were consulted nationally with stakeholders and coordinated regionally with neighbouring countries.

The Federal Government submitted its final NECP to the European Commission in June 2020 (BMWi (2020h)). The final NECP provides an overview of German energy and climate policy as well as the current status of planning in these areas. In particular, the German NECP takes into account the measures contained in the Climate Action Programme 2030, which will shape German energy and climate policy up to 2030 and beyond. Also taken into account are the contents of the Energy Efficiency Strategy 2050 (EffSTRA) with the German energy efficiency target of a 30% reduction in primary energy consumption by 2030 (compared with 2008) as a contribution to achieving the EU energy efficiency target, as well as the long-term modernisation strategy of the Federal Government (see also Chapters 5 and 6). Furthermore, the final NECP confirms the Federal Government's 2030 target for greenhouse gas reduction of at least -55% (compared with 1990), the commitment to greenhouse gas neutrality in 2050, and the German contribution of 30% to the EU target for the share of renewable energy sources in gross final energy consumption.

In September 2020, the European Commission published the EU-aggregated evaluation of the NECP of the EU Member States. According to its findings, the Member States are on track to achieve the EU target for the expansion of renewable energy sources for 2030 (EU target: at least 32%; NECP evaluation: 33.7%). In contrast, according to the data in the 27 NECPs, the EU target for increasing energy efficiency for 2030 has not yet been achieved (EU target: at least 32.5%; NECP evaluation: 29.5%). A country-specific evaluation of the NECP was published on 14 October as part of the European Commission's Communication on the State of the Energy Union. The European Commission considers the Federal Government's NECP to be sufficiently ambitious in terms of its contributions to the EU targets. In addition, it evaluates the NECP's statements on the individual dimensions of the Energy Union and identifies key energy policy areas that can stimulate a rebuilding of the economies following the pandemic. This part of the evaluation is formulated as a recommendation to the Federal Government to be addressed in the Federal Government's Recovery and Resilience Plan.

As the NECPs only provide information on the plans submitted by the Member States, the actual achievement of the targets will continue to be monitored and it remains to be seen what will in fact be achieved. From 2023 onwards, the

European Commission will assess Member States' progress towards achieving the EU 2030 targets through regular NECP progress reports every two years. In addition, EU Member States will be able to update their plan once for the decade after five years. If the NECP progress reports and the update on the path to 2030 show that the efforts of the Member States to achieve the EU energy target are not sufficient, the European Commission can propose measures at Union level. In the area of renewable energy sources, the so-called gap filler mechanism is also applied. Under this mechanism, those Member States that have contributed too little are to make additional efforts.

The governance system will also spread beyond the EU Member States. For example, the Ministerial Council of the Energy Community, which is composed of the EU and several of the EU's neighbours in South-East Europe, adopted general policy guidelines in December 2019, setting targets as ambitious as those of the EU for 2030. The Energy Community Member States are also developing National Energy and Climate Plans to guide the targets.

With the new European Commission taking up its work in December 2019, work on the so-called Green Deal has begun. The Green Deal is to be part of the political guidelines published by Commission President von der Leyen in December 2019. It is a key strategy in the EU's 2019–2024 legislature and aims to make Europe the world's first climate-neutral continent while strengthening competitiveness.

The long-term goal of climate neutrality is to be made binding in the European Climate Act, for which the European Commission presented a proposal in March 2020. The corresponding EU regulation provides for EU-wide net zero emissions by 2050. The increased EU climate target for 2030 will also be enshrined in it.

Together with the Climate Target Plan, it has also presented an impact assessment on this particular subject. According to this assessment, increasing the GHG reduction target would have positive economic effects, especially through investment signals in favour of low-carbon technologies and the avoidance of lock-in effects in the economy. In this way, momentum could be created for innovation, competitiveness, growth and jobs. According to the impact assessment, the energy system costs would increase only slightly from 10.6% of GDP in 2015 to 11% in 2030 if the reduction target were raised. Raising the reduction target to at least -55% would require €350 billion more per year to be invested in the energy system in the 2021–2030 period than in the 2011–2020 period. Furthermore, the European Commission concludes that a higher reduction target would only slightly increase household energy expenditure. However, since energy expenditure accounts for a relatively high share of total expenditure for low-income households, these households would be more heavily penalised than households with higher incomes.

By June 2021, the European Commission will now have to assess the extent to which existing climate and energy-related EU regulations need to be amended and new regulations implemented in order to achieve the new 2030 reduction target (e.g. EU ETS, EU Climate Change Regulation, LULUCF Regulation, Renewable Energy Directive amendment, Energy Efficiency Directive amendment, Building Efficiency Directive

amendment). The progress made by EU Member States towards achieving greenhouse gas neutrality in the EU by 2050 is to be assessed by the European Commission every five years from 2023 onwards, according to the proposal on the EU Climate Change Act.

Measures included in the Green Deal that affect various sectors of the economy, including industry, agriculture, transport, the building sector, foreign trade and finance are now being discussed. Particularly relevant for energy policy are thoughts being given to extending the ETS to other sectors such as transport (including maritime transport) and buildings, to revising the Energy Taxation Directive, to energy system integration and to introducing a carbon border tax. The structural impacts of the measures are to be cushioned in those regions and sectors that particularly affected with the help of a Just Transition Mechanism. In addition to the reduction of climate-damaging gases, the European Commission wants to focus on open and well-functioning energy markets, in addition to international cooperation, which primarily concerns energy trade.

Financing aspects

In order to meet the EU energy and climate targets by 2030, the European Commission anticipates an additional investment requirement of €350 billion per year from 2021 compared with the 2011–2020 period – which is equivalent to around 1.5% of the EU's 2018 GDP. A large part of this will be in the buildings sector, with further significant funding estimated for the energy and transport sectors.

For this sum to be reached, sufficient financial resources must be made available. With this in mind, the European Commission published an investment plan in January 2020 to help put the Green Deal on a solid financial footing. On the basis of this investment plan, a total of €1 trillion in public and private funds are to be mobilised between 2021 to 2030. The new Multiannual Financial Framework (MFF) 2021–2027 and the Next Generation EU (NGEU) construction instrument, with a total volume of €1.82 trillion, will also play a vital role in this respect. In view of this situation, the following measures are key to the financing of the EU's climate neutrality target:

- As the most important contribution, at least 30% of the total funds from the Multiannual Financial Framework 2021-27 and the NGEU development instrument are to be used for climate-related purposes and represented by appropriate sectoral targets in the various programmes.
- Large-scale investments are to be triggered via the EU budget guarantee of the InvestEU programme, which will help to cushion the risk of investments.
- For the classification of sustainable investments, the so-called taxonomy is to be applied as a uniform framework from 2021 onwards, on which the Council and Parliament agreed in December 2019.
- The European Investment Bank (EIB) will play a much stronger role in future by almost doubling its share of climate action activities to 50% by 2025 (EU Climate Bank).
- With the investments they make in the future 2021–2027 funding period, the EU Structural

Funds will make an important contribution to achieving the overarching goal of the Multiannual Financial Framework to support climate protection goals with at least 30% of the expenditure of the EU budget. A total of €330.2 billion is earmarked for the European Regional Development Fund (ERDF) in the Multiannual Financial Framework 2021–2027. At EU level, according to the proposal made by the European Commission, the ERDF is to contribute with a quota of 30% to achieve the climate goals. The Member States themselves must earmark a minimum share of ERDF funding for investments in Political Objective 1 (innovative and intelligent economic change) and Political Objective 2 (climate and environmental protection) as part of the thematic concentration. A special focus under Political Objective 2 is the funding of renewable energy sources and energy efficiency measures as well as the reduction of CO_2 emissions. In the 2014–2020 funding period, the ERDF funds CO_2 reduction in all sectors of the economy and is thus an important economic policy instrument for achieving climate goals. In the current funding period, the focus in Germany – besides renewable energy sources and energy efficiency measures – is on sustainable urban mobility and resource efficiency.

- The so-called Just Transition Mechanism (JTM) combines funds from the EU budget, the InvestEU Guarantee Fund and an EIB loan facility, as well as co-financing from Member States. They are intended to cushion the structural problems in regions with a high dependence on coal, peat or oil shale extraction or on carbon-intensive industries. Included in this mechanism is the Just Transition Fund (JTF) with a dedicated budget of €7.5 billion for the period 2021–2027 plus €10 billion in additional Covid-19 aid for the period 2021–2023, of which €2.24 billion would go to German regions. In addition, the state aid rules are to be better tailored to the needs of particularly affected regions and sectors.
- Last but not least, revenues from the auctioning of ETS allowances are to be used to finance investments in climate protection; this is to be done on the one hand via the Innovation and Modernisation Funds, which are part of the ETS, and on the other hand via allocations of auctioning revenues to the EU budget.
- Independently of the construction instrument, the Multiannual Financial Framework 2021–2027 already contains an important instrument for the funding of the energy infrastructure as a whole and cross-border projects in the field of renewable energy sources with the Connecting Europe Facility (CEF). In the current draft version, the CEF provides an allocation for the energy sector of €5.18 billion.

The EU Renewable Energy Financing Mechanism, which was created in 2018 under the EU Energy Union Governance Regulation and will be operational by the end of 2020, can implement EU-wide auctions for the expansion of renewable energy and support cross-border projects through investment grants. The auctions or investment grants can be financed by contributions from the Member States or by Union funds. So far, however, no Union funds are available.

In addition to the EIB, large parts of the financial market industry now attach greater importance to so-called green financing than before.

Numerous central banks and financial supervisory authorities, including the Deutsche Bundesbank and the German Federal Financial Supervisory Authority (BaFin), joined forces in September 2017 to form the NGFS (Network for Greening the Financial System) to strengthen sustainable aspects in the global financial system. The network currently has around 70 members. Some central banks and sovereign wealth funds are working specifically to redesign their portfolios in such a way that securities with risks for sustainability are not included or that specific emission targets are actually achieved. Calling themselves the Net-Zero Asset Owner Alliance, various large investors under the umbrella of the United Nations have decided to make their investment portfolios climate neutral by 2050. The number of members is growing and has already achieved a high market share. In addition, various insurance business enterprises have announced that they will no longer insure business enterprises that rely primarily on coal or fossil fuels in general. According to REN21 (2019), by the end of 2018, a total of around 1,000 different institutions with professionally managed investment portfolios amounting to almost $8 trillion had announced their intention of withdrawing from financing fossil energies. In Germany, 16 German banks and financial players – including major banks such as Deutsche Bank and Commerzbank – signed a voluntary commitment for more climate protection in July 2019. They are committed to bringing their lending and investment operations in line with the Paris climate protection goals by 2022 and to introduce mutually accepted methods for measuring the climate impact of its lending and investment operations.

To add substance to the deliberations on the Green Deal was one of the tasks of the German EU Presidency in the second half of 2020. In the wake of the Covid-19 pandemic, there is the additional challenge of exploiting the opportunities of the Green Deal relating to the innovative energy technologies that are required, in order to put the European economy back on track for growth, to strengthen its resilience in crisis situations and also to strive for a leading role in important technologies. The thematic priorities set for the Presidency contributed to this goal: strengthening cooperation on offshore and other renewables and the ramp-up of a European hydrogen market. In addition, instruments for achieving the EU 2020 targets for renewable energy sources and energy efficiency, in addition to questions of security of supply in times of crisis are on the agenda for the German Presidency. The strategies for the energy sector presented by the European Commission in the second half of 2020 provide a key basis for this and will also be discussed extensively in order to prepare the legislative dossiers announced for 2021.

Specifically, the European Commission has already presented its strategies for energy system integration and hydrogen. The Energy System Integration Strategy aims at a comprehensive and accelerated energy transition for a climate-neutral economy, based on the idea of coordinated planning and operation of the energy system as a whole – across different energy sources, infrastructures and consumption sectors. Fundamental to the strategy are the concepts of a circular energy system with energy efficiency at its core, greater direct electrification and the use of renewable and low-carbon energy sources that include hydrogen. In a comprehensive action plan, the European Commission has presented legislative

and non-legislative individual measures for the years ahead. The EU hydrogen strategy complements the strategy for integrating the energy system and describes a strategic roadmap on how hydrogen should contribute to achieving a decarbonised European energy system. In addition, the strategy aims to contribute to unlocking the major industrial policy opportunities of hydrogen technologies for European business enterprises. In particular, an investment agenda and specific projects are to be developed via the European Clean Hydrogen Alliance.

In addition to this, the European Commission published a communication on a modernisation wave in Europe in October 2020. The aim is to at least double the annual quota of energy-efficient modernisations of residential and non-residential buildings by 2030 through appropriate measures and thus to give the construction industry important economic incentives. Closely linked to the measures included in the Green Deal is the NGEU, the so-called Recovery Plan of the European Commission. It was designed as a reaction to the pandemic-related economic crisis and also contains energy-related aspects. Some of the financial instruments – partly newly created, partly strengthened – from the Recovery Plan can support the energy sector (e.g. a stronger Just Transition Mechanism). However, an agreement between Council and Parliament is still pending (see the box on Financing aspects). Both strategies are intended to contribute to the achievement of the EU's sustainable development goals and the targets of the Paris Agreement.

As early as November 2018, the European Commission presented a communication containing its thoughts on a long-term EU climate strategy. In its communication, the European Commission presented various scenarios, including how net zero emissions could be achieved by 2050. The scenarios contain a broad, varying portfolio of mitigation options. These include, first of all, the extensive use of renewable energy sources and an increase in energy efficiency. In addition, potentials of the circular economy are to be used, changes in consumer behaviour are to be aimed for, a fuel switch to alternative fuels is to be funded, natural carbon sinks are to be strengthened, and negative emissions are to be achieved, for example, via CCS. According to the European Commission, to achieve net zero greenhouse gas emissions, it will be necessary to maximise the potential of all options, to expand sinks on a large scale and to consistently rethink mobility. The strategy was adopted by the European Council in March 2020 and, as agreed in the Paris Agreement, submitted to the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC).

The new EU electricity market design, which was adopted at the end of 2018, gears the European internal electricity market to the challenge of a secure and affordable energy supply with increasing shares of renewable energy sources. It focuses on more competition and thus corresponds to the German decision for an electricity market 2.0. In particular, free price signals, a stronger role for consumers and an unhindered cross-border exchange of electricity, also at short notice, are to encourage competition. In addition, minimum requirements are to apply to capacity markets so that they do not distort competition; in particular, time limits are envisaged. Subsidies for carbon-intensive power plants are to be gradually phased out. In many cases, Member States are to be given more flexibility in how they address certain challenges; for example, they can decide for

themselves how to eliminate internal congestion that impedes cross-border trade.

The clear target, whatever happens, is that 70% of the transmission capacity in the Member States will have to be made available for cross-border trade in stages by the end of 2025. In the event that a Member State does not comply with this regulation, the European Commission can decide to reallocate the bidding zones as a last resort. Dividing Germany up into several bidding zones must be avoided. This is because the large German market area makes it possible to use geographical balancing effects in generation and consumption. The high liquidity in the electricity market helps to bring supply and demand closer in a flexible and efficient manner, even with fluctuating electricity generation from renewable energy sources. It also reduces the power of large suppliers over the market performance and enables innovative players to enter the market. Uniform wholesale prices ensure that the most cost-effective generation technologies prevail in the electricity mix, regardless of location within Germany.

In order to comply with the 70% transmission capacity, Germany submitted an action plan at the end of 2019. This action plan is provided for under the new Electricity Market Regulation. It contains all the necessary measures to guarantee gradual compliance with the 70% transmission capacity for trading by 2025. At the core of the action plan are numerous measures to reduce grid congestion and optimise redispatch processes. The measures are subdivided into national measures and regional initiatives for cross-border cooperation. In addition, the bidding zone action plan sets out the principles for calculating the initial values for the minimum trading capacities. They are the basis for the linear increase paths to 70%, which have applied since the beginning of 2020.

An important prerequisite for a functioning internal electricity market is good regional cooperation. Germany's participation in various cooperation platforms has proven its worth here. In the Pentalateral Energy Forum, for example, Germany works closely with the Benelux countries and France on electricity and gas issues and – in the case of electricity issues – with Austria and Switzerland. The goals are to interlink national energy markets more closely, to jointly discuss issues of security of supply and risk prevention, and to develop a common picture of the challenges and the measures required for implementing a European energy transition. In January 2020, Germany took over the presidency of the North Sea Energy Cooperation for one year. The aim here is to fund the expansion of offshore energies, especially wind energy, and the offshore grid infrastructure. In July 2020, the energy and economics ministers of the North Sea countries and the European Commissioner for Energy issued a joint declaration calling for improved conditions in the form of an EU-enabling framework for joint and hybrid offshore wind projects. In the BEMIP cooperation (Baltic Energy Market Interconnection Plan), Germany exchanges information with the Baltic Sea states on various energy issues, but also focuses more on offshore wind energy. Ultimately, of course, Germany makes use of its electricity neighbours to regularly consult with its neighbouring states on national energy policy. There is also intensive bilateral cooperation with other EU Member States. In January 2019, for example, on the occasion of the Aachen Treaty, Germany and France agreed to establish a joint high-level working group on energy policy.

Specifically, there are a number of cross-border projects between Germany and its neighbouring countries that serve to integrate the European electricity market. Two examples: within

the framework of the German-French Energy Platform, the energy agencies dena on the German side and ADEME on the French side are collaborating on the implementation of a showcase project for system integration in the form of a cross-border smart grid. The aim of the so-called Smart Border Initiative is in particular to optimise the management of the distribution systems in the Saarland-Lorraine region via a virtual management tool as well as via a new physical connection at distribution system level. The planned smart grid is also to include interconnectors and additional modules for electric mobility and heat/energy efficiency. The project has passed through Project of Common Interest (PCI) status. In addition, the construction of the first German-Belgian electricity bridge at transmission system level, i.e. a connection between the two national electricity grids, has begun between Germany and Belgium. The aim is to stabilise grid operations in the region and to cover the Belgian demand for electricity from Germany as well.

In order to integrate the European electricity and gas markets more closely, improve security of supply and reduce system costs, the EU supports infrastructure projects of common interest. The European Commission has identified a need for investment in European electricity and gas infrastructure of over €200 billion. To meet this need, various programmes are used, such as the Connecting Europe Facility (CEF) or the European Energy Programme for Recovery. The Union's financial support under the CEF is an important factor in the implementation of some crucial energy infrastructure projects of common interest (PCIs) in the electricity and gas sectors. The projects are also intended to help Member States achieve their interconnection target.

Diversification of the energy supply also makes a decisive contribution to security of supply. It is therefore of major concern at both European and national level. An important building block for the diversification of the European Union's energy supply is the direct import of liquefied natural gas (LNG) from various supply sources. The Federal Government contributed to improving the conditions for the development of corresponding LNG infrastructure in Germany in 2019 with a legal ordinance (see Chapter 9). Private investors are currently planning LNG import terminals in Germany. The so-called Southern Gas Corridor and the Nord Stream 2 pipeline, which is currently under construction, will contribute to more diversification in the European Union.

With regard to the internal gas market, the European Commission is planning a regulatory reform in 2021. This will include the further implementation of the 3rd internal market package in the gas sector, competition issues for LNG, a reduction in barriers to sector coupling and a market designed for the future EU internal market for hydrogen. In order to achieve stable supply relations with Russia and Ukraine in the long term, the Federal Government has supported the negotiations between these countries. In this way, an initial five-year framework for supply relations was negotiated, which can be extended to ten years. All of this indicates very clearly that the gas market is coming more and more into focus at national and European level. However, at the moment the global recession associated with the Covid-19 pandemic is having a negative effect on gas demand.

Key measures of the European energy policy implemented to date

Clean Energy for All Europeans Package

- Energy Union Governance Regulation and Final National Energy and Climate Plan (NECP)
- Amendment to the Renewable Energies Directive
- (Concerted Action Renewable Energies (CA-RES))
- Amendment to the Energy Efficiency Directive
- Amendment to the Building Efficiency Directive
- (Initiative Accelerating the Clean Energy Transition in Buildings)
- Amendment to the Regulation on the Internal Electricity Market
- Amendment to the Directive on the Internal Electricity Market
- Amendment to the ACER Regulation
- Risk Provision Ordinance
- (EU 2030 interconnectivity target)

Climate protection and the Green Deal

- Communication on the Green Deal
- European Climate Change Act
- Climate Target Plan
- Energy-related aspects of the Recovery Plan
- EU Investment Plan with measures to finance the Green Deal
- Just Transition Mechanism (JTM) Fund
- EU Action Plan Financing Sustainable Growth
- Strategy for the integration of the energy system (energy system integration)
- EU hydrogen strategy
- Strategy for renewable energy sources at sea
- "Renovation Wave" plan
- Long-term EU climate protection strategy
- Environment and Climate Policy Programme (LIFE)
- EU Ecodesign Directive
- Strategy to reduce methane emissions
- European Climate Pact

Infrastructure, security of supply, cross-border cooperation

- Cross-border grid expansion
- Regional cooperation
- Electricity bottleneck management on the German-Austrian border
- Amendment to the TEN-E Regulation
- Electricity and gas infrastructure financing programmes
- Amendment to the Directive on the internal market in natural gas
- Measures to diversify the gas infrastructure
- Energy Diplomacy Action Plan

3.2 Climate protection in European emissions trading and under European effort sharing

The European Emissions Trading System (EU ETS), introduced in 2005, records the emissions of around 10,600 installations in the energy sector and energy-intensive industry across Europe and, since 2012, the emissions of intra-European aviation in the 28 EU Member States as well as Norway, Iceland and Liechtenstein. Together, the

sectors covered account for about 40% of all GHG emissions in Europe. The goal of reducing GHG emissions EU-wide by 20% by 2020 compared with 1990 and by 14% compared with 2005 is divided: some two-thirds of the reductions are to come from sectors within the EU ETS, and one-third from sectors outside the EU ETS. This will result in a reduction target for the EU ETS sectors of 21% by 2020 compared with 2005 (aviation: minus 5%). In order to achieve this target, the total amount of emission allowances on the market must decrease by a factor of 1.74%, or 38 million emission allowances, each year in the third trading period 2013 – 2020. The allowances are either allocated to installations or air transport operators free of charge or they have to buy them at auction. They are freely tradable on the market.

There is no agreement as yet on the future post-Brexit relationship of the UK and the EU with regard to the EU ETS. The UK government plans to leave the scheme and create its own carbon pricing system. As the UK is currently still a member of the EU ETS, the analysis in this sub-chapter on ETS and non-ETS is carried out for the EU-28 aggregate.

The 2020 reduction target for the sectors covered by the EU ETS has already been surpassed. Compared with 2005, there was an overall emission decrease of 36% in 2019 (required: 21%) in stationary plants (excluding aviation) from 2.37 to 1.53 billion tonnes of CO_2 equivalent.[1] Compared with 2018, there was a decrease of just over 9%, which was mainly due to electricity and heat generation. In industry, on the other hand, emissions fell only slightly. In aviation, they continued to rise, but to a lesser extent than in previous years (plus 1%). The significant decrease in emissions does not yet reflect the effects of the Covid-19 pandemic, which began in spring 2020.

In Germany, according to the German Emissions Trading Authority (DEHSt), 1,851 installations (excluding aviation) were registered in the EU ETS in 2019, roughly half of which were made up of installations in the energy and industrial sectors (DEHSt (2020)). Together, they emitted 363 million tonnes of CO_2 equivalent, 14% less than in the previous year (2018: 422 million tonnes). The decrease is the strongest since the start of emissions trading in 2005 and is mainly due to the energy sector. Over the entire period from 2005 to 2019, emissions in Germany fell by around 30%, which is less than the European average (minus 36%). Since the start of the third trading period of the EU ETS in 2013, however, the decline in emissions has slowed across Europe: in 2019, emissions were around 20% below the 2013 level. The decline in emissions in Germany over the same period was slightly more pronounced at minus 25%.

A well-functioning European ETS with adequate price signals for investments in low-carbon technologies is a crucial prerequisite for a climate-friendly economy. Between 2008 and 2013, the price of emission allowances in the EU ETS had shown a sharp downward trend (see Diagram 3.5). The reason for the price decline was that large quantities of surplus allowances accumulated, partly as a result of the economic and financial crisis. In the reform of the EU ETS for the fourth trading period 2021–2030, which entered into force in April 2018, the Federal Government, together with other Member States, successfully campaigned for a boosting of emissions trading

1 Provisional data from the European Commission, as of 1 May 2020.

and in particular its price signal by sustainably reducing the surplus of allowances.

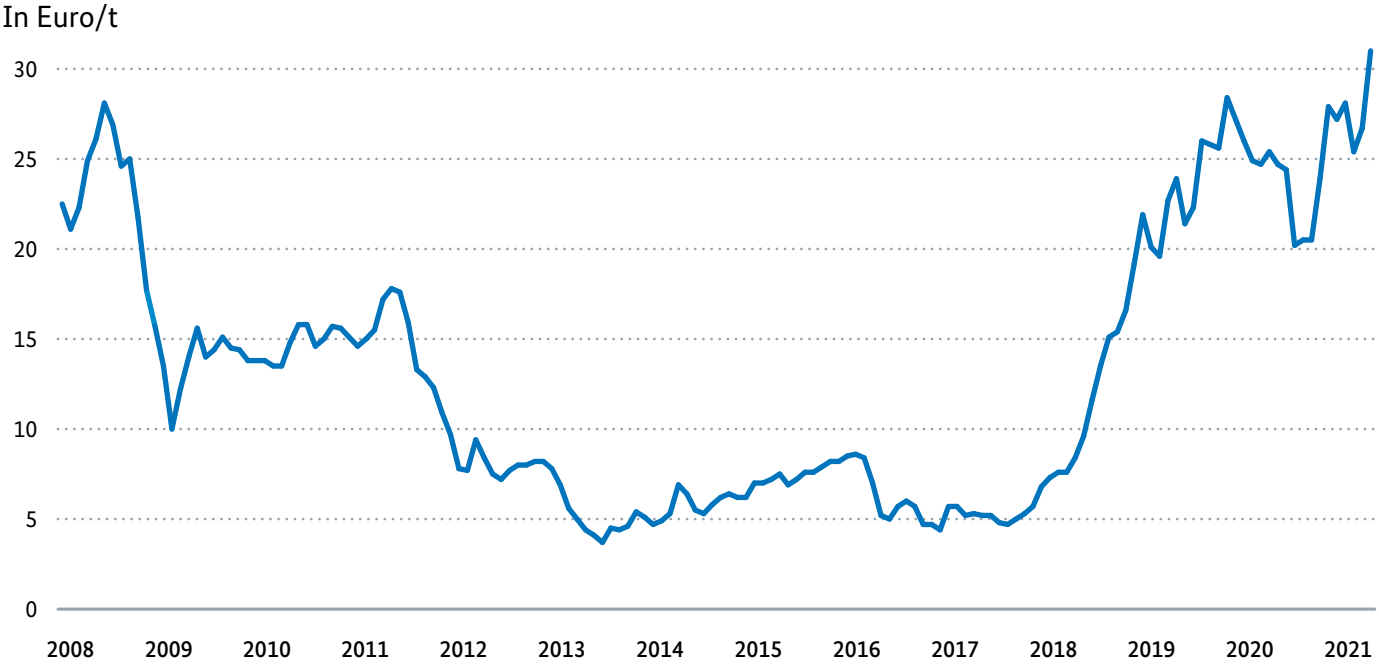
A so-called market stability reserve has been operating since 2019. This reserve is used to adjust the supply of certificates in the emissions trading market. Of the total quantity of surplus allowances determined each year (the so-called quantity in circulation), a portion is transferred to the reserve and no longer auctioned if the quantity in circulation exceeds the threshold of 833 million allowances. If the surplus falls below a minimum of 400 million allowances, allowances are transferred from the reserve back to the market. The reform of emissions trading increased the withdrawal rate of the market stability reserve from 12 to 24% of the quantity in circulation. At the end of 2019, the total surplus was still about 1.39 billion allowances. In addition, it was decided not to auction the 900 million emission allowances that had previously been held back by "backloading" as originally planned, but to transfer them to the market stability reserve. From 2023, the total number of certificates held in the market stability reserve will also be limited to the number of certificates auctioned in the previous year. The remaining certificates in the reserve will be deleted. In addition, it is also possible for countries to remove certificates from the market if their power plant capacities are shut down. Germany, for example, has such a solution for its coal phase-out. The Coal Phase-out Act stipulates that at least two independent expert reports analyse whether the Federal Government will cancel certificates that become available, and if so, to what extent.

The success of the reform is evident in the development of the pricing: from the middle of 2017, the price for European emission allowances rose sharply and averaged around €25 in 2019. In this way, incentives were created for the fuel switch from coal to gas and the conditions for investments in low-CO_2 technologies were strengthened. However, certificate prices fell again significantly in March 2020, especially in the wake of the Covid-19 pandemic, and then rose again. The price is currently quoted at around €25 (as of 17 November 2020). The world market prices for important fossil energy sources such as oil and gas also reached lows in March 2020, but then stabilised again.

In general, the reform of the EU ETS foresees that the ETS sectors of energy and industry will reduce their emissions by 43% by 2030 compared with 2005. This means that the total number of emission allowances will decrease faster than before, by 2.2% per year (around 48 million) from 2021 instead of 1.74% (around 38 million) in the current trading period. This corresponds to a reduction of about 484 million tonnes of CO_2 equivalent between 2021 and 2030, which is more than half of Germany's annual greenhouse gas emissions. The possibility of crediting certified emission reductions in third countries via the Clean Development Mechanism (CDM) or Joint Implementation (JI) programmes will no longer exist from 2021.

In addition, the reform ensures that energy-intensive and internationally competitive industries continue to be protected from unfair competition from business enterprises in countries with lower climate protection requirements. Accordingly, measures to avoid so-called carbon leakage will also be taken in the coming trading period (see also Chapter 10). Carbon leakage is

Diagram 3.3: CO_2 price in the EU Emissions Trading Scheme (ETS)



Source: AGEB 04/2020

the shifting of CO_2 emissions due to the relocation of production to countries with less ambitious climate protection policies. To prevent this, there will continue to be a pro rata allocation of free allowances to emitters exposed to the risk of carbon leakage in the 2021–2030 trading period. Compared with the current trading period, however, the regulations are more specifically tailored to the actual carbon leakage risk. For example, the list of sectors to benefit from free allocation is significantly shorter than the list valid until the end of 2020, with 63 sectors instead of 175. In addition, a European Innovation Fund and a Modernisation Fund will be set up to modernise energy systems and fund technologies that will contribute to a climate-friendly transformation of the economy in the long term. The funds will be financed from auction proceeds from the EU ETS. Innovative industrial technologies in Germany will also be eligible for funding.

Outside the EU, other regions worldwide have also established emissions trading systems or are in the process of doing so. Besides China, which plans to introduce a national system in the future in addition to ongoing pilot systems in 8 provinces, they include California, for example, some Canadian provinces, South Korea, New Zealand and Switzerland. The EU ratified an agreement with Switzerland that linked the two systems on 1 January 2020. This extended the levy-related scope of application in aviation to include flights between the European Economic Area (EWR) and Switzerland. The linking of European emissions trading with other emissions trading systems worldwide remains a concern of the Federal Government, which it is introducing through various initiatives and in various forums, including the G20.

However, it is not enough to focus solely on the EU ETS to achieve the EU emission reduction target. The non-ETS sectors (especially buildings, transport excluding aviation, agriculture, small industrial plants and waste) must also make a decisive contribution to reducing emissions. In this sector, EU-wide emissions in 2018 were already a good 11% below the 2005 level, and they also fell by 0.9% compared with 2017 after a three-year increase. This means that achieving the 2020 target of minus 10% is hardly jeopardised. The picture in the individual sectors is very different: while emissions in transport have been rising continuously for five years, there is a downward trend in other sectors such as the industrial companies included in the non-ETS sector or in waste management.

Unlike the target for the EU ETS sectors, the reduction target for the non-ETS sectors is divided into national targets for each Member State. These are set until 2020 in the EU Effort Sharing Decision adopted in 2013.

Germany could fail to reach its target of reducing emissions in the non-ETS sector by 14% by 2020. This will largely depend on how much emissions will fall in 2020 due to the effects of the Covid-19 pandemic. Member States are not legally obliged to meet their respective 2020 targets on time. However, they must demonstrate that they have sufficient emission allocations from the EU Effort Sharing Decision to cover actual emissions for each year between 2013 and 2020. Unused allocations can be carried over indefinitely into later years of the validity period or to other Member States. According to the German Emissions Trading Authority (DEHSt), Germany exceeded its emissions within the effort sharing procedure for 2019 by around 21.6 million tonnes. Accordingly, even the emission allowances saved in previous years will probably no longer be sufficient to cover this gap.

For sectors outside the EU ETS, the new EU Climate Change Regulation entered into force in July 2018. It provides for an EU-wide reduction of greenhouse gas emissions by 30% by 2030 compared with 2005. The binding national targets for this period range between zero and 40% greenhouse gas reduction. Germany is at the upper end with 38%. There is a specific target path specified for this, however, which defines the emission reductions to be achieved over the entire period until 2030. The level of ambition corresponds in magnitude to the corresponding national sector targets for 2030 from the Climate Action Plan 2050 and has increased significantly compared with the 2020 target: between 2020 and 2030, consid-

erably more far-reaching annual reductions will have to be achieved than in the past. The Member States can distribute the annual emission allocations assigned to them over time and transfer them among themselves to a limited extent. Of particular importance in the non-ETS sector are the transport and buildings sectors, which are responsible for about a quarter and a seventh of the EU's greenhouse gas emissions respectively. In Germany, the national emissions trading scheme adopted by the Federal Government as part of the 2030 Climate Action Programme will introduce a carbon price for the non-EU ETS sectors as of 2021. Combined with other instruments and measures, it is intended to make a significant contribution to achieving the emission reduction targets in transport and buildings (see Chapter 8).

By June 2021, the European Commission intends to review the EU ETS and the EU Climate Change Regulation, in addition to the Renewables and Energy Efficiency Directives, and propose changes as appropriate. This will also include the possibility of extending the EU ETS to sectors that have not been included so far. Germany would welcome and support such an extension. A proposal for a border adjustment mechanism has also been announced, which should at least reflect the carbon content of products from abroad in the import prices. After all, if the EU climate target is raised, the existing measures against carbon leakage may no longer be sufficient.

For international aviation, which is responsible for around 2.5% of energy-related CO_2 emissions, the International Civil Aviation Organisation (ICAO) adopted binding guidelines and recommendations for offsetting CO_2 emissions growth from 2020 for international aviation (CORSIA: Carbon Offsetting and Reduction Scheme for International Aviation) in June 2018. The CO_2 emissions monitoring requirements that are included will apply as of 2019, while the carbon offsetting requirements will apply as of 2021 (pilot phase). Intra-European aviation has been participating in the European Emissions Trading Scheme since 1 January 2012. The ICAO regulations are to be implemented in the EU via the Emissions Trading Directive. The European Commission will review the effectiveness of the CORSIA regulations and, on this basis, recommend how the scope of the European emissions trading system for aviation should be designed.

In maritime shipping, the international initiative to reduce climate-damaging emissions outside of emissions trading schemes is currently being backed up with measures: 173 Member States of the International Maritime Organisation (IMO) agreed in 2018 as part of a voluntary, non-binding pledge to reduce the carbon intensity of international shipping by at least 40% by 2030 compared with 2008, with a target of 70% by 2050. It also aims to at least halve annual greenhouse gas emissions by 2050. The European Commission plans to present proposals in 2021 that take account of climate protection in maritime transport as part of the Green Deal and the increased EU climate target, while, from the Federal Government's point of view, it is important to ensure that the various EU measures are effectively interlinked and that planned EU initiatives also take into account decisions and developments at IMO level. In addition to that, shipping companies operating in the cruise industry recently presented a voluntary commitment aimed at reducing the annual CO_2 emissions of cruise ships by 40% by 2030 compared with 2008. The Maritime Research Programme supports this approach by increasingly promoting projects that make a significant

contribution to the maritime energy transition (see Chapter 16). By improving the general conditions for using shore-side electricity and promoting investments in shore-side electricity systems, for example, emissions from ships during their laytime in German ports are to be reduced. As a major emitter of CO_2, maritime shipping is responsible for 2 to 3% of all global CO_2 emissions, emitting more carbon dioxide annually than Germany as a whole. If the economic effects of the Covid-19 pandemic are ignored, there will be a strong upward trend in emissions.

Key climate protection measures implemented to date inside and outside the European Emissions Trading Scheme

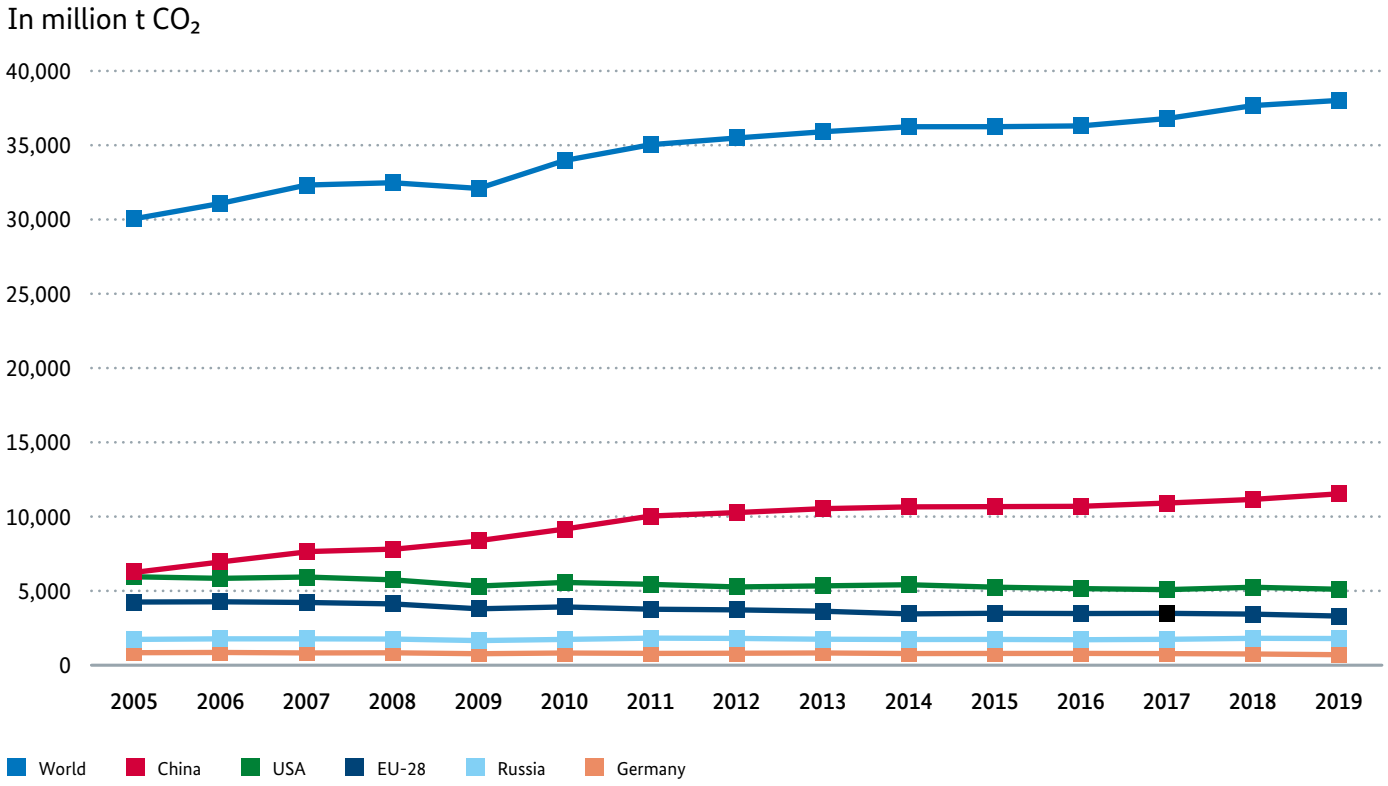
- Market Stability Reserve in the EU ETS
- Reform of emissions trading for the 2021 – 2030 trading period
- Transfer of backloading certificates to the market stability reserve
- Linking the EU ETS with the Swiss Emissions Trading Scheme
- CORSIA
- EU climate protection regulation (limitation of emissions outside emissions trading 2021 – 2030)
- European Climate Initiative
- Franco-German Meseberg Climate Working Group
- Europe on the Move mobility package (see Chapter 7)
- Second mobility package: CO_2 fleet targets for passenger cars and light commercial vehicles beyond 2020 (see Chapter 7)
- First-time introduction of CO_2 fleet targets for new heavy goods vehicles (HGV) (see Chapter 7)
- EU Member States' declaration on a Clean Energy and Mobility Future (see Chapter 7)
- Improving the regulatory framework conditions for the use of shore-side electricity in ports

3.3 International energy policy

After the rise in global CO_2 emissions came to a brief halt in 2015, emissions have been rising again since 2016 (see Diagram 3.4), reaching their highest level ever in 2019 at a good 38 billion tonnes. The largest emitter is still China with a share of almost one third of global emissions, followed by the USA with slightly less than half of China's emissions and the EU with a global share of less than a tenth. China's influence on global emissions development is correspondingly large: the small increase in 2015 and 2016 was largely due to the fact that emissions in China hardly increased at all. However, this development did not continue in the following years, mainly due to the dedicated expansion of coal-fired power generation. In the case of energy-related CO_2 emissions, which account for by far the largest share of total emissions, the global upward trend continued in 2018; the International Energy Agency (IEA) specifically assumes an increase of around 2%. China, India and the USA were primarily responsible for this increase, while emissions in the EU fell, counter to the global trend (IEA (2019)). In 2019, however, according to the IEA (2020d), emissions remained more or less constant.

Overall, the global energy transition towards a lower-emission energy supply continues to progress, but at an inadequate pace and with regional differences. In 2019, for example, accord-

Diagram 3.4: CO_2 emissions in selected world regions



Source: EDGAR 12/2020

ing to the REN21 Global Status Report (REN21 (2020)), investments in renewable energy (excluding large hydropower) increased by 2% to around $302 billion, after declining in 2018. If large hydropower is included, they came to around $317 billion. The main reason for the increase is that the decline in investment, especially in China, which continues to account for the largest share of global investment in renewables, was more than offset in other regions of the world by significant increases in the USA and other countries in North and South America. Wind energy and PV accounted for by far the largest share of these investments. In many regions of the world (including parts of China, the EU, India and the USA) it is now cheaper to invest in new wind or PV installations than to continue operating old coal-fired power plants.

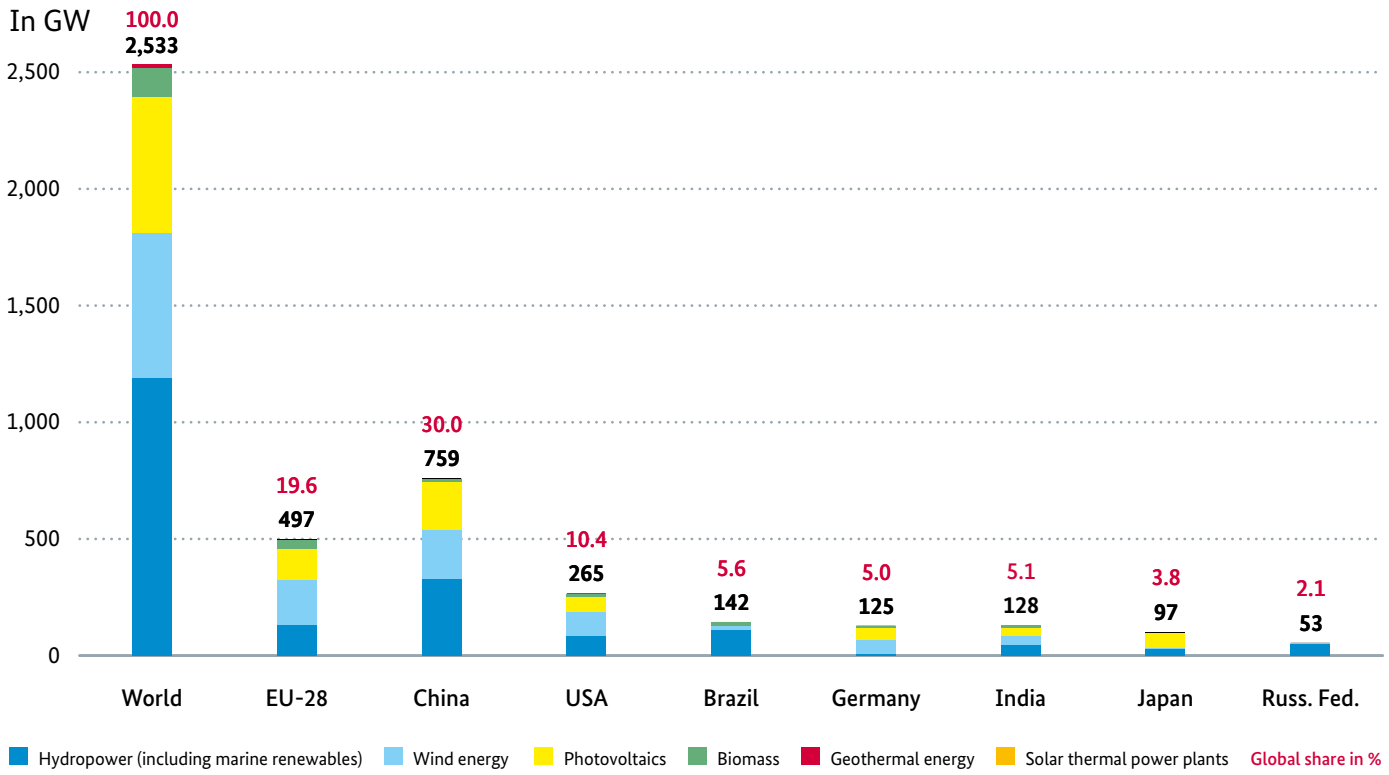
According to IRENA, a good 176 GW of new renewable generation capacity was installed in 2019. This means that almost 2,533 GW of renewable electricity generation capacity (including large hydropower) was available at the end of 2019. Compared with the previous year, this is again an increase of about 7.5%. With a share of 70% of newly installed electricity generation capacity, the increase in renewable generation capacity is higher than that for fossil and nuclear energies combined for the fifth year in a row. 2019 also

marked the fifth consecutive year in which investment in renewable power generation capacity in developing countries exceeded that in developed countries (OECD excluding Chile, Mexico, Turkey) (Frankfurt School of Finance and Management – UNEP-Centre, BNEF (2020)). The tendency of investment funds to become more evenly distributed geographically continued in 2019, with a record number of 21 countries recording investments of more than $2 billion. With investments of $4.4 billion, Germany ranked fourth in a Europe-wide comparison (including the UK) and 13th worldwide.

Despite rising emissions from coal-fired power, the global coal phase-out is gaining momentum. In its World Energy Outlook 2020, the IEA predicts that the peak for coal use has already been reached. The COVID-19 pandemic has made the market situation for coal power more difficult worldwide. Likewise, the number of states, regions and business enterprises that have joined the Powering Past Coal Alliance grew.

In terms of installed renewable capacity, Germany was the frontrunner within Europe in 2019 with over 125 GW. This corresponds to just under a quarter of the installed capacity across the **EU.** Wind energy accounted for about half. Only

Diagram 3.5: Globally installed renewable capacity in 2019



Source: IRENA 07/2020

China, the USA, Brazil and India had more renewable electricity generation capacity (see Diagram 3.5). Globally, renewables now hold a share of electricity generation capacity of about one-third. This means that on average more than every fourth kilowatt hour of electricity is generated (REN21 (2020)).

In 2018, almost one seventh of global primary energy consumption was covered by renewable energy sources. In terms of final energy consumption, the share was around 17%, or a good 10% without traditional biomass. In the meantime, the fast-growing modern renewables around wind and solar energy have a greater weight than traditional biomass, whose use is declining slightly worldwide (REN21 (2019) and REN21 (2020)).

With regard to energy efficiency, there was some progress in the international environment. In 2019, primary energy intensity fell by about 2% compared with the previous year, according to the IEA (2020a). Energy efficiency investments, which hovered around $250 billion globally in 2018 and 2019, had changed little from the levels of the respective previous year. Europe accounted for the largest share of energy efficiency investments, ahead of China. Despite progress in energy efficiency, primary energy demand worldwide rose by 2.4% in 2018 compared with the previous year. The main reason for this was global economic growth. However, as economic development slowed down significantly in the following year, the IEA (2020b) assumes that the increase in primary energy demand in 2019 will have slowed down to around 0.7% compared with 2018.

Under Germany's Presidency, the Energy Efficiency Hub was founded in 2020 as a so-called Special Activity within the framework of the IEA. The idea for the hub goes back to an initiative of the German G20 Presidency in 2017 and also replaces the previous G20 initiative linked to the IEA, the International Partnership for Energy Efficiency Cooperation (IPEEC). The hub is intended to strengthen international cooperation on energy efficiency and thus contribute to faster progress in this area. The Energy Efficiency Hub to date has 20 members. The secretariat is in currently being set up.

The Paris Agreement, which entered into force in November 2016, sets the broad framework for global energy transition. It pursues three main goals:

- to limit global warming to well below 2°C compared with pre-industrial levels and to make efforts to limit the temperature increase to 1.5°C;
- to increase the ability to adapt to the adverse effects of climate change and to fund resilience to climate change and low GHG emission development, and
- to align financial flows with a low-emission GHG and to develop resistance to changes in the climate.

The Convention has now been ratified by 189 of the 197 Parties to the Framework Convention on Climate Change, including the EU and Germany. In the agreement, all Parties have committed themselves to developing and submitting Nationally Determined Contributions (NDCs). The Federal Government is supporting the rapid submission and implementation of NDCs worldwide with various measures. The US withdrawal from the agreement, driven by former US President Donald Trump, took effect in November 2020. However, under the new US President Biden, the US will re-enter the agreement.

The publication of the Intergovernmental Panel on Climate Change's (IPCC) special report on the potential impacts of 1.5°C global warming in October 2018 has added momentum to the climate change debate (IPCC (2018)). The report shows higher risks for nature and people between 1.5°C and 2°C global warming than was previously realised. The mitigation pathways considered by the IPCC for limiting to 1.5°C include reducing global CO_2 emissions by about 45% below 2010 levels by 2030 and reaching net zero emissions around 2050. Limiting to below 2°C would require about a 25% CO_2 reduction by 2030, net zero emissions by about 2070. With current emissions trends, 1.5°C warming would likely be reached in the 2040s (between 2030 and 2052). According to the IPCC, the emission reduction level targeted for 2030 in the NDCs submitted so far is not sufficient to limit global warming to well below 2°C above pre-industrial levels. According to the United Nations Environment Programme (UNEP), countries must at least quintuple their ambition level in order not to exceed the 1.5°C target of the Paris Agreement. To achieve this, emissions would have to fall by 7.6% annually from 2020 onwards.

IRENA also notes insufficient ambition on the part of the signatory states to achieve the goals of the Paris Climate Agreement. Global energy demand, for example, must not increase if the targets are to be met (IRENA (2020)). On the basis of current plans, a significant increase is expected, namely by a quarter by 2040 compared with the year 2000.

At the UN Secretary-General's Climate Summit in New York in September 2019, 66 countries announced their intention to increase their ambitions in order to meet the climate goals set out in the Paris Agreement. In this case, Germany confirmed its intention to pursue greenhouse gas neutrality by 2050 as a long-term goal. Currently, there are more than 70 countries aiming to achieve climate neutrality by 2050. In autumn 2020, Japan and South Korea were the most recent countries to declare their political goal of achieving carbon neutrality by 2050. US President-elect Biden is also committed to this goal. China wants to become carbon neutral by 2060. There are also similar initiatives in the business sector: for example, 87 business enterprises from around the world, including large international corporations, have committed to achieving net zero emissions by 2050.

At the virtual Climate Ambition Summit hosted by the UN, the UK, Italy, Chile and France to mark the fifth anniversary of the Paris Agreement on 12 December 2020, a further 45 countries announced higher NDCs by the climate conference in Glasgow and a further 25 countries announced net zero emissions by 2050, meaning that so far countries responsible for over 65% of global emissions have announced net zero emissions targets. Germany has pledged to increase its climate finance contribution beyond existing commitments, and the EU has announced its updated NDC of at least 55% GHG emission reductions from 1990 levels by 2030 in order to follow an emissions development path compatible with the goal of climate neutrality by 2050.

At the 25th World Climate Conference (COP 25) in Madrid in December 2019, there was no significant progress in the implementation of the Paris Climate Agreement. For example, the Parties could not agree on common rules to use international market mechanisms in order to

reduce GHG emissions. Such market mechanisms allowed states to implement climate protection projects abroad and count the resulting carbon savings towards their own climate targets. The EU NDC must be achieved within the EU; participation in international market mechanisms would count as additional ambition. For 2020, the Paris Agreement requires parties to the agreement to revise their NDCs and adapt them in view of the 1.5 °C target, and requires all parties to submit long-term climate strategies with a view to achieving climate neutrality. The EU submitted its long-term strategy to become climate neutral by 2050 in March and its updated NDC of at least 55% GHG emission reduction in December to the United Nations Framework Convention on Climate Change. The 26th World Climate Conference is expected to take place in Glasgow in November 2021 with the aim of assessing progress towards achieving the long-term climate goals.

In the run-up to the 24th World Climate Conference in Katowice in December 2018, Germany – along with other industrialised countries – had already announced that it would provide greater support to poorer countries against the consequences of climate change. Thus, twice as much funding as before, namely €1.5 billion from 2019, is to be paid into the Green Climate Fund. The Green Climate Fund helps developing and emerging countries to reduce greenhouse gas emissions and adapt to the already noticeable consequences of climate change. Overall, the Federal Government will double its international climate financing from budgetary funds to €4 billion (budgetary funds and gift equivalent in development loans) by 2020, based on the 2014 target of €2 billion; in 2018, it was €3.3 billion. The EU as a whole provides over 40% of global climate finance; this was more than €21 billion in 2018 and around €22 billion in 2019.

Role models and good practices are important in shaping the international energy transition. Germany is an important partner here for many countries and is also an international technology leader in many areas, such as wind energy, system integration and efficiency technologies. There is great interest worldwide in German experience, competence and technologies, for example when it comes to adapting legal bases or integrating renewable energy sources into a secure supply system. This is also evidenced by the export figures for energy technologies and the positive developments on the labour market in this area. However, there must be an assurance that switching to renewable energy sources and efficient technologies in Germany will be successful. Only if at the same time we manage to succeed in remaining a leading industrial location with secure and sustainable jobs will other countries follow us.

The transformation of energy systems has gained momentum in many regions of the world. This is very important, as an energy transition on a global scale opens up opportunities to reduce costs and exploit synergies through economies of scale. Against this background, Germany is committed to further intensifying international energy cooperation. In this context, formats such as the G20 or the G7 as well as international energy institutions (IEA, IRENA) should be used more intensively and further bilateral energy partnerships developed. In this way, win-win situations can arise – for example, when partnerships are concluded with countries with abundant sunshine that can be used to produce hydrogen for the European or German market. Such partnerships make it possible to leverage market potential for the German economy and at the same time advance climate protection. Germany is currently engaged in intensive negotiations with

more than 20 partners on various aspects of the energy transition and supports mainly small to medium-sized enterprises in exporting climate-friendly energy technologies through the Energy Export Initiative.

Key measures implemented to date in international energy policy

- 25th World Climate Conference (COP 25)
- Petersberg Climate Dialogue
- Intensifying existing bilateral energy partnerships and establishing new partnerships (most recently with Chile, Jordan and Ukraine)
- Berlin Energy Transition Dialogue (BETD)
- Energy Efficiency Hub
- Export Initiative Energy
- Development cooperation to fund the global energy transition
- Touring exhibition Germany's energy transition

Part I: Quantitative targets of the energy transition

The quantitative goals of the energy transition are related to five areas:

4. Renewable energy
5. Energy consumption and energy efficiency
6. Buildings and heat transition
7. Transport
8. Greenhouse gas emissions

4. Renewable energy

Where do we stand?

The share of renewables in gross electricity consumption was 42.0% in 2019. The target of at least 35% in 2020 had already been exceeded in 2017.

In the final energy consumption for heat, renewables achieved a share of 14.7% in 2019. The national target of at least 14% in 2020 was already achieved in 2018.

What is new?

In order to make an additional contribution to the climate protection targets, the Omnibus Energy Act introduced special auctions for photovoltaics and onshore wind energy at the end of 2018 for the years 2019 to 2021.

With the Buildings Energy Act (GEG), the 52 GW expansion cap for photovoltaics (PV) was lifted in August 2020 and the Länder were given the option of setting minimum distances of no more than 1,000 metres for wind turbines.

At the same time, the Coal-fired Power Generation Termination Act laid down the target of increasing the share of electricity generated from renewable energy sources in gross electricity consumption to 65% by 2030.

With the Offshore Wind Energy Act (WindSeeG), the increase of the expansion target for 2030 from 15 to 20 GW was enshrined in law in December 2020 and a long-term target of 40 GW by 2040 was adopted.

The Renewable Energy Sources Act (EEG) was amended at the end of 2020. The EEG 2021 contains, among other things, expansion paths to achieve the 65% target and, as a long-term goal, that all electricity generated or consumed in Germany should be generated in a greenhouse gas-neutral manner before the year 2050.

	2018	2019	2020	2030	2040	2050
RENEWABLE ENERGY						
Share of gross final energy consumption	16.8%	17.4%	18%	30%	45%	60%
Share of gross electricity consumption	37.8%	42.0%	at least 35%	65%**		***
Share of heat consumption	14.8%	14.7%	14%			

**Target according to Climate Action Programme 2030 and EEG 2021. The prerequisite for this is a further determined, efficient, grid-synchronous and increasingly market-oriented expansion of renewable energy sources in the coming years.

***The EEG 2021 stipulates that before the year 2050, all electricity generated or consumed in the federal territory must be generated in a greenhouse gas-neutral manner.

4.1 Share of renewables in gross final energy consumption

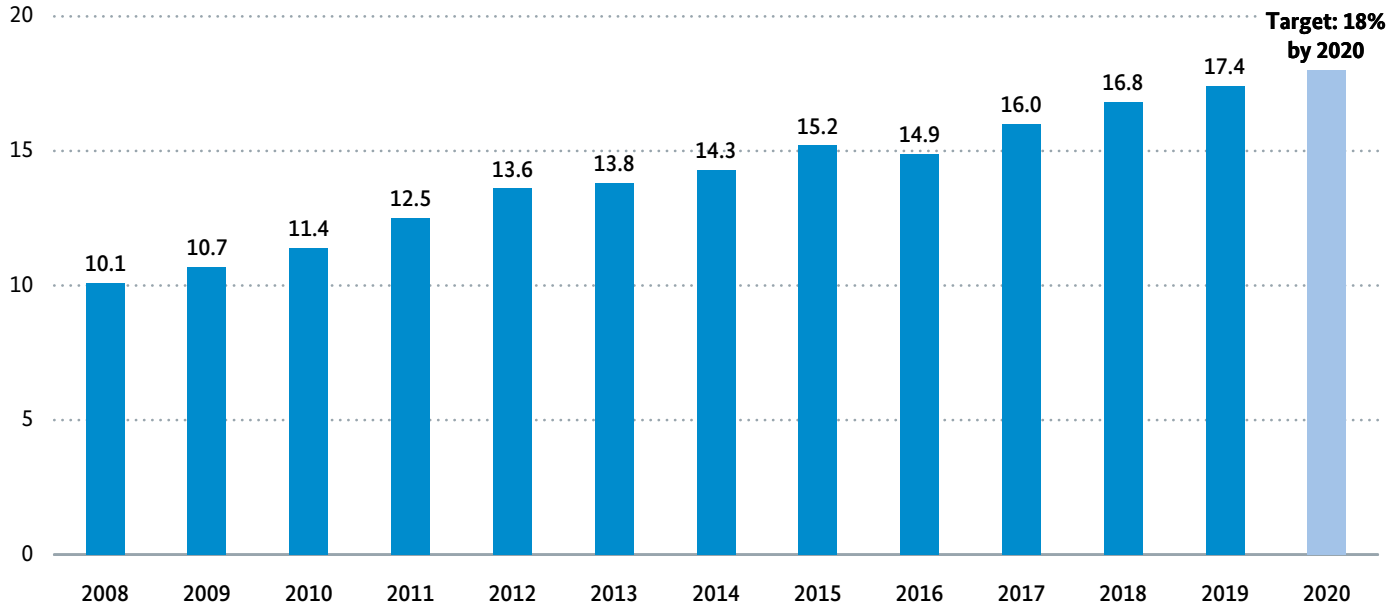
The share of renewable energy sources in total energy consumption continues to increase in all sectors. The reference value in this case is gross final energy consumption, which comprises the total final energy consumption of end consumers for electricity, heating and mobility, plus transmission or line losses and the internal consumption of CHP plants (see Chapter 5). The demand for electricity accounts for about a quarter of the gross final energy consumption, while the use of energy sources for heating and cooling applications account for about a half, with fuels accounting for about a quarter.

The share of renewable energy sources in gross final energy consumption increased by seven percentage points from 2008 to 17.4% in 2019 (16.8 % in 2018, see Diagram 4.1). This positive development was driven primarily by the increase in renewable generation in the electricity sector, with renewables in the heating and transport sectors increasing at a moderate rate only. Germany is expected to reach its target of 18% in 2020.

Diagram 4.1: Target profile: Renewable energy sources and gross final energy consumption

Target 2020	Share of renewables in gross final energy consumption of 18%
Status 2019	17.4%

Share of gross final energy consumption (according to energy concept) in %



Source: AGEE-Stat 08/2020

Trend	●●●●●
Measures	Renewable Energy Sources Act, Market Incentive Programme, Building Energy Act, Greenhouse Gas Reduction Quota, etc.

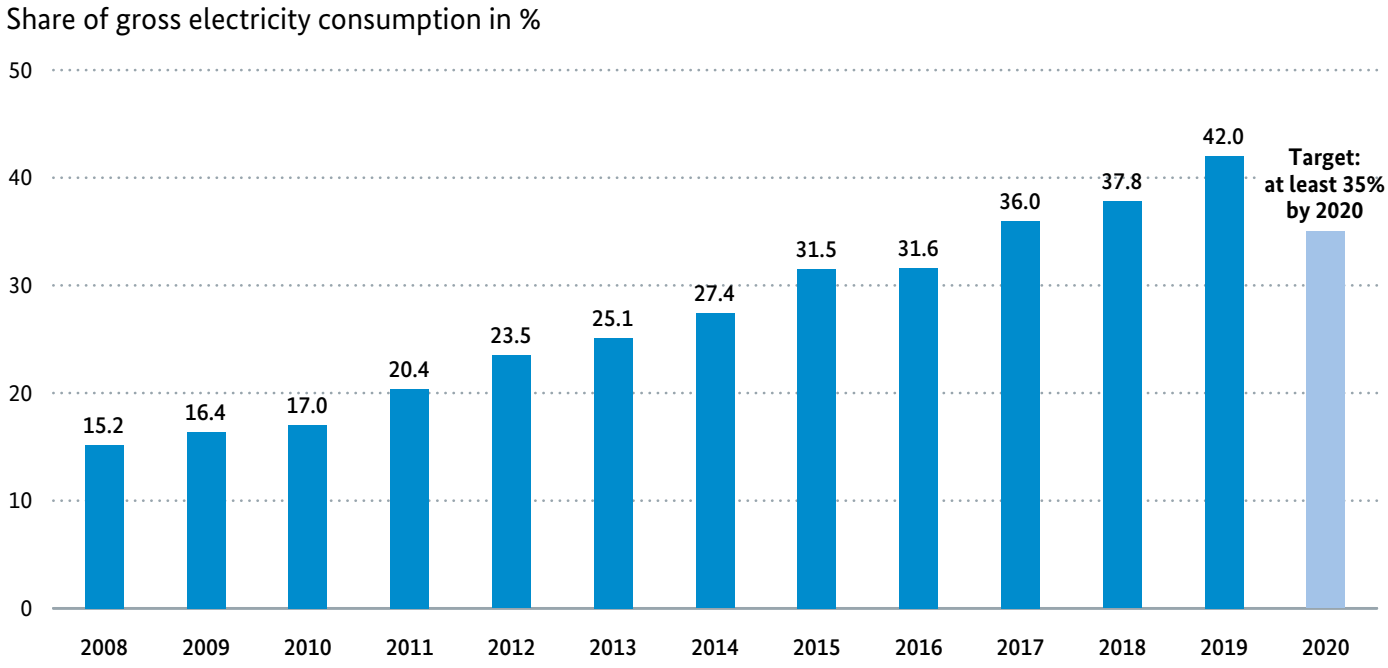
4.2 Renewable energy in the electricity sector

Gross electricity generation from renewable energy sources amounted to 242.5 TWh in 2019. Compared with the previous year, this was an increase of around 8% (2018: 224.8 TWh). The share of renewable energy sources in gross electricity consumption rose accordingly from 37.8% in 2018 to 42.0% in 2019, almost tripling since 2008 (15.2%). The expansion target of the EEG 2012 to achieve a share of renewable electricity generation in gross electricity consumption of at least 35% by 2020 had already been achieved in 2017. In 2019, at 42.0%, the EEG 2017 target corridor for 2025 of 40-45% had also been achieved.

The driver of growth in renewable electricity generation in recent years has been wind energy. Gross electricity generation from onshore wind turbines increased significantly to 101.2 TWh in 2019 compared with the previous year 2018 (90.5 TWh). Gross electricity generation from offshore wind turbines also rose sharply, increasing from 19.5 TWh in 2018 to 24.7 TWh in 2019. This was due to above-average wind conditions in 2019 combined with the construction of new state-of-the-art turbine generations from 2015 to 2017. Overall, electricity generated by onshore and offshore wind turbines accounted for more than half (around 52 %) of the total electricity generated by renewable energy sources.

Diagram 4.2: Target profile: Renewable energy sources and gross electricity consumption

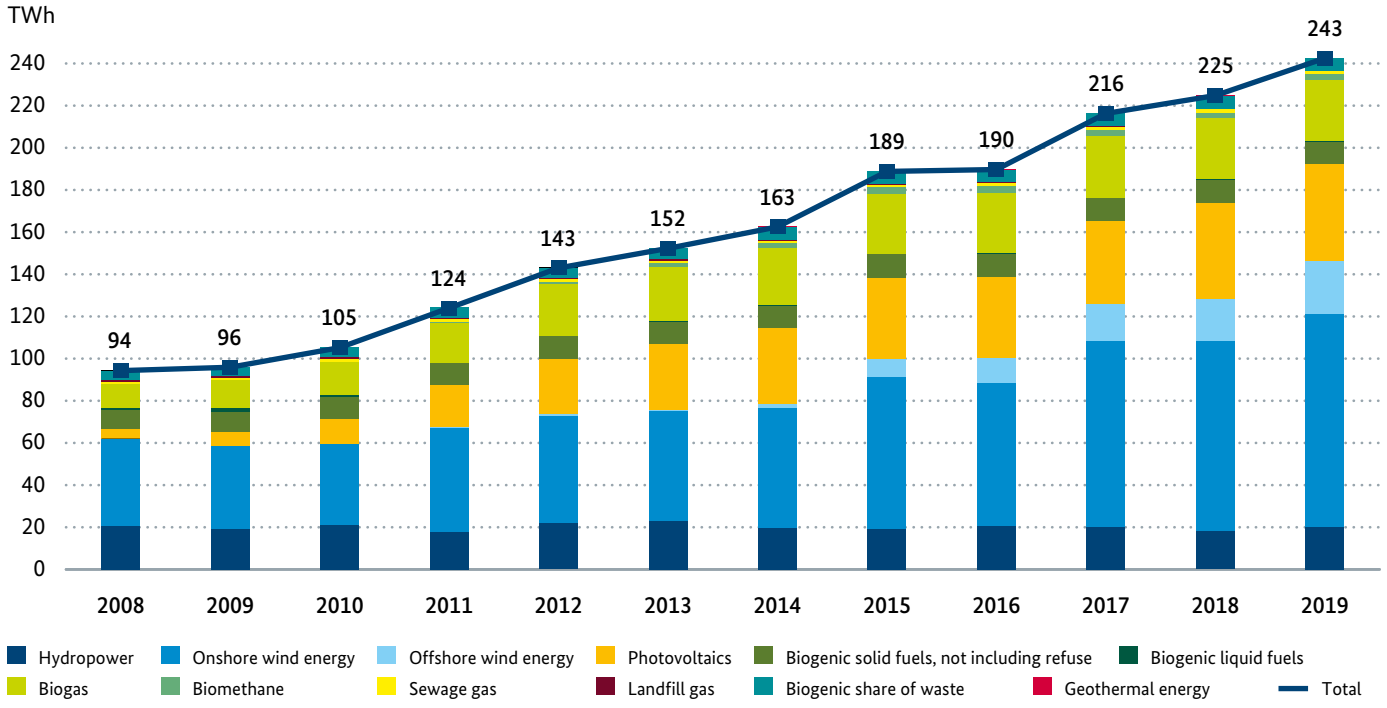
Target 2020	Share of renewables in gross electricity consumption of at least 35%
Status 2019	42.0%



Source: AGEE-Stat and AGEB 09/2020

Trend	●●●●●
Measures	Renewable Energy Sources Act

Diagram 4.3: Gross electricity generation from renewable energy sources



Source: AGEE-Stat 08/2020

The increase in the number of new onshore wind turbines has slowed significantly since 2018. Taking decommissioned plant capacity into account, the net addition of 886 MW in 2019 was 61% lower than in the previous year (2,273 MW in 2018). The annual gross new construction target of 2,800 MW specified in the EEG 2017 for the years 2017 to 2019 was not reached in either of the two years. The reasons for this, on the one hand, were the hesitant designation of new areas subject to planning approval and regulatory approval obstacles. On the other hand, the privileged treatment of so-called citizens' energy companies when the auction system was introduced meant that almost the entire auction volume in 2017 was awarded to projects with no Federal Immission Control approval and with long completion periods of 4.5 years.

New offshore wind turbines were installed with a total capacity of 990 MW in 2018 and 1,111 MW in 2019. The total installed capacity of offshore wind energy had thus reached some 7,507 MW by the end of 2019, which far exceeded the 2020 target of 6,500 MW set out in the EEG 2017.

Electricity generation from photovoltaics grew to 46.4 TWh in 2019 (2018: 45.8 TWh). A gross addition of 2,888 MW in 2018 and 3,857 MW in 2019 resulted in the expansion corridor of the EEG 2017 being exceeded. Biomass, hydropower and geothermal power together generated around 70.3 TWh of electricity in 2019 (2018: 69.0 TWh). The slight increase is due in particular to higher precipitation in 2019 following a dry year in 2018, while electricity generation from biomass declined. The significance of electricity generation from geothermal energy remained low at 0.2 TWh.

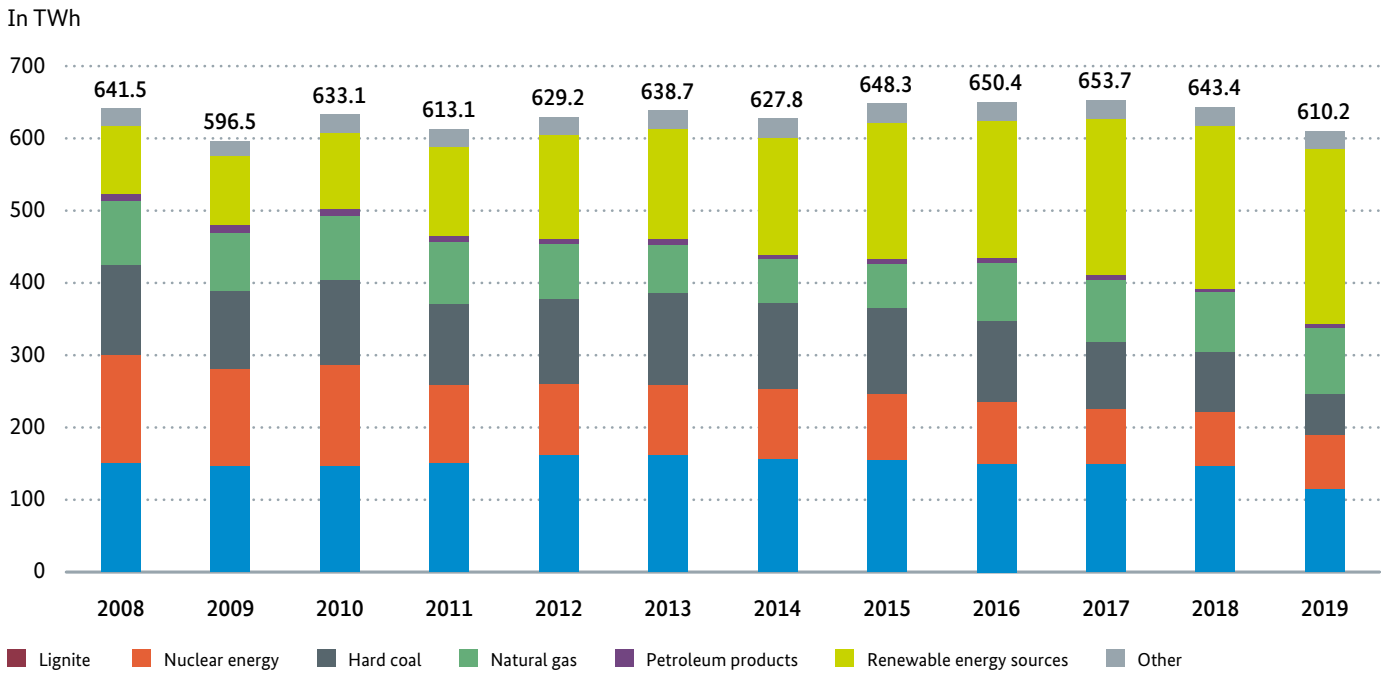
Table 4.1: Expansion corridor in accordance with EEG 2017 (as of June 2020), including special auctions and actual new installations in 2018 and 2019

Technology	Target for increasing installed capacity in accordance with § 4 of the EEG 2017 and Omnibus Energy Act	Actual new installations in ...	
		2018	2019
Onshore wind energy	2,800 MW per year (gross), from 2020: 2,900 MW, plus special auctions in 2019: +1,000 MW 2020: +1,400 MW	2,457 MW (gross) 2,273 MW (net)	963 MW (gross) 886 MW (net)
Offshore wind energy	Total 6,500 MW by 2020	990 MW	1,111 MW
Photovoltaics	2,500 MW per year (gross) plus special auctions in 2019: +1,000 MW 2020: +1,400 MW	2,888 MW (gross)	3,857 MW (gross) 3,835 MW (net)
Biomass	up to 150 MW per year (gross)	43 MW (gross)*	87 MW (gross)*

Source: AGEE-Stat 03/2020 based on BNetzA. *The total increase in installed capacity of biomass plants, due primarily to a non-generation-related change in capacity to increase flexibility in biomass plants entitled to EEG remuneration, amounted to 428 MW (net) in 2018 and 328 MW (net) in 2019.

The importance of renewable energy sources is growing rapidly in the German electricity generation mix. Benefiting from a significant decline in total gross electricity generation in 2019, renewables were able to increase their share in the electricity generation mix to over 40% (2018: 35%). As shown in Diagram 4.4, the strong growth in wind and PV electricity generation in 2018 and 2019 resulted in

Diagram 4.4: Gross electricity generation by energy source



Source: AGEB, AGEE-Stat 09/2020

renewables overtaking coal-fired electricity generation in particular as Germany's main energy source. Furthermore, modern natural gas-fired power plants in Germany and abroad have been able to increase their competitiveness compared with coal-fired power plants due to low raw material prices and a simultaneous increase in CO_2 certificate prices.

4.3 Renewable energy in the heating sector

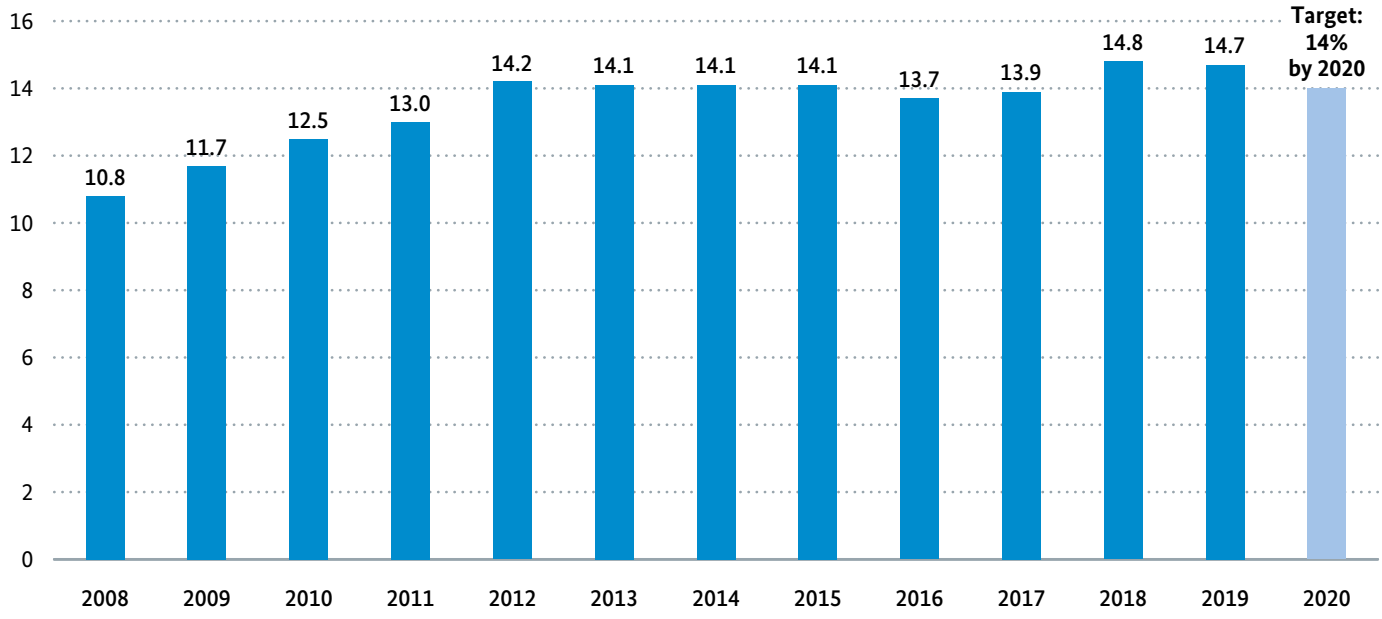
The use of renewable energy sources for the generation of heat increased in 2019, partly as a result of the cooler weather compared with the previous year. As overall final energy consumption for heating and cooling also increased slightly due to the weather conditions, the share of renewable energy sources remained virtually constant at 14.7% (2018: 14.8%).

Biomass remains the most important heat source of renewable energy sources. Due to weather conditions, wood energy consumption (including wood pellets) increased last year in private households and in the trade, commerce and services sector (+2.4 TWh). This was one of the reasons why the share of biomass (solid, liquid, gaseous and

Diagram 4.5: Target profile: Share of renewable energy sources in final energy consumption for heating and cooling

Target 2020	Share of renewables in final energy consumption for heating and cooling of 14%
Status 2019	14.7%

Share of renewable energy sources in final energy consumption for heating and cooling in %



Source: AGEE-Stat 08/2020

Trend	●●●●●
Measures	Buildings Energy Act, Market Incentive Programme

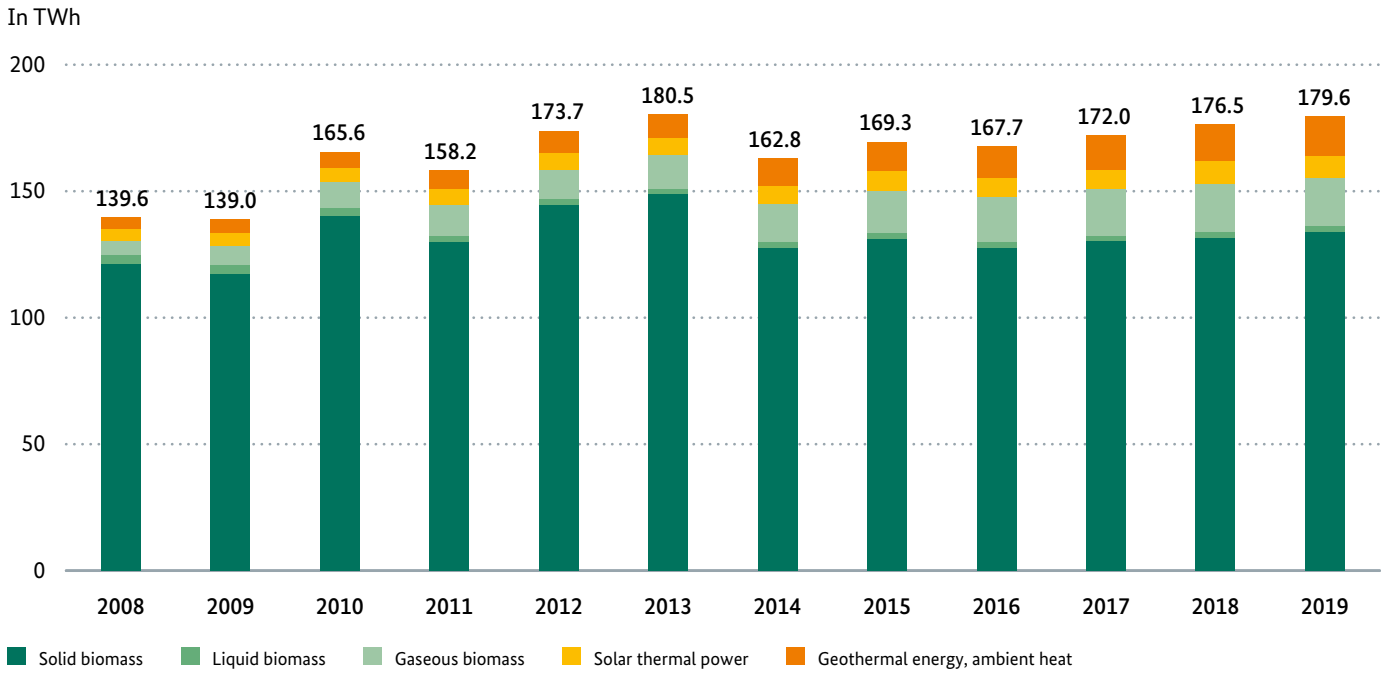
biogenic waste) in the production of renewable heat remained stable at about 86%. Furthermore, the amount of environmental heat made available using heat pumps increased by around 9% (+1.2 TWh) compared with the previous year due to the construction of new plants, while solar thermal heat generation was down 4% (-0.4 TWh) due to the decline in global radiation compared with the 2018 record year.

In order to achieve a targeted climate-neutral building stock by 2050, the renewable share in terms of heating and cooling is to be further increased in the years ahead, among other things, by decarbonising the heat networks. As the National Energy and Climate Plan shows, this will also require an ambitious improvement in energy efficiency in the building sector (see also Chapter 6).

4.4 Renewable energy in the transport sector

The share of renewable energy sources in the total final energy consumption in the transport sector declined slightly in 2019 to 5.5% compared with the previous year (5.6%), while final energy consumption in the transport sector increased to 36.2 TWh in 2019 compared with 36.0 TWh in 2018. Although sales of gaseous biofuels (biomethane) had increased significantly, they were offset by a slight increase in total energy consumption in the transport sector (not including international air traffic).

Diagram 4.6: Development of final energy consumption from renewable energy sources for heating and cooling by energy source



Source: AGEE-Stat 08/2020

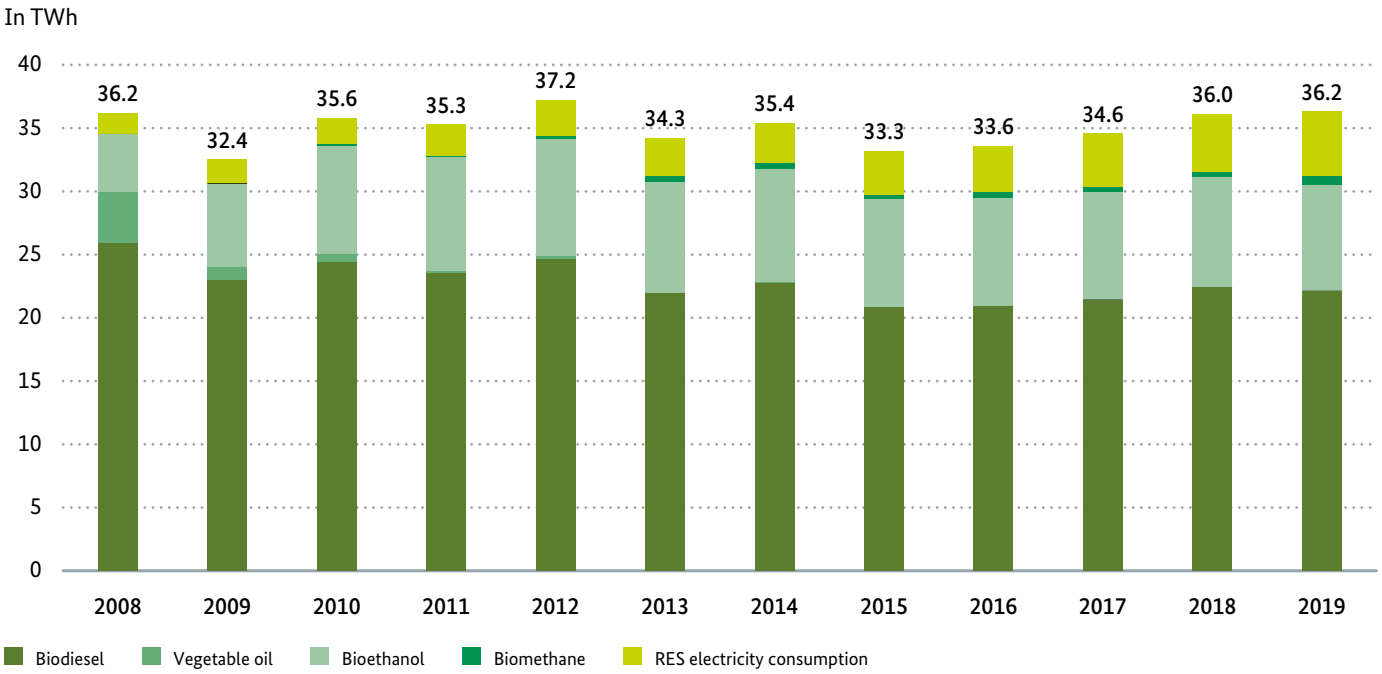
The greenhouse gas reduction quota has been updated. In 2015, the system of funding was changed from a quota based on energy content for biofuels to a greenhouse gas reduction quota. As a result of this change, the petroleum industry was required to reduce its greenhouse gas emissions per unit of fuel by 4% from 2017 onwards and by 6% as of 2020. Since January 2018, in addition to biofuels, other climate protection options in the transport sector can now count towards the greenhouse gas reduction quota (e.g. natural gas sales, electricity-based fuels and electricity used in electric vehicles) and additionally since 2020 greenhouse gas savings in the fuel supply chain (so-called upstream emission reductions).

4.5 Key measures implemented to date

The Renewable Energy Sources Act (EEG) is the central instrument for steering the expansion of renewable energy sources. Since its introduction in 2000, the Act has been continuously updated – with amendments in 2004, 2009, 2012, various PV amendments, the EEG 2014 and the EEG 2017. The EEG 2017 was brought in line with the Omnibus Energy Act (EnSaG) in 2018 and also with amendments in 2019 and 2020. The EEG was extensively amended most recently in December 2020. The EEG 2021 entered into force on 1 January 2021.

The paradigm shift in the funding of renewables from state-administered fixed remunerations to funding rates determined on a competitive basis, which was implemented with the EEG 2017, is

Diagram 4.7: Final energy consumption from renewable energy sources in the transport sector



Source: AGEE-Stat 08/2020

an important step towards moving the market integration of renewable energy sources forward. Since then, onshore wind energy, offshore wind energy, very large PV plants, ground-mounted PV installations and biomass in particular have had to hold their own in competitive auctions. This is because only the most economically advantageous bids are awarded a contract. With the passing of the Offshore Wind Energy Act (WindSeeG) in 2017, a central system of state designation and preliminary investigation of areas and the auctioning for sites in parallel with the required offshore grid connections was introduced. Following the amendment to the Offshore Wind Energy Act (WindSeeG) in 2020, the expansion target for 2030 was increased from 15 to 20 gigawatts, a long-term target of 40 gigawatts by 2040 was adopted, and a number of adjustments were made, such as the maximum value and certain completion deadlines necessary to achieve the targets. With the EEG 2017 and the entering into force of the Offshore Wind Energy Act (WindSeeG), the funding of innovative technologies with politically determined funding levels has ended, although the fixed feed-in tariffs continue to remain for hydropower, geothermal energy and for small and medium-sized roof-mounted PV installations. This step has led to a more cost-effective development of renewable energy sources. Effective competition between bidders for wind and photovoltaic projects was also an important prerequisite in bringing this about. As for onshore wind energy, however, auctions since 2018 have been undersubscribed.

Since the introduction of compulsory direct marketing with funding provided via a market premium and other direct marketing activities, renewable energy sources have been integrated more effectively into the market. The subsequent technical connection of the installations simultaneously leads to better system integration. In addition, the operators now assume full balancing group responsibility for these installations.

Compared with the total generation capacities, the share of generation capacities reported to the grid operators for the market premium increased from 43% in 2013 to around 65% in 2019. Directly marketed generation capacities totalled almost 80 gigawatts (GW) at the end of 2019 (2018: 74 GW). At around 51 GW, the portfolio of electricity from renewable energy sources that is directly marketed continues to be influenced strongly by wind energy. The reported capacity for PV was around 14 GW at the end of 2019, with the reported capacity for biomass around 6.5 GW. Some 94% of the installed capacity of onshore wind turbines and 100% of the electricity generated by offshore wind turbines is marketed via the market premium model. In the case of biomass, this amounts to around 85% and around 29% in the case of PV. Information on direct marketing can be found at https://www.netztransparenz.de/EEG/Monatliche-Direktvermarktung.

The total amount of electricity sold through funded and other direct marketing activities has increased steadily since 2012. This can be attributed, on the one hand, to the gradual reduction in the thresholds for compulsory direct marketing and, on the other hand, to existing installations switching to this type of sales model. Furthermore, the majority of newly constructed wind farms and an increasing proportion of solar plants now sell their electricity within these two sectors. The amounts are sector-specific and increased from 2012 to 2019 to some 177,000 gigawatt hours (GWh). This corresponds to an 80% share of the total amount of electricity marketed under the Renewable Energy Sources Act (EEG) in 2019 (around 222,000 GWh). Financial support for the

market premium in 2019 amounted to €16.3 billion (2018: €13.9 billion).

Results from the competitive auctions for the development of wind energy and PV following amendments to the EEG 2014 and 2017 have demonstrated that the reforms are important steps on the way to achieving a successful energy transition. The auctions have led to a sustainable and significant reduction in funding costs, in particular for photovoltaics and offshore wind energy:

Solar installations: Competitive auctions were used in the PV sector for the first time from 2015 to 2016 as part of the pilot auctions for ground-mounted installations and later under the EEG 2017. The auctions were characterised by a high level of competition and were oversubscribed several times. The average funding level for electricity from large-scale PV plants declined continuously and was reduced by around 50% in the course of all the auction rounds (including the pilot phase). The lowest average award value of an auction to date was reached in February 2020 (3.55 ct/kWh). This value rose again in the subsequent auction rounds. Further details are provided in Table 4.2. Final results for the completion rate are available for all six pilot auctions and auctions up to mid 2017. According to these results, an average of 96% of the installations that were awarded state funding were implemented and commissioned within the two-year completion period.

Onshore wind energy: In May 2017, the first auctions for onshore wind turbines were launched under the new regulations of the EEG 2017. The first three auctions for onshore wind in 2017 were characterised by a high level of competition and declining funding levels. This was due to the special rules for citizens' energy projects. For example, the average volume-weighted surcharge price fell from 5.71 ct/kWh in the first round to 3.82 ct/kWh in the third auction round in 2017, resulting in funding levels of between 3.40 ct/kWh (at a 120% site) and 4.93 ct (at a 70% site). Following the elimination of the special rules for citizens' energy projects, the number of bids submitted in the 2018 auction rounds and the bid volume declined. In the auction rounds since May 2018 – with the exception of the December 2019 auction – the auctioned volume could not be awarded in full. As a result, the average volume-weighted award values have increased and have settled at values between 6.1 and 6.2 ct/kWh (legally permissible maximum value of 6.30 ct/kWh in 2018 and 6.20 ct/kWh in 2019 and 2020). As a result of the low level of competition, the award values are significantly above the level of the May 2017 auction and close to the maximum value. Further details can be found in Table 4.3 below.

Offshore wind energy: At the end of the first auction round (1 April 2017) for existing projects in the so-called transitional system, four offshore wind farms with a total of 1,490 MW were awarded contracts. The average mean value of the awards was 0.44 ct/kWh. Three projects were awarded 0 ct/kWh, one wind farm 6 ct/kWh. In the second transitional auction (1 April 2018), six awards were made with a total volume of 1,610 MW. The average volume-weighted award value in the second round was 4.66 ct/kWh. The highest bid that was also awarded a contract was 9.83 ct/kWh. At least two awards were made for 0 ct/kWh. The average volume-weighted surcharge value for both rounds was 2.3 ct/kWh. Further details are provided in Table 4.4 below. After the transitional auctions for existing projects from 2017 and 2018 (commissioning from 2021 to 2025), the auctions from 2021 onwards will take place in the so-called central model. The bidders compete in

auctions for the award of the contract and thus the right to grid connections as well as the – provided it is not a 0 ct/kWh bid – funded construction of a wind farm in areas designated by the Federal Maritime and Hydrographic Agency (BSH) in its Site Development Plan, followed by a site investigation. In future, one bidding date per year will be held for this purpose. From 2024 and 2025 onwards, the bidding volumes will increase significantly in order to achieve the expansion targets of 20 gigawatts (GW) by 2030 and 40 GW by 2040, which were raised by the amendment to the Offshore Wind Energy Act that entered into force in December 2020.

Biomass remains an exception: The previous auction rounds for biomass plants differed from the auctions for solar and wind energy with regard to the group of participants and the auction result. In contrast to the other auctions, operators of existing plants, whose previous funding entitlement still amounts to a maximum of eight years, can also participate in the auction and receive an award for a 10-year follow-up funding. Participation, however, remained low, since most of the plants still want to make extensive use of the existing EEG funding. The four biomass auction rounds conducted until the end of 2019 show a low level of competition, with awards close to the respective maximum value. Further details can be found in Table 4.5 below.

Table 4.2: Results of the first auction for solar installations under the EEG 2017

Auctions	2018			2019				
Bid deadline	1 Feb 18	1 Jun 18	1 Oct 18	1 Feb 19	1 Mar 19	1 Jun 19	1 Oct 19	1 Dec 19
Number of bids received	79	59	76	80	163	105	153	346
with bid volume	546 MW	360 MW	551 MW	465 MW	869 MW	556 MW	648 MW	1,344 MW
Excluded bids	16	1	3	2	17	13	11	76
Lowest bid value	3.86 ct/kWh	3.89 ct/kWh	3.86 ct/kWh	4.11 ct/kWh	3.90 ct/kWh	4.97 ct/kWh	4.59 ct/kWh	3.85 ct/kWh
Highest bid value	5.74 ct/kWh	6.26 ct/kWh	8.73 ct/kWh	8.67 ct/kWh	8.76 ct/kWh	7.49 ct/kWh	7.50 ct/kWh	7.49 ct/kWh
Number of bids awarded	24	28	37	24	121	14	27	121
Awarded bid volume	201 MW	183 MW	192 MW	178 MW	505 MW	205 MW	153 MW	501 MW
Lowest award value	3.86 ct/kWh	3.89 ct/kWh	3.86 ct/kWh	4.11 ct/kWh	3.90 ct/kWh	4.97 ct/kWh	4.59 ct/kWh	4.70 ct/kWh
Highest award value	4.59 ct/kWh	4.96 ct/kWh	5.15 ct/kWh	5.18 ct/kWh	8.40 ct/kWh	5.58 ct/kWh	5.20 ct/kWh	6.20 ct/kWh
Average award value	4.33 ct/kWh	4.59 ct/kWh	4.69 ct/kWh	4.80 ct/kWh	6.59 ct/kWh	5.47 ct/kWh	4.90 ct/kWh	5.68 ct/kWh

Source: BNetzA

Table 4.3: Results of the first auction for onshore wind turbines under the EEG

Auctions	2018				2019					
Bid deadline	1 Feb 18	1 May 18	1 Aug 18	1 Oct 18	1 Feb 19	1 May 19	1 Aug 19	1 Sep 19	1 Oct 19	1 Dec 19
Number of bids received	132	111	91	62	72	41	33	22	25	76
with bid volume	989 MW	604 MW	709 MW	396 MW	499 MW	295 MW	239 MW	188 MW	204 MW	686 MW
Excluded bids	2	0	5	5	5	6	1	1	0	2
Lowest bid value	3.8 ct/kWh	4.30 ct/kWh	4.00 ct/kWh	5.00 ct/kWh	5.24 ct/kWh	5.40 ct/kWh	6.19 ct/kWh	6.19 ct/kWh	6.19 ct/kWh	5.74 ct/kWh
Highest bid value	6.28 ct/kWh	6.28 ct/kWh	6.30 ct/kWh	6.30 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh
Number of bids awarded	83	111	86	57	67	35	32	21	25	56
Awarded bid volume	709 MW	604 MW	666 MW	363 MW	476 MW	270 MW	208 MW	179 MW	204 MW	509 MW
Lowest award value	3.80 ct/kWh	4.65 ct/kWh	4.00 ct/kWh	5.00 ct/kWh	5.24 ct/kWh	5.94 ct/kWh	6.19 ct/kWh	6.19 ct/kWh	6.19 ct/kWh	5.74 ct/kWh
Highest award value	5.28 ct/kWh	6.28 ct/kWh	6.30 ct/kWh	6.30 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.20 ct/kWh	6.18 ct/kWh
Average volume-weighted award value	4.73 ct/kWh	5.73 ct/kWh	6.16 ct/kWh	6.26 ct/kWh	6.11 ct/kWh	6.13 ct/kWh	6.20 ct/kWh	6.19 ct/kWh	6.20 ct/kWh	6.11 ct/kWh

Source: BNetzA

Table 4.4: Results of the first auctions for offshore wind turbines under the Offshore Wind Energy Act (WindSeeG)

Auctions	2017	2018
Bid deadline	1 Apr 17	1 Apr 18
Number of bids awarded	4	6
Awarded bid volume	1,490 MW	1,610 MW
Lowest award value	0.00 ct/kWh	0.00 ct/kWh
Highest award value	6.00 ct/kWh	9.83 ct/kWh
Average award value (volume-weighted)	0.44 ct/kWh	4.66 ct/kWh

Source: BNetzA

Table 4.5: Results of the first auction for biomass under the EEG

Auctions	2017	2018	2019	
Bid deadline	1 Sep 17	1 Sep 18	1 Apr 19	1 Nov 19
Number of bids awarded	24	79	19	50
Awarded bid volume	27.55 MW	76.5 MW	25.5 MW	56.7 MW
Lowest award value	9.86 ct/kWh	10.00 ct/kWh	9.53 ct/kWh	9.35 ct/kWh
Highest award value	16.9 ct/kWh	16.73 ct/kWh	16.56 ct/kWh	16.56 ct/kWh
Average award value (volume-weighted)	14.3 ct/kWh	14.73 ct/kWh	12.34 ct/kWh	12.47 ct/kWh

Source: BNetzA

In order to make an additional contribution to achieving the climate protection targets, the EEG will also implement special auctions for onshore wind energy and photovoltaics as of 2019. A total of 4 GW each for both onshore wind energy and photovoltaics are to be additionally auctioned in the period from 2019 to 2021. In order to achieve a higher level of competition, the auction volumes for onshore wind energy and photovoltaics are to be increased successively from 1 GW in 2019 to 1.4 GW in 2020 and 1.6 GW in 2021. The ordinance authority for innovation auctions will also be adjusted in the Renewable Energy Sources Act (EEG). In 2020, 650 MW were auctioned in the innovation auctions and 500 MW are to be auctioned in 2021. The innovation auction volumes will be deducted from the regular auction volumes for onshore wind turbines and solar installations and will serve as a testing ground for more competition and more grid and system efficiency.

The new expansion target for 2030 has now been passed into law. On 3 July 2020, in the course of the coal phase-out, the Bundestag and Bundesrat decided that renewable energy sources were to account for 65% of German electricity consumption in 2030. The increase in the target to 65% and bringing forward the relevant assessment year to 2030 were approved in the Federal Government's Climate Action Programme and will be implemented with the new version of Section 1 (2) sentence 1 number 1 of the EEG 2017. A prerequisite for a successful energy transition and climate protection policy is a further expansion of renewable energy sources that is fit for purpose, cost-effective, grid-synchronised and increasingly market-driven. The amendment implemented in this case was made in anticipation of the extensive amendment to the Renewable Energy Sources Act 2021, the Federal Requirements Plan Act and other laws intended to shape the framework for the further expansion of renewable energy sources as a whole in accordance with the requirements as specified. The specific renewable energy path to achieve this 65% expansion target was laid down in the EEG 2021. However, the expansion paths do not yet take into account the stricter EU climate target, as there are currently no legislative proposals from the European Commission. The expansion paths will have to be re-examined in the light of the higher EU 2030 climate target, taking into account the motion for a resolution tabled by the coalition parliamentary groups under the EEG 2021. An increase in the EEG surcharge, however, must be avoided.

The expansion targets for offshore wind energy have been significantly increased. With the amendment to the Offshore Wind Energy Act (WindSeeG) in December 2020, the increase of the expansion target for 2030 from 15 to 20 GW became law and a long-term target was set at 40 GW by 2040. Furthermore, the amendment made adjustments that are necessary to achieve these targets. These included an increase in the maximum value for auctions, a shortening of completion times and the necessary financial resources and staff for the competent authorities, first and foremost the Federal Maritime and Hydrographic Agency and the Federal Network Agency.

Privileges will no longer be granted to citizens' energy companies. In the past, citizens' energy companies have been able to participate in auctions on simplified terms. This privilege, however, led to misguided incentives. It provided major incentives to participate in the auctions at a very early stage. It was possible to submit speculative bids specifying turbine types that were not yet available. It subsequently allowed large project developers, who had set up citizens' energy companies, to appear on the scene. These complied with the formal requirements, but lacked any involvement with municipalities and thus ran counter to what the law had been designed to achieve. As a

result, contracts were awarded almost exclusively to projects supported by citizens' energy companies with no immission control approval, most of which were never built. This intensified the slump in the expansion of onshore wind energy. These misguided incentives were removed with an amendment to the EEG that entered into force on 29 May 2020. In future auctions for onshore wind turbines, bidders may only submit bids for projects that have already been approved.

Transparency, participation and acceptance in the field of renewable energy sources

Measures to increase the acceptance of onshore wind energy

In order to increase the acceptance of the expansion of renewable energy sources, an examination is being made to determine how municipalities can become more closely involved in the value creation process for the generation of electricity from renewable energy sources by introducing a Germany-wide regulation. With the Buildings Energy Act issued on 8 August 2020, a so-called Länder exemption clause was included in the Federal Building Code to regulate the distance between wind turbines in order to strike an appropriate balance between the justified concerns of the local residents affected on the one hand and the expansion of wind energy on the other.

In the case of onshore wind energy, the Omnibus Energy Act (EnSaG) 2018 introduced on-demand night-time marking (BNK) for new and existing onshore and offshore wind turbines (mandatory in coastal areas) in order to increase acceptance. The implementation deadline for onshore wind turbines was extended until 31 December 2022 and for offshore wind turbines until 31 December 2023. The purpose of this regulation is to eliminate the continuous flashing of warning lights on wind turbines at night and thus help to improve acceptance. The General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation (AVV) was amended for the approval of on-demand night-time marking based on transponder signals. The regulation entered into force on 1 May 2020 and means that the new BNK systems can now be approved through type tests.

In addition, the Wind on Land action programme published by the Federal Ministry of Economic Affairs and Energy in October 2019 contains further measures to place greater focus on the expansion of onshore wind energy and improve acceptance.

Making landlord-to-tenant electricity more economically attractive

Landlord-to-tenant electricity funding now aims to include tenants in the energy transition as well and to create further incentives for the operation of solar systems on the rooftops of residential buildings. Landlord-to-tenant electricity is referred to as electricity that is generated by a solar installation on the rooftop of a residential building and then passed on to final consumers, specifically including tenants, in this building or in residential buildings and ancillary facilities located in the immediate vicinity without being fed through the public grid. Electricity not used by the tenants is fed into the public grid and reimbursed. Unlike purchasing electricity from the public grid, some cost components (e.g. grid fees and electricity tax) do not apply to landlord-to-tenant electricity. There is also funding available for each kWh of landlord-to-tenant

electricity – the so-called landlord-to-tenant electricity surcharge – which is financed via the EEG surcharge. In this way, the project is intended to benefit the landlord as a result of the direct and indirect funding, while tenants receive low-cost electricity from their own rooftop. This means they are ultimately helping to drive the expansion of renewable energy sources in cities. The potential is there: up to 3.8 million housing units could be supplied with landlord-to-tenant electricity. To date, however, landlord-to-tenant electricity as a rule has not been profitable for landlords, in part because landlord-to-tenant electricity models incur considerable costs for distribution, metering and billing. The landlord-to-tenant electricity surcharge is intended to make landlord-to-tenant electricity more economically attractive. Since 2019, it has been easier for housing cooperatives and associations to offer their tenants landlord-to-tenant electricity. Housing cooperatives and associations were made exempt from corporation tax under Section 5 (1) No. 10 of the Corporation Tax Act (KStG) to the extent they build or acquire housing units, for example, and rent them to members for use on the basis of a tenancy agreement or on the basis of a cooperative usage agreement. Other activities are subject to tax. However, the tax exemption of cooperatives as well as associations does not apply completely if they engage in other activities in addition to the traditional activity of renting out housing units and income from these other activities exceeds 10% of the total income. For landlord-to-tenant electricity, this so-called harmless limit was increased to 20% by the "Act on Tax Incentives for the Construction of New Rental Housing" of 4 August 2019 (Federal Law Gazette 2019 I, no. 29, p. 1122). By raising the exemption limit, the legislative body intends to support the generation of solar electricity based on landlord-to-tenant electricity models.

The Registry of Guarantees of regional Origin for electricity from renewable energy sources has now been launched.

The new Registry of Guarantees of regional Origin makes it possible to issue regional Guarantees of Origin for electricity from renewable energy sources. This enables end customers to verify that this electricity was generated in their region, by the wind turbine down the road, for example. The Registry of Guarantees of regional Origin makes the energy transition in the region more tangible for electricity customers. Electricity suppliers can now give their products a regional face. Electricity from the region increases local acceptance of the energy transition. When using Guarantees of regional Origin, electricity suppliers are now allowed to show in their electricity labelling that the EEG electricity they supply – i.e. electricity from renewable energy sources financed by the EEG surcharge – comes from installations in the region. Through the Registry of Guarantees of regional Origin, the German Environment Agency ensures that the regional characteristic of a kWh of electricity generated from renewable energy sources is only sold once.

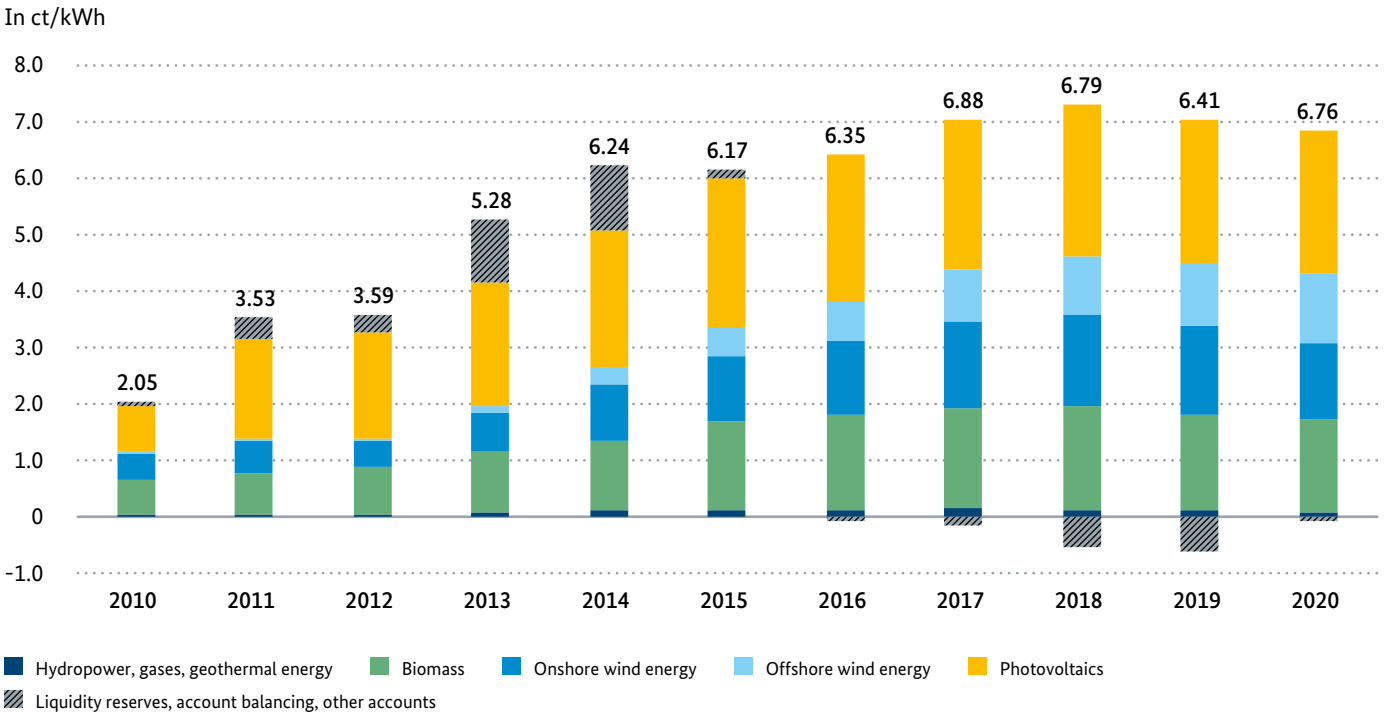
The financing requirements for funded renewable energy plants continued to rise in 2018 and 2019. This corresponds to the difference between EEG remuneration or premium payments to the operators of renewable energy installations and the revenue from the sale of electricity from renewable energy sources on the electricity exchange. Electricity production from renewable energy sources increased by around 8% in 2019 compared with 2018, with a subsequent increase in payments for feed-in tariffs and market premiums. This was due primarily to the weather-related high level of electricity generated by photovoltaic and wind energy installations. As a result of their low

marginal costs, renewable energy sources are also helping to lower electricity prices on the exchange (so-called merit order effect), which increases the financing requirements in the EEG. Overall, following a decline in previous years (from €23.4 billion in 2017 to €23.1 billion in 2018), the financing requirements in 2019 rose again more sharply to around €25.5 billion. The remuneration for existing renewable installations is based on guaranteed remuneration rates over a period of 20 years. In the case of new installations, auction results have shown that cost reduction potential achieved through technical advances are evident in competitive processes and the EEG remuneration rates decrease accordingly.

The financing requirements are offset by the positive effects of renewable energy sources, such as avoided greenhouse gas emissions and air pollutants, in addition to the reduced impact on human health and the environment. The use of renewable energy sources saved some 201 million tonnes of CO_2 equivalent in 2019. Furthermore, the expansion of renewable energy sources will result in macroeconomic stimuli, such as the saving of fossil energy sources, which in turn reduces energy imports (see Chapters 3, 8 and 11). In addition, the funding of renewable energy sources in Germany beyond the EEG has also contributed internationally to the reduction of technology costs in the field of renewable energy sources (see Chapter 15).

The EEG surcharge for 2020 is 6.756 ct/kWh. Recently, after the surcharge had fallen twice in succession, it increased by around 6% compared with 2019. Since 2014, the surcharge has been between 6.2 and 6.9 ct/kWh. This high level is therefore not due to developments of the last

Diagram 4.8: EEG surcharge by technology sector



Source: BMWi based on the TSOs' forecast in accordance with the Renewable Energy Sources Ordinance (15.10.2019)

few years, but rather to the increase that took place until 2014 (see Diagram 4.8). Revenues from the national carbon price and subsidies from the Covid-19 pandemic Economic Stimulus and Future Technologies Package will reduce the EEG surcharge to 6.5 ct/kWh in 2021 and to 6.0 ct/kWh in 2022. The reforms implemented in the course of the last few years have significantly dampened the development of EEG costs. The auctions in particular have a cost-reducing effect on expenditure for new installations. However, the lower costs achieved through auctions will only show up gradually in the EEG surcharge. Up to and including 2020, for example, offshore wind turbines receiving a comparatively high feed-in tariff under the EEG were still being commissioned. In the years to come, however, the auctions will also begin to have a cost-reducing effect on offshore wind turbines.

As a result of the EEG reforms in 2014 and 2017, it was possible to limit the increase in the EEG surcharge and at the same time drive the expansion of RES. This subsequently slowed down the cost dynamics of the previous years.

Furthermore, further RES expansion will be significantly more cost-effective than the previous RES expansion, as there is currently a general reduction in costs for new wind and PV installations. As a result, a balanced mix of onshore and offshore wind turbines and PV installations will reduce grid and system integration costs and ultimately the overall costs (see Chapters 8 and 15).

Key measures implemented to date in the field of renewable energy sources in the electricity, heating and transport sectors

- Omnibus Energy Act (including implementation of special auctions for onshore wind energy and photovoltaics)
- Buildings Energy Act (including statutory abolition of 52 GW PV cap/introduction of statutory Länder exemption clause for wind turbine distance rules)
- Act to Amend the Renewable Energy Sources Act (EEG 2017) and other provisions of energy law (elimination of privileges for citizens' energy companies in onshore wind auctions, prevention of missed deadlines in the EEG compensation mechanism due to the Covid-19 pandemic)
- Coal phase-out law (including adjustment of 65% expansion target under the EEG for 2030 to implement the Federal Government's Climate Action Programme 2030)
- Amendment to the Renewable Energy Sources Ordinance (EEV) to create possibility of state subsidies for EEG surcharge (goal: to limit the EEG surcharge to 6.5 cents per kilowatt hour in 2021 and max. 6.0 cents per kilowatt hour in 2022)
- Amendment to Offshore Wind Energy Act (WindSeeG) and thus statutory increase in expansion target from 15 to 20 GW by 2030, in addition to establishing a long-term target of 40 GW by 2040
- Amendment to Market Incentive Programme of 2015, including heat pump funding and addition of Energy Efficiency Incentive Programme (APEE) since 2016 (see Chapters 5 and 6)
- Coordinated regulatory framework for heating market (see Chapter 5)
- Funding of low-temperature heat networks with seasonal heat storage
- Electric mobility/biofuels/rail transport measures (see Chapter 7)

5. Energy consumption and energy efficiency

Where do we stand?

Primary energy consumption (PEC) was down 2.9% and 2.6% respectively in 2018 and 2019 each compared with the previous year. The main contributors to this development in 2018 were higher energy prices, mild weather conditions and improvements in energy efficiency and energy productivity. In 2019, further improvements in energy efficiency and shifts in the energy mix resulted in a decline in energy consumption.

Final energy consumption was down 2.7% in 2018 and up slightly by 1% in 2019 each compared with the previous year. Adjusted for temperature and inventory, final energy consumption was below the respective previous year's value in both years.

Primary energy and final energy productivity, however, adjusted for temperature and inventory effects, were up in 2018 and 2019 each compared with the previous year.

Gross electricity consumption decreased by 0.5% and 2.7% in 2018 and 2019, respectively, each compared with the previous year.

In 2014, the National Action Plan on Energy Efficiency (NAPE) set the target of saving 390-460 PJ of primary energy and 25-30 million tonnes of CO_2-equivalent (eq.) greenhouse gases (GHG) by 2020; of which 350-380 PJ of primary energy and 21.5-23.3 million tonnes of CO_2-eq. GHG through NAPE immediate measures. By the end of 2019, a total of 320 PJ primary energy (217 PJ final energy) and 20 million t CO_2 eq. GHG have been saved through the measures recorded in the NAPE monitoring since their respective start. The savings achieved by the end of 2019 correspond to about 2.4% of final energy consumption, about 2.5% of primary energy consumption and about 2.5% of Germany's GHG emissions in 2019.

The new primary energy savings stimulated by NAPE in 2019 amounted to 45 PJ. Particularly high primary energy savings were achieved through the CO_2 Building Modernisation Programme for residential buildings (122 PJ) and the Energy Efficiency Networks Initiative (IEEN, 63 PJ).

The CO_2 Building Modernisation Programme, as a key measure of the Federal Government in the building sector, has been enhanced once again as part of the Climate Action Programme 2030. Together with the Market Incentive Programme for the Funding of Renewable Energies in the Heating Market (MAP), the Energy Efficiency Incentive Programme (APEE) and the Heating Optimisation Funding Programme (HZO), it will be merged into the new Federal Funding for Efficient Buildings (BEG) as of 2021.

The Energy Efficiency Networks Initiative (IEEN) has proven to be one of the most successful instruments of the National Action Plan on Energy Efficiency (NAPE) since 2014. By mid-2020, 278 networks had already been set up and the savings target of around 5 million tonnes of CO_2 is expected to be achieved by the end of 2020. On 14 September 2020, the continuation and further development of the IEEN was agreed. By the end of 2025, up to 350 new networks are to be established, saving up to six million tonnes of greenhouse gas emissions per year.

What is new?

In order to set the course for achieving the medium to long-term energy and climate targets at an early stage, the Federal Government adopted the Energy Efficiency Strategy 2050 (EffSTRA) on 18 December 2019. The EffSTRA sets a national energy efficiency target for 2030 of minus 30% primary energy consumption (compared with 2008). The aim is to halve primary energy consumption by 2050.

To achieve the energy efficiency goals, a mix of instruments and measures with far-reaching sectoral and cross-sectoral effects has been developed. On this basis, the energy efficiency-related measures of the Climate Action Programme 2030 (e.g. expansion of funding arrangements, CO_2 pricing) will make a significant contribution to increasing energy efficiency by 2030. These and other measures will be bundled, specified in detail and implemented in the updated National Action Plan on Energy Efficiency (NAPE 2.0). The NAPE 2.0 also contains supplementary measures to support the harnessing of efficiency potential in ways that make sense. While the measures of the Climate Action Programme 2030 are aimed at exploiting the considerable potential for reducing emissions, the supporting measures of NAPE 2.0 are intended to address barriers (e.g. information deficits, low motivation of those involved and bureaucratic effort in financing) that prevent the potential to achieve greater efficiency from being harnessed. Many of the supporting measures use digital solutions to facilitate access to information for consumers and energy advisors and to create more transparency. The Federal Government's energy efficiency policy is based on a broad mix of instruments for all sectors, which builds on the principle of advice and information, funding, demand and research.

	2018	2019	2020	2030	2040	2050
EFFICIENCY AND CONSUMPTION						
Primary energy consumption (compared with 2008)	-8.7%	-11.1%	-20%	-30% →		-50%
Final energy productivity (2008 – 2050)	1.6% per year	1.4% per year	2.1% per year			
Gross electricity consumption (compared with 2008)	-4.2%	-6.9%	-10% →			-25%

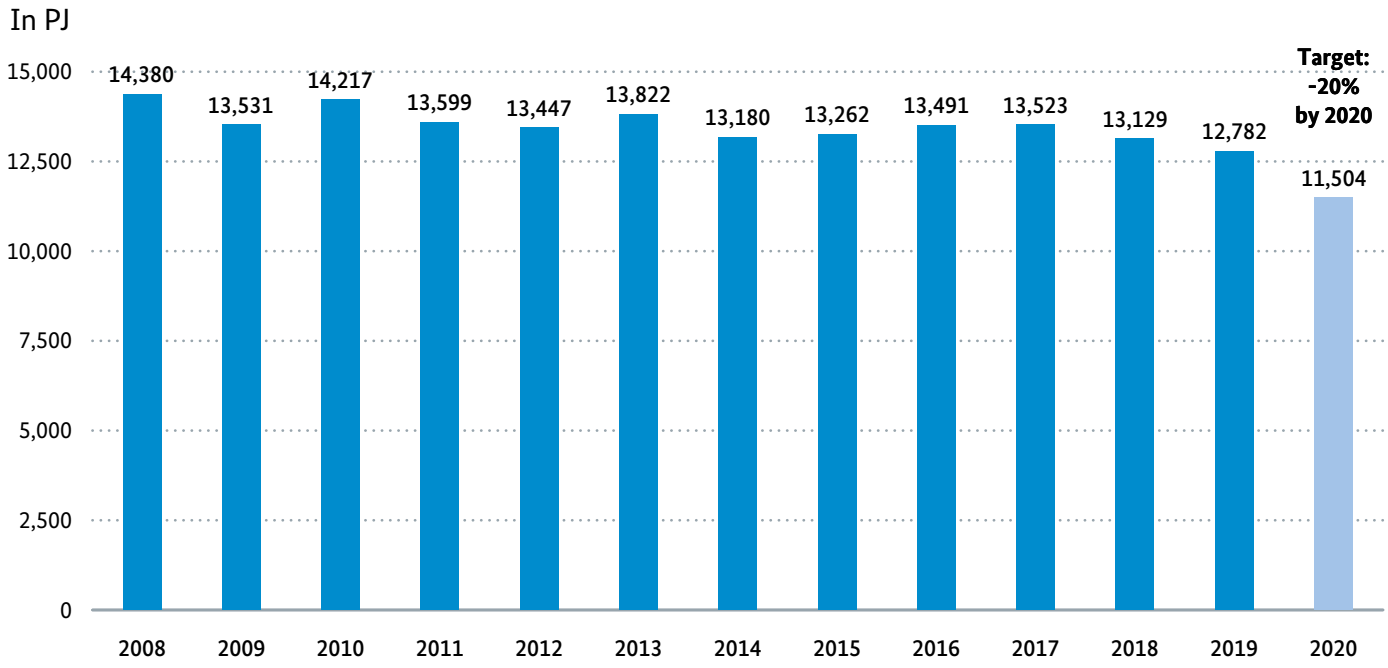
5.1 Primary energy consumption and primary energy productivity

Primary energy consumption was down in 2018 and again in 2019. Primary energy consumption in 2018 and 2019 was 13,129 PJ and 12,782 PJ respectively, which was 2.9% and 2.6% lower in each case compared with the previous year (see Diagram 5.1). Energy consumption in Germany had thus dropped to its lowest level since the early 1970s. In 2018, increased energy prices, mild weather and improvements in energy efficiency and energy productivity contributed to this development. In 2019, further improvements in energy efficiency and shifts in the energy mix resulted in a decline in energy consumption.

The use of renewable energy sources continued to increase in 2018 and 2019. While mineral oil and natural gas were less in demand in 2018 due to higher prices and mild weather, demand increased again in 2019. The main reason for the increase in consumption of natural gas was the further rise in the importance of this energy source in electricity and heat generation. In contrast, the consumption of hard coal, lignite and nuclear energy declined in both years, in line with the long-term trend. Renewable energies were

Diagram 5.1: Target profile: Development of primary energy consumption

Target 2020	Reduction of primary energy consumption by 20% (compared with 2008)
Status 2019	-11.1%



Source: AGEB 06/2020

Trend	●●○○○
Measures	National Action Plan on Energy Efficiency (NAPE) and its continuation and further development as NAPE 2.0

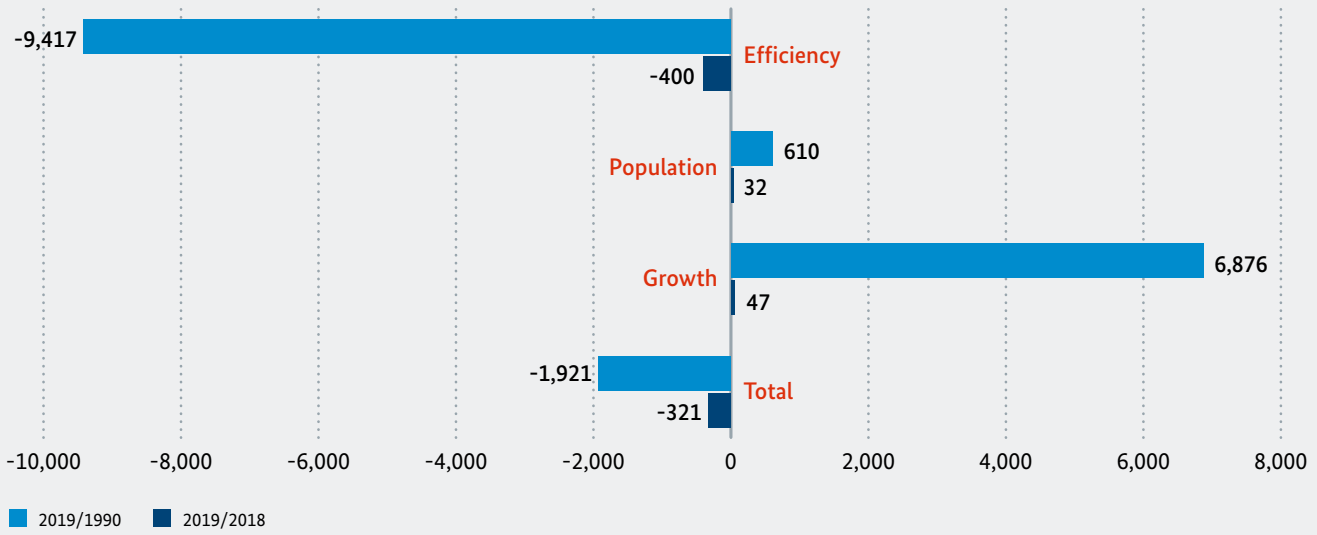
used to an increasing extent. In addition to further growth in new generating capacity, the weather conditions that favoured the use of renewable energy sources also contributed.

Compared with the reference year 2008, primary energy consumption in Germany was down by a total of 11.1% in 2019. In order to still achieve the reduction target for primary energy consumption by 2020, primary energy consumption would have to fall by a further 8.9 percentage points compared with the 2019 level. In absolute terms, this would correspond to around 1,280 PJ, or about two-thirds of Germany's total electricity consumption in one year. Achieving such a decrease by 2020 is very unlikely.

Factors influencing energy consumption

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

Diagram 5.2: Contributions of various factors (components) influencing the changes in (adjusted) primary energy consumption in Germany (changes in 2019 compared with 2018 and 1990)



Source: In-house data from the BMWi based on AGEB 03/2020

As a result, the overall decrease of 1,921 PJ in temperature-adjusted primary energy consumption between 1990 and 2019 is largely attributable to improvements in energy intensity. In contrast, the positive economic development during this period led to an increase in energy consumption. Population growth alone, which totalled around 3.4 million people in the period under consideration from 1990 to 2019, also led to a slight increase in energy consumption. Component decomposition shows that improvements in efficiency from 1990 to 2019 were more than able to compensate for effects that tended to drive up consumption, such as the increasing per capita income and a growing population. This is also confirmed by the results of calculations carried out by the European Commission for the individual consumption sectors from 2005–2015 (COM-1). These results show that in the industry as well as commerce, trade and services (CTS) sector, the increase in final energy consumption from 2005 to 2015 can be attributed in particular to increased economic activity. The results of the European Commission also show that an improvement in energy intensity in the industry and CTS sector and a slight shift to less energy-intensive processes (structural effect) offset an increase in consumption in the same period.

In addition to the absolute consumption of energy, knowing how efficiently an economy uses energy as a resource is essential. One measure of this is energy productivity. This is calculated by comparing the economic output of a country (e.g. gross domestic product or gross value added) with the energy consumption. This means that energy productivity indicates the value of the goods and services that can be provided with one unit of energy.

Primary energy productivity increased in 2018 and 2019 each compared with the previous year. In 2018 and 2019, each compared with the previous year, 4.6% and 3.3% more products and services respectively were provided with the same energy input (see lower curve in Diagram 5.3). Adjusted for the effects and changes in inventories, the increase amounted to 3.1% (2018) and 3.7% (2019). This means that the decoupling of economic growth from energy consumption shows a growing trend.

5.2 Final energy consumption and final energy productivity

Final energy consumption decreased in 2018 compared with the previous year and increased slightly in 2019. Final energy is the share of primary energy that is available to consumers after deducting transmission and conversion losses and non-energy consumption. In 2018 and 2019, final energy consumption amounted to 8,963 PJ and 9,050 PJ respectively, representing a decline of 2.7% and an increase of 1% compared with the previous year in each case. Adjusted for temperature and inventory effects, final energy consumption in 2018 and 2019 was down 0.9% and 0.4% respectively compared with the previous year. A breakdown of final energy consumption by sector shows the following: whereas all sectors in 2018 reported a decrease in final energy consumption compared with the previous year (trade, commerce and services: -9.4%, industry: -2.4%, households: -0.9% and transport: -0.8%), only

final energy consumption in industry was down in 2019 compared with the previous year (-2.5%). Households, on the other hand, consumed 3.4% more final energy than in the previous year, the trade, commerce and services sector 3.3% more and transport 1.1% more.

If we look at the individual energy sources, the consumption of heating oil was down 15.4% in 2018 and up 18.4% the following year. Gas and fuel also recorded a decline in consumption in 2018 (-2.1% and -1.6% respectively) and an increase in 2019 (0.2% and 1.2% respectively). By contrast, consumption of hard coal (2018: -1.6%, 2019: -7.2%), lignite (2018: -2.3%, 2019: -2.3%), electricity (2018: -1.1%, 2019: -2.3%) and district heating (2018: -4.1%, 2019: -1.5%) declined continuously in the years under review.

Final energy productivity was up 4.3% in 2018 and down 0.4% in 2019 each compared with the previous year. The Federal Government's energy concept also links the efficiency target to final energy productivity, i.e. to the real gross domestic product per unit of final energy consumption. In 2019, final energy productivity stood at €358.1/GJ compared with €359.5/GJ in the previous year (see upper curve in Diagram 5.3). Adjusted for temperature and inventory effects, final energy productivity was up 2.5% in 2018 and 1% in 2019.

Transparency, participation and acceptance in the field of energy efficiency

In summer 2016, the BMWi launched the Green Paper on Energy Efficiency, a broad consultation process designed to involve all members of society in the further development of energy efficiency policy in both the medium and long term.

The findings of the Green Paper process have also been incorporated into the Federal Government's Energy Efficiency Strategy 2050 (EffSTRA), which was adopted in December 2019 and which in particular includes the need for a long-term strategic focus of energy-efficiency policy. Against this background, the EffSTRA provides for the development of an Energy Efficiency Roadmap 2050 for the perspective after 2030 to 2050. The aim of this roadmap is to outline possible ways in which the reduction target can be achieved by 2050 in the various sectors and will be developed within the framework of a dialogue-driven participation format (dialogue process on the Energy Efficiency Roadmap 2050). Besides taking into account what impact the paths that have been identified will have on the various groups involved (including consumers, energy suppliers, politics), the measures necessary to achieve the target are to be identified in consultation with the stakeholders. In addition, structures and approaches are to be developed for the legal, economic and political setting required. The kick-off event of the corresponding Roadmap Energy Efficiency 2050 stakeholder participation format took place on 26 May 2020. The work will now continue, primarily in sector-specific and cross-sectoral working groups, and is expected to lead to specific outcomes by 2022.

A broad-based campaign to boost energy efficiency was launched in May 2016. The "Germany makes it efficient" awareness-raising campaign is intended to inform all members of

society about the joint energy transition project and to convince them of the need to use energy even more efficiently than at present. The campaign is aimed at private households, business enterprises and public institutions alike and seeks to involve everyone in the stakeholder dialogue.

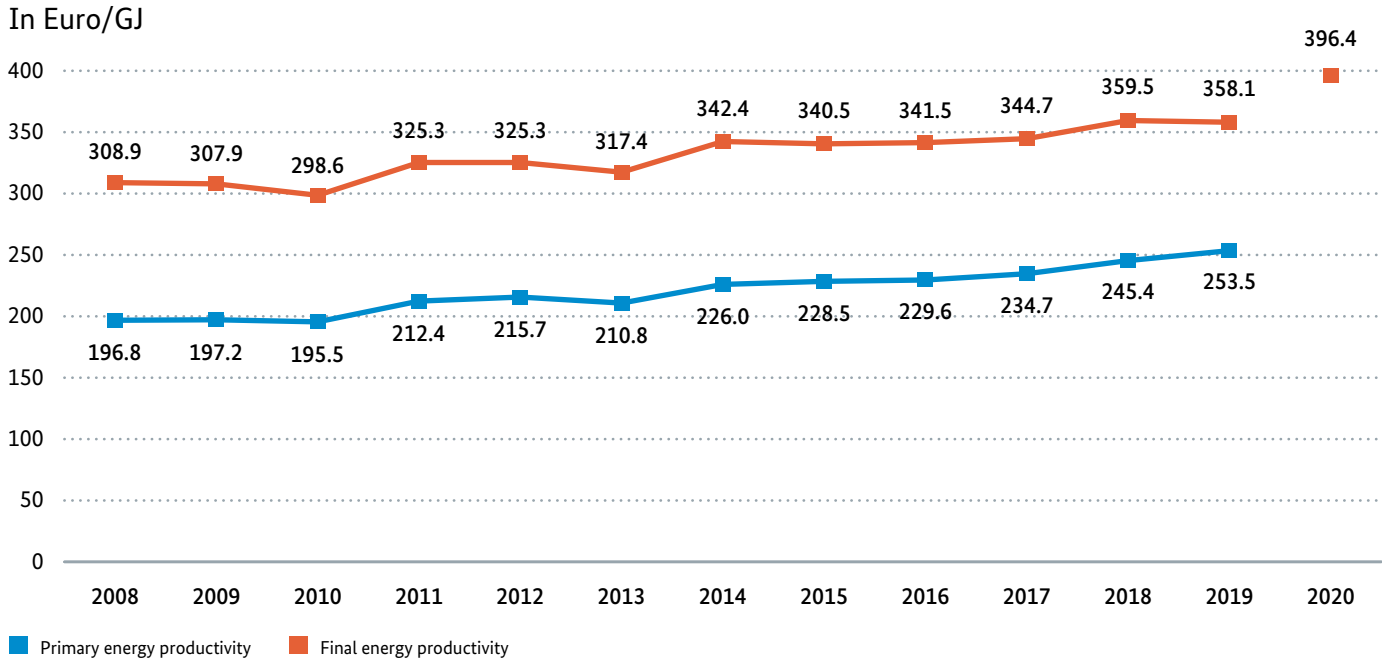
As part of the Germany makes it efficient campaign, the BMWi has developed an Energy Efficiency Funding Guide (https://www.machts-effizient.de/foerderwegweiser), for example, an online tool for anyone wishing to obtain specific information on funding programmes suited to their particular efficiency project.

Energy efficiency in particular is an area that offers many opportunities for citizens, business enterprises and municipalities to actively shape and benefit from the energy transition. To this end, the Federal Government provides high levels of financial support for private households, business enterprises and municipalities. Even minor measures, e.g. in the building sector, for which investment grants or loans are available, can be financially worthwhile due to the energy savings they achieve. As an attractive alternative in terms of the funding available, owner-occupiers will also have access to tax incentives for energy-efficient modernisation measures beginning with the 2020 tax year. In this case, expenses for efficiency measures amounting to 20% of the eligible costs can be claimed against tax over a period of three years.

Between 2008 and 2019, final energy productivity increased by 1.4% on average each year, which is well below the target of an annual increase of 2.1%. To meet the Energy Concept target for final energy productivity, it would have to improve by 10.7% in the remaining months of the year between the 2019 reporting year and the 2020 target year, which is most unlikely. However, the goal is and remains to produce the real gross domestic product with the lowest possible final energy input and to avoid unnecessary energy consumption. For this reason, private households, business enterprises and the public sector must continue to focus on the efficient use of energy resources.

Diagram 5.3: Target profile: Development of energy productivity

Target 2020	To increase final energy productivity by 2.1% per year
Status 2019	1.4% annually since 2008



Source: In-house data from the BMWi based on AGEB and StBA 06/2020

Trend	●●●○○
Measures	National Action Plan on Energy Efficiency (NAPE)

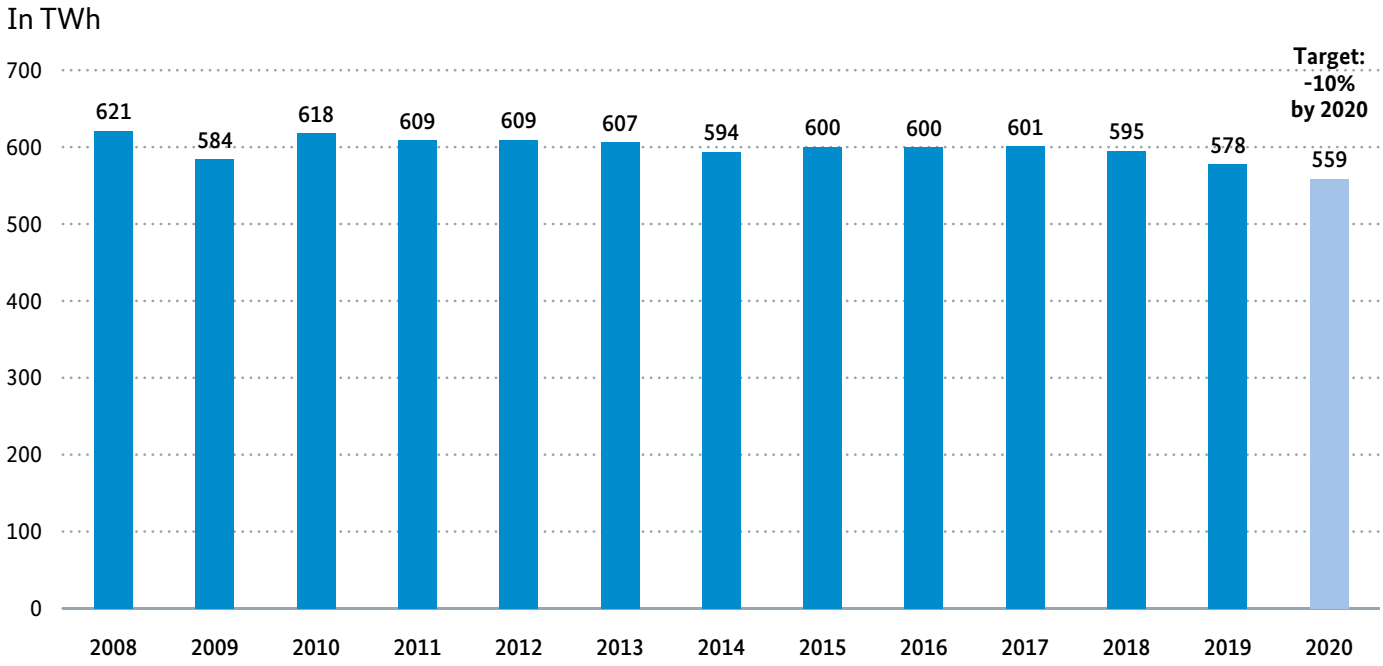
5.3 Electricity consumption and electrical energy efficiency

Gross electricity consumption decreased by 1.0% and 2.9% in 2018 and 2019 respectively, in each case compared with the previous year. Gross electricity consumption reflects the amount of electricity consumed domestically. It stood at approximately 595 TWh and 578 TWh in 2018 and 2019 respectively (see Diagram 5.4).

Between 2008 and 2019, gross electricity consumption declined by 6.9%. The target is a reduction in gross electricity consumption by 10% by 2020 (compared with 2008). To achieve this target, consumption would have to decrease by a further 3.1 percentage points, or about 19 TWh, in the remaining months of the year between the reporting year 2019 and the target year 2020. It must also be taken into account that, in order to move forward with decarbonising the heating and transport sectors, more renewable electricity will have to be used in an efficient manner in these sectors with the aid of sector coupling. This will result in new electricity consumers. To keep the additional demand for renewable electricity as low as possible, however, as a basic principle, sector coupling should employ technologies that convert electricity into heating, cooling or propulsion efficiently and can thus replace as many fuels as possible using as little renewable electricity as possible (see Chapter 13).

Diagram 5.4: Target profile: Development of electricity consumption

Target 2020	Reduction of gross electricity consumption by 10% by 2020 (compared with 2008)
Status 2019	-6.9%



Source: AGEB 09/2020

Trend	●●
Measures	National Action Plan on Energy Efficiency (NAPE)

Macroeconomic electricity productivity continued to improve in 2018 and 2019. Macroeconomic electricity productivity represents the relationship of real gross domestic product to total gross electricity consumption and is thus a measure of how efficiently electricity is used in an economy. It recorded a year-on-year increase of 2.7% and 3.5% in 2018 and 2019 respectively. There has been a trend towards greater decoupling of economic growth from the development of electricity consumption ever since the 1990s. In 2019, macroeconomic electricity productivity was around 46.5% above the 1990 level and had increased on average by around 1.6% each year during this period.

5.4 Key measures implemented to date

With the National Action Plan on Energy Efficiency (NAPE) the Federal Government launched a comprehensive strategy in 2014 designed to increase energy efficiency. The NAPE defines immediate actions and follow-up work processes to achieve the national efficiency and climate goals. The NAPE also makes a significant contribution to the Climate Action Programme 2020.

The key action areas of energy efficiency policy are:

- Promoting energy efficiency in the building sector
- Establishing energy efficiency as a return on investment and business model
- Increasing personal responsibility for energy efficiency

For these action areas, the NAPE defines cross-sectoral measures designed to reduce energy consumption on the demand side. The aim is to save a total of 390 to 460 PJ of primary energy by 2020 by means of measures designed to increase energy efficiency on the basis of the NAPE.

Programmes based on decisions taken by the leaders of the CDU, CSU and SPD coalition parties on 1 July 2015 have been added to the NAPE. The aim is to save an additional 5.5 million tonnes of CO_2 by 2020 through energy efficiency measures in the buildings sector, in municipalities, in industry and at Deutsche Bahn AG.

Since January 2019, measures to increase energy efficiency have largely been financed by the Energy and Climate Fund (ECF). Previously, the majority of the energy efficiency measures were financed by the ECF special fund, with the remainder coming from the general federal budget. With the 2019 federal budget, all energy efficiency measures implemented by the BMWi were transferred to the ECF, where they will be restructured. The ECF is funded with the proceeds from the auctioning of emissions allowances and a federal subsidy. It also has access to reserves. In 2018, the ECF had a total volume of around €6 billion. From 2016 to 2020. a total of around €17 billion are available for the funding of energy efficiency and heating from renewable energy sources.

On 18 December 2019, the Federal Government adopted the Energy Efficiency Strategy 2050 (EffSTRA) presented by the Federal Minister for Economic Affairs and Energy. The Federal Government is pursuing the goal of shaping the German economy into the most energy-efficient economy worldwide and drastically reducing primary energy consumption in order to achieve greenhouse gas neutrality by 2050. This is because only by continuously increasing energy efficiency can the energy transition be implemented cost-effectively and the climate goals achieved. The EffSTRA sets a medium-term energy efficiency target for the year 2030 of minus 30% for primary energy consumption compared with the base year 2008. It also bundles and specifies energy efficiency measures in an updated National Action Plan on Energy Efficiency (NAPE 2.0). This implements the energy efficiency measures of the Climate Action Programme 2030, which were adopted by the Federal Government on 9 October 2019, as well as further measures. The supporting measures of the strategy are intended to address existing barriers (e.g. information deficits, low motivation of those involved and bureaucratic effort in financing) that prevent the potential to achieve greater efficiency from being harnessed. In addition, a dialogue process for a long-term roadmap to reduce primary energy consumption by 2050 (dialogue process on the Energy Efficiency Roadmap 2050) will be initiated.

By 2019, the NAPE measures for which corresponding savings values can be reliably quantified achieved around 320 PJ of primary energy savings or around 20 million tonnes of CO_2 savings. These savings include both savings in 2019

resulting from efficiency measures implemented in previous years and new savings from efficiency measures implemented in 2019 (so-called NAPE logic). New savings, i.e. those resulting from efficiency measures implemented in 2019, amount to 45 PJ of primary energy savings. A direct comparison with the projected effects of NAPE is not possible, as in some cases only the increased funding for individual programmes was taken into account. Adjustments were made to some measures regarding the savings achieved in 2018 and previous years due to the results of evaluations that are now available or due to the analysis of new data.

The direct and indirect savings resulting from energy efficiency instruments in some cases is not easy to quantify. In particular, it is difficult to measure how the information provided will affect the actions actually taken by those involved. In addition, awareness raising and advisory measures frequently have only an indirect effect, e.g. when accompanying other measures or activating actual energy efficiency investments at a later date. Considerable methodological difficulties and different methodological approaches also exist when quantifying deadweight, multiplier and overlapping effects. Overlapping effects, i.e. counting savings twice, are to be avoided. They can occur when a unit of energy saved is attributed to both the indirect effect of an awareness raising and activation measure and the direct effect of a funding programme (e.g. insulation of a building).

The monitoring of all efficiency measures will be continued and in future important measures of the NAPE 2.0 will also be recorded. To this end, the methodology used for evaluating all efficiency measures will be continuously improved and further standardised.

In order to increase the effectiveness and efficiency of the funding programmes further, the BMWi launched a new "Funding strategy for energy efficiency and heat from renewables" and fundamentally reformed its funding of and investment. This means that, from 2017 to 2020, the funding programmes will gradually be reorganised, bundled by specific topic and designed for specific target groups. Funding programmes are structured on a modular basis that allows for individual elements to be combined and consist of advisory modules, entry-level funding, systemic funding and ambitious innovation projects. In order to provide incentives to make energy saving more effective, funding is based on the principle "The more ambitious your investment, the more attractive the funding". In addition, customer focus is to be further increased and access to funding simplified. The guiding principle is to create a one-stop shop that bundles all the relevant information and provides interested citizens and business enterprises alike with step-by-step guidance from initial information on how to save energy saving to the implementation of a funding measure.

In 2018, as part of its funding strategy, the BMWi bundled the funding programmes for industry. The approach is technology-neutral and available to all sectors. Furthermore, funding is now provided either as a direct grant or repayment grant. It is also possible to receive funding by participating in the BMWi's energy efficiency funding competition, which takes into account the various financing needs of business enterprises. The reorganisation of the funding programmes for industry is intended to provide more effective funding for investments in more complex efficiency measures designed to achieve systemic, energy-related optimisation of production processes. In addition,

funding for individual measures in the field of highly efficient cross-cutting technologies, renewable technologies for the provision of process heat, in addition to instrumentation and control technology and energy management software will continue to be possible. The new funding package entered into force in 2019. In 2019 and 2020, funding in the buildings sector was also restructured (see Chapter 6).

Table 5.1: Quantifiable effects of efficiency measures since 2016

NAPE measure and programmes based on decisions taken by the leaders of the CDU, CSU and SPD coalition parties on 1 July 2015	Primary energy savings* (in PJ)				CO_2 savings* (in million tonnes of CO_2 equivalent)			
	2016	2017	2018	2019	2016	2017	2018	2019
NAPE measures								
CO_2 Building Modernisation Programme: Non-residential Buildings	4.21	5.51	6.82	7.95	0.27	0.34	0.42	0.43
CO_2 Building Modernisation Programme: Residential Buildings	104.76	111.00	116.68	122.15	5.75	5.86	8.02	7.85
Market Incentive Programme for the Funding of Renewable Energies in the Heating Market (MAP)	2.08	3.10	3.99	3.99	1.44	1.83	2.14	2.41
Energy Efficiency Incentive Programme (APEE)	1.71	4.26	6.92	9.98	0.09	0.23	0.42	0.56
National efficiency label for old heating systems	0.01	0.35	0.87	1.51	0.00	0.03	0.06	0.11
KfW Energy Efficiency Programme for Production Facilities and Processes	8.86	17.78	20.40	25.00	0.34	0.50	0.63	1.31
Energy Efficiency Networks Initiative	24.67	35.55	54.65	63.36	1.36	1.90	2.87	3.09
Energy audit obligation for non-SMEs	4.81	9.61	14.42	19.22	0.27	0.52	0.76	0.93
SME Energy Transition and Climate Action Initiative (MIE)	0.63	0.89	1.19	1.29	0.04	0.05	0.06	0.06
Energy-efficient and climate-friendly production processes**	3.21	3.86	5.02	5.02	0.17	0.20	0.26	0.25
Market monitoring	0.00	0.00	0.19	0.41	0.00	0.00	0.01	0.02
National Top Runner Initiative (NTRI)**	0.00	0.02	0.15	0.35	0.00	0.00	0.01	0.02
STEP up! Exploiting electrical energy efficiency potential**	0.10	0.15	0.58	1.01	0.01	0.01	0.03	0.05
Energy Savings Meter pilot programme	0.00	0.01	0.01	0.03	0.00	0.00	0.00	0.00
Energy management systems**	0.52	0.69	0.73	0.73	0.03	0.04	0.04	0.04
Energy consulting	10.01	12.80	17.65	23.37	0.55	0.68	0.93	1.14
Programmes based on decisions taken on 1 July 2015								
Funding of heating optimisation using high-efficiency pumps and hydraulic balancing	0.14	0.85	1.49	1.79	0.01	0.05	0.08	0.09
Cross-cutting technologies**	4.27	5.28	6.60	6.76	0.25	0.29	0.35	0.32
Waste Heat Directive**	1.00	3.16	16.64	25.65	0.05	0.16	0.87	1.27
Overall effect	**171**	**215**	**275**	**320**	**11**	**13**	**18**	**20**

Source: BMWi 11/2020

* Cumulative impact in accordance with NAPE logic since the beginning of the respective measures up to and including 2016, 2017, 2018 and 2019.

** Efficiency measure has expired or has since been transferred to other measure(s). The efficiency improvements implemented prior to the end of the programme, however, continue to deliver corresponding savings effects beyond the lifetime of the measure.

In addition to national measures, various EU measures also make an important contribution to increasing energy efficiency. These include the EU ecodesign and EU energy labelling. EU ecodesign is a major factor in ensuring that only energy-efficient technologies and appliances can be offered by dealers and become established on the market. From September 2018 to January 2019, ambitious ecodesign standards were adopted for the product group consisting of household refrigerating appliances, lighting equipment, TVs and electronic displays, household dishwashers, household washing machines, motors, transformers, external power supplies, welding equipment and refrigerating appliances with a direct sales function. The regulations specify the ecodesign requirements for energy-related products in order to exploit the potential for design-related improvements in terms of their environmental performance.

Monitoring of the key measures for funding energy savings

KfW Energy Efficiency Programme for Production Facilities and Processes			
Brief description	The KfW Energy Efficiency Programme supports energy efficiency measures for production facilities and processes of industrial companies with low-interest loans. Funding is provided for any investments that achieve energy savings of at least 10% (entry standard) or at least 0% (premium standard). Both upgrades and investments in new machines/plants/process technology, compressed air/vacuum/extraction technology, electric drives/pumps, process heat/cooling, waste heat recovery/waste heat utilisation, instrumentation and control technology, information and communications technology, and CHP plants are eligible for funding. The maximum loan amount is usually as high as €25 million per project, with repayment terms of 5, 10 or 20 years.		
Current status 2019	The programme has been updated continuously. A total of 478 loans worth some €1.41 billion were approved in 2018, and 219 loans worth around €0.97 billion were granted in 2019.		
Character of the instrument	Funding programme		
Target group	Companies		
Energy sources concerned	All		
Maturity of the instrument	2015, then open-end		
Implementation	KfW		
Last evaluation	2019		
Next evaluation	None		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	20.403	24.999	30
Final energy savings (in PJ)	6.667	8.034	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.626	1.313	2

Energy Efficiency Networks Initiative			
Brief description	The goal of the Energy Efficiency Networks Initiative, which is sponsored by the Federal Government, together with 22 associations and organisations from the business community, is to establish around 500 new energy-efficiency networks (EEN) in Germany by the end of 2020 and thus save 5 million tonnes of CO_2 or 75 PJ of primary energy. In mid-September 2020, the Federal Government agreed to continue the initiative as the Energy Efficiency and Climate Protection Networks Initiative along with 21 supporting associations and ten cooperation partners. The second phase is to run until the end of 2025 (targets: 300-350 new networks, savings of 9-11 TWh of final energy and 5-6 million tonnes of GHG emissions). Under the IEEN, at least five business enterprises have joined together to set up a network for a fixed period of time and, once the network is in place, to specify both individual energy savings targets and a common target, and to exchange information on the implementation of appropriate energy efficiency measures. The relevant industry sectors, the energy industry, in addition to representatives of small craft industries and business, are all involved in the alliance. The guiding principle is that through the sharing of experience within the network, those involved will be encouraged to implement considerably more energy efficiency measures in their business operations than if they were not included. Expert energy consultants assist in structuring and supporting their networking efforts. Mutual motivation and the guided sharing of experience between the various business enterprises will contribute to the success of their networking efforts. In this way, business enterprises can acquire the necessary technical and organisational knowledge in the networks to achieve significant progress in efficiency.		
Current status 2019	In 2019, 36 new networks were registered with the initiative's office. At the end of 2019, a total of 252 networks had registered.		
Character of the instrument	Voluntary commitment on the part of the business community		
Target group	Business enterprises in industry, trade and commerce		
Energy sources concerned	All		
Maturity of the instrument	3 December 2014 until 31 December 2025		
Implementation	Addressing business enterprises through business associations and organisations. In individual cases, these also act as network initiators. The Federal Government provides support in particular through public relations work and financing an office.		
Last evaluation	31 December 2019		
Next evaluation	31 December 2020		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	54.651	63.357	75
Final energy savings (in PJ)	36.937	42.820	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	2.869	3.094	5

Energy audit obligation for non-SMEs	
Brief description	In order to increase the energy efficiency of business enterprises, since 22 April 2015, under the Energy Services Act (EDL-G), all business enterprises that do not fall within the category of small to medium-sized enterprises (SMEs) have been required to carry out an energy audit by 5 December 2015 and to carry out a further energy audit at least every four years as of this date. If business enterprises have introduced an energy management system (EMS) or an environmental management system in accordance with EU Eco-Management and Audit Scheme (EMAS), they are exempt from the audit obligation. Around 50,000 large business enterprises are affected by the audit obligation, of which some 30% have an energy or environmental management system and are thus exempt from the audit obligation. By introducing the audit obligation as part of the NAPE, the Federal Government has implemented Article 8 (4-7) of the European Energy Efficiency Directive.

Continuation: Energy audit obligation for non-SMEs

Current status 2019	The amendment to the EDL-G has been successfully implemented. The following key changes were made: • Introduction of an online reporting obligation for those business enterprises affected • Business enterprises with a total energy consumption of less than 500,000 kWh per year are only required to submit an online report on their energy consumption and costs. • Introduction of a regular further training obligation for energy auditors to improve the quality of the energy audit The changes entered into force on 21 November 2019. In addition, a new guideline was published by the energy audit department of the Federal Office for Economic Affairs and Export Control (BAFA) to support business enterprises in implementing the audits.		
Character of the instrument	Regulatory law		
Target group	Non-SMEs/ business associations and organisations		
Energy sources concerned	All		
Maturity of the instrument	1 May 2015 with first evidence of obligation to conduct an energy audit by 5 December 2015 or alternatively energy management system in accordance with ISO 50001 or EMAS by 31 December 2016 and to continue indefinitely		
Implementation	BAFA		
Last evaluation	-		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	14.418	19.224	51
Final energy savings (in PJ)	9.030	12.040	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.762	0.930	3.4

Cross-cutting technologies			
Brief description	The aim of funding investments in highly efficient cross-cutting technologies is to quickly harness the existing potential for efficiency improvements in technologies that are generally applicable in industry and commerce. The funding programme thus creates special incentives for business enterprises to invest in these technologies. In terms of individual measures, support is provided for electric motors and drives, pumps, fans, compressed air systems and standard technologies for waste heat utilisation. In the case of systemic measures, the renewal of at least one technical system in the technologies listed under individual measures will be funded. The prerequisite for systemic measures is participation in a programme. The funding rates, range between 20-30%, depending on the size of the company. In the case of systemic measures, the funding rates also depend on the verifiable energy savings (at least 25%).		
Current status 2019	In 2019, approval was granted to the remaining 688 measures for which applications had been submitted to BAFA by the end of 2018. New measures will no longer be funded under this programme. Since only residual approvals were granted in 2019, the indicators (see below) are correspondingly lower compared with the previous year.		
Character of the instrument	Funding programme		
Target group	Business enterprises (especially SMEs)		
Energy sources concerned	All		
Maturity of the instrument	2012 until at least 2019		
Implementation	BAFA		
Last evaluation	March 2020		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	6.604	6.756	No information available
Final energy savings (in PJ)	3.178	3.262	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.355	0.318	0.9

Waste Heat Directive			
Brief description	The aim of the programme to fund waste heat avoidance and utilisation in industrial and commercial companies (waste heat programme) is to save 1 million tonnes of CO_2 annually by 2020. The programme is designed to implement the Waste Heat Prevention Campaign included in the NAPE and provide funding for investments in the replacement, modernisation, expansion or new construction of facilities if this results in the avoidance of waste heat or previously unused waste heat being utilised efficiently both internally and externally. Funding is granted either as an investment grant or a KfW loan repayment subsidy (grant: 30-40% of eligible investments, bonus of 10% for SMEs). A prerequisite for the funding is the submission of a waste heat concept prepared by an accredited energy consultant.		
Current status 2019	The funding measure expired on 1 December 2018. In 2019, applications received by the end of 2018 that had not yet been approved were subsequently granted approval. By the end of 2018, a very high number of applications had been received, which meant that not all applications could be approved. This was also one of the reasons why the launch of the project was delayed. This situation was not remedied until the beginning of the second quarter of 2019, following the approval of the corresponding request for a higher-than-anticipated commitment appropriation.		
Character of the instrument	Funding programme		
Target group	Companies		
Energy sources concerned	Electricity and fuels		
Maturity of the instrument	2016 until 2018		
Implementation	KfW		
Last evaluation	March 2020		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	16.641	25.655	No information available
Final energy savings (in PJ)	12.360	19.406	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.867	1.272	1

Funding of energy-saving contracting (contracting deficiency guarantees and funding programme for contracting advice)			
Brief description	Energy-saving contracting is to be funded through two programmes: (i) The Contracting deficiency guarantees programme, the aim of which is to remove financing obstacles for small to medium-sized enterprises (SMEs), such as craft and skilled trades and service providers, and thus to boost the implementation of contracting measures in the commercial sector (in particular through deficiency guarantees from the guarantee banks in the field of energy-saving contracting) and (ii) the Contracting Funding Guideline, which also provides funding for advice given to municipalities and SMEs on the use of energy-saving contracting for the implementation of energy-saving investments.		
Current status 2019	-		
Character of the instrument	Funding programme		
Target group	Municipalities and SMEs		
Energy sources concerned	All energy sources		
Maturity of the instrument	Contracting deficiency guarantees : 2015 to 2017 and contracting advice: 2015 to 2018		
Implementation	BAFA		
Last evaluation	-		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.125	0.125	No information available
Final energy savings (in PJ)	0.074	0.074	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.007	0.006	No information available

SME Energy Transition and Climate Action Initiative (MIE)			
Brief description	Since 1 January 2013, the SME Energy Transition and Climate Action Initiative (MIE) has provided funding to business enterprises implementing the energy transition and has offered SMEs in trade and industry in the field of energy efficiency and climate protection specific assistance with training and networking projects. The business enterprises receive targeted support with the aid of optimised information and advice, in addition to more intensive further training, development and sharing of experience. The SME initiative is a joint project sponsored by the BMWi, BMU, DIHK and ZDH. Half of the project volume is financed by the BMWi and the BMU from the ECF, with a 20% contribution from the project partners. To avoid mixed financing, the DIHK projects receive funding from the BMU, with the ZDH projects funded by the BMWi.		
Current status 2019	• The previous (transfer) partners in the project were provided with information, 5 new partners were found and continuation agreements were concluded. • More than 100 additional efficiency dialogues have taken place with new business enterprises. • The energy efficiency toolbox has been continuously updated by all environment centres in the assigned thematic areas. • The “minutes of meeting” tool has been adapted to the needs of all trades and the energy efficiency checklists have been revised. • Pilot business profiles for all MIE pilot businesses are now available online in the new Pilot business map. • New “work2gether” internal communications platform for data exchange, communication and project management. • “Electric mobility and alternative drive concepts” has been included in the MIE web guide on energy efficiency. • The HPI tool has been finalised in its basic form (the final working status was forwarded to the BMWi mid-2019). • A market study was completed and more than 100 software packages from the small business community were examined to determine how close or suitable they were for the future e-tool app, in addition to a further 220+ software packages (BAFA list of “Energy management software eligible for funding”). • Attendance at various trade fairs, press releases, etc.		
Character of the instrument	Funding programme		
Target group	Businesses (SMEs and craft and skilled trades)		
Energy sources concerned	Electricity and fuels		
Maturity of the instrument	2013 to 2021		
Implementation	BAFA		
Last evaluation	-		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	1.192	1.290	No information available
Final energy savings (in PJ)	0.670	0.730	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.063	0.062	No information available

Energy-efficient and climate-friendly production processes	
Brief description	Funding was provided for measures to increase energy efficiency in commercial and industrial production processes. These include, in particular, making production processes more energy efficient and implementing measures for the efficient use of energy from production processes and production facilities. Funding was provided for up to 20% of the eligible expenditure. To be eligible, the cumulative requirements of at least €50,000 in additional investment costs, a specific energy saving of at least 5% compared with the average consumption of the last three years and a saving of at least 100 kg CO_2/year for every €100 of investment costs must be met.
Current status 2019	The programme has been integrated into the new Federal funding for energy efficiency in commerce programme.

Continuation: Energy-efficient and climate-friendly production processes

Character of the instrument	Funding programme		
Target group	Businesses and contractors		
Energy sources concerned	Electricity and fuels		
Maturity of the instrument	2013 to 2017		
Implementation	Project Management Agency Karlsruhe – Production Technology		
Last evaluation	-		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	5.025	5.025	5
Final energy savings (in PJ)	3.635	3.635	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.262	0.248	0.35

Support for market monitoring			
Brief description	To strengthen the reliability, effectiveness and efficiency of existing and, if necessary, new testing methods and standards, and thus ultimately to improve the effectiveness and credibility of the EU's product-related energy efficiency instruments, the Federal Institute for Materials Research and Testing (BAM) was commissioned to carry out this project. For this purpose, interlaboratory comparisons were conducted to validate the test methods or to identify possible shortcomings. The purpose of the comparisons was to determine whether the methods and standards used in the market monitoring tests were appropriate, i.e. reproducible, effective and efficient, and whether they realistically reflect the energy consumption that occurs in practice. The methods were also examined with regard to the possibility of simplifying and optimising them by having further individual tests conducted at independent institutes, whereby any major shortcomings in the products examined can also be identified.		
Current status 2019	Examination of the following product groups was finalised in 2019: tumble dryers, cooker bonnets, heat pumps and air conditioners, in addition to the project evaluation. The measure was subsequently extended to include the following product groups from 2019 to 2021: boilers and combi boilers, water heaters and storage tanks, solid fuel boilers, space heaters, ventilation and air conditioning systems. As the work started in 2019, no savings can be achieved for these product groups. For the 2019 reporting year, only the savings resulting from the long-term effect of the measures from 2016–2018 have been taken into account.		
Character of the instrument	Market monitoring		
Target group	Appliance manufacturers, market monitoring authorities and households		
Energy sources concerned	All		
Maturity of the instrument	1 April 2016, then initially until 31 December 2022		
Implementation	Federal Institute for Materials Research and Testing (BAM)		
Last evaluation	July 2019		
Next evaluation	Scheduled for June 2022		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.192	0.408	0.2
Final energy savings (in PJ)	0.080	0.170	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.010	0.019	0.014

National Top Runner Initiative (NTRI)			
Brief description	With the National Top Runner Initiative (NTRI), the Federal Government aims to bundle measures to accelerate the market penetration of energy-efficient products (top runners) in order to increase product-related and cross-sectoral electrical energy efficiency. This is to be achieved by increasing motivation and expertise in electrical energy efficiency, product-related energy efficiency and the rational use of energy along the entire value-added chain – from appliance manufacturers via the retailers to the consumers. The NTRI covers all products regulated by the EU Ecodesign and EU Label Directives. It was launched in January 2016 and focuses primarily on the following areas: (a) consumer communications (energy efficient products, user behaviour), (b) retail trade as an efficiency multiplier, (c) providing stimuli for the development of future products, prototype of the EU product database and (d) stakeholder events.		
Current status 2019	The timeframe of the measure was initially intended to end on 31 December 2018 and was then extended until 31 December 2019. In 2019, the focus was on ensuring there was more information available in order to increase the coverage and get more consumers involved. Accordingly, the campaign developed from an awareness-raising campaign to an activation and amplification campaign, including active press and media work, trade fair appearances, distribution of flyers and the involvement of influencers, the creation of a landing page and use of SEO, SEA and native ads. In addition, the retail sector was actively involved as a multiplier by using the point of sale as a customer advice and campaign tool (e.g. shelftalkers). Stakeholders were also involved in method workshops and dialogue events on the subject of Consumer communications or Label revision were organised and training programmes were made available on various platforms. Generally speaking, the main focus was on setting up an extensive stakeholder and multiplier network throughout Germany and spreading the principles of the NTRI among members of the professional community. Furthermore, the NTRI played a direct role in drafting the Development of a national digital application for the EU energy label for consumers and retailers based on the European product database for Energy Labelling (EPREL) and has been included in all related consultation forums of the European Commission.		
Character of the instrument	Public relations work		
Target group	Equipment manufacturers, retailers and consumers		
Energy sources concerned	All		
Maturity of the instrument	2016 to 2019		
Implementation	BAFA and BfEE		
Last evaluation	2019 / 2020		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.146	0.355	1.02
Final energy savings (in PJ)	0.061	0.148	0.425
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.008	0.016	0.0595

EU Energy Labelling Framework Regulation			
Brief description	As part of the EU negotiations on the Energy Labelling Framework Regulation, Germany successfully campaigned for a clear and informative energy label. The regulation provides for a rescaling of the labels from A+++ to an A to G scale and describes the procedure and the timescale within which the rescaling is to be completed. The establishment of an EU product database is intended to make it easier for consumers to compare the efficiency of products and for market monitoring authorities to check the label requirements. For the first five product groups (e.g. refrigerators, TVs and monitors, washing machines and dishwashers), the new energy label will be displayed in shops and online as of March 2021.		
Current status 2019	The European Commission will continue to comply with its obligation to develop a product database as described in the Energy Labelling Framework Regulation. Manufacturers and suppliers are able to enter the relevant product data for their respective product groups into the database and test accounts for market monitoring authorities have been set up. Meetings of experts are being held in parallel with the development of the database. In addition, consultation forums are being held on the implementation of the obligation to carry out awareness-raising campaigns by Member States, which is also described in the Energy Labelling Framework Regulation. Germany has entered into initial talks with an appropriate agency, which is expected to be entrusted with preparing the concept and implementing the project. In addition, the coordination meeting are being held on European projects (LABL2020 and BELT) with their national coordinators, who will support the Member States in the introduction of the rescaled energy label.		
Character of the instrument	Information and regulatory law		
Target group	Appliance manufacturers, retailers and households		
Energy sources concerned	All		
Maturity of the instrument	1 August 2017, then open-end		
Implementation	BMWi		
Last evaluation	-		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.000	0.000	No information available
Final energy savings (in PJ)	0.000	0.000	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.000	0.000	No information available

STEP up! Exploiting electrical energy efficiency potential			
Brief description	The pilot phase of the STEP up! funding programme to fund electrical energy efficiency measures was launched in June 2016 and was scheduled to run until the end of 2018. STEP up! is the first competitive auctioning model to be implemented in Germany for the funding of energy efficiency measures. The programme is designed to activate the market's search function for cost-optimised savings opportunities and to give no preference to any specific technology, individual group or sector. On the basis of the cost-benefit value (subsidy euro/saved kWh), each of the funding applications received in a round of auction submissions is evaluated in comparison with the other applications. The contract is subsequently awarded to those measures with the highest economic cost-benefit values in competition for the funding grants. The open auctions are supplemented by so-called closed auctions with changing thematic areas. During the pilot phase, the feasibility of using competitive auctions for energy efficiency measures is to be tested and the programme continuously updated and improved (learning programme).		
Current status 2019	No round of auction submissions was conducted in 2019, but the approval procedures from the last round of auction submissions in 2018 were completed in 2019. The measures have been approved and are now being implemented. The status of the approvals was used for the evaluation.		
Character of the instrument	Funding programme		
Target group	Businesses (possibly including private consumers via a collective project)		
Energy sources concerned	Electricity; savings from other energy sources are permitted from the fourth round onwards on the basis of closed auctions; extension to include heating is to be examined by the end of 2018.		
Maturity of the instrument	1 June 2016 until 2018		
Implementation	Project Management Agency VDI/VDE-IT GmbH		
Last evaluation	2019		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.583	1.012	No information available
Final energy savings (in PJ)	0.243	0.422	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.032	0.047	No information available

Energy Savings Meter pilot programme	
Brief description	The Energy Savings Meter pilot programme funds digital platforms for the energy transition. Any company that intends to test innovative digital systems and business models based on them for saving energy and to develop them as a scalable business model with end customers is eligible for funding. The prerequisite is that digital systems such as smart homes, smart meters, smart buildings, measurement and control technology are installed at the customers' premises and help them to save energy. Half of the project funding is dependent on proof of the energy savings achieved at the end customers' premises by means of an energy savings meter. Pilot projects to save electricity, gas, heating and cooling can receive up to €1 million in project funding. The guiding principle is to identify actual energy savings potential on an individualised basis (assistant) with the aid of continuously measured individual energy consumption values and, based on this, to provide value-added services for energy efficiency on digital platforms. In addition, the funding programme for the first time creates the methodology prerequisites for quantifying actual energy savings – using methods that are comparable in each case. Among other things, the extent of rebound effects is to be quantified, countermeasures developed and value-added services such as load management for sector coupling implemented. Also eligible for funding is the development of digital platforms and energy services that encourage savings among end customers, but not the implementation of the savings measures themselves; this will be determined by the market.
Current status 2019	To date, 101 applications have been submitted for the savings meter funding programme. Of these, 68 applications have been approved (as of 23 June 2020). The majority of the approved projects are in the second or third verification procedure. Some projects were able to save energy by implementing efficiency measures. Further savings are expected as soon as the beneficiaries have set up their systems. The second funding period began in February 2019. With the new guideline, even more emphasis is placed on the innovative features of the product.

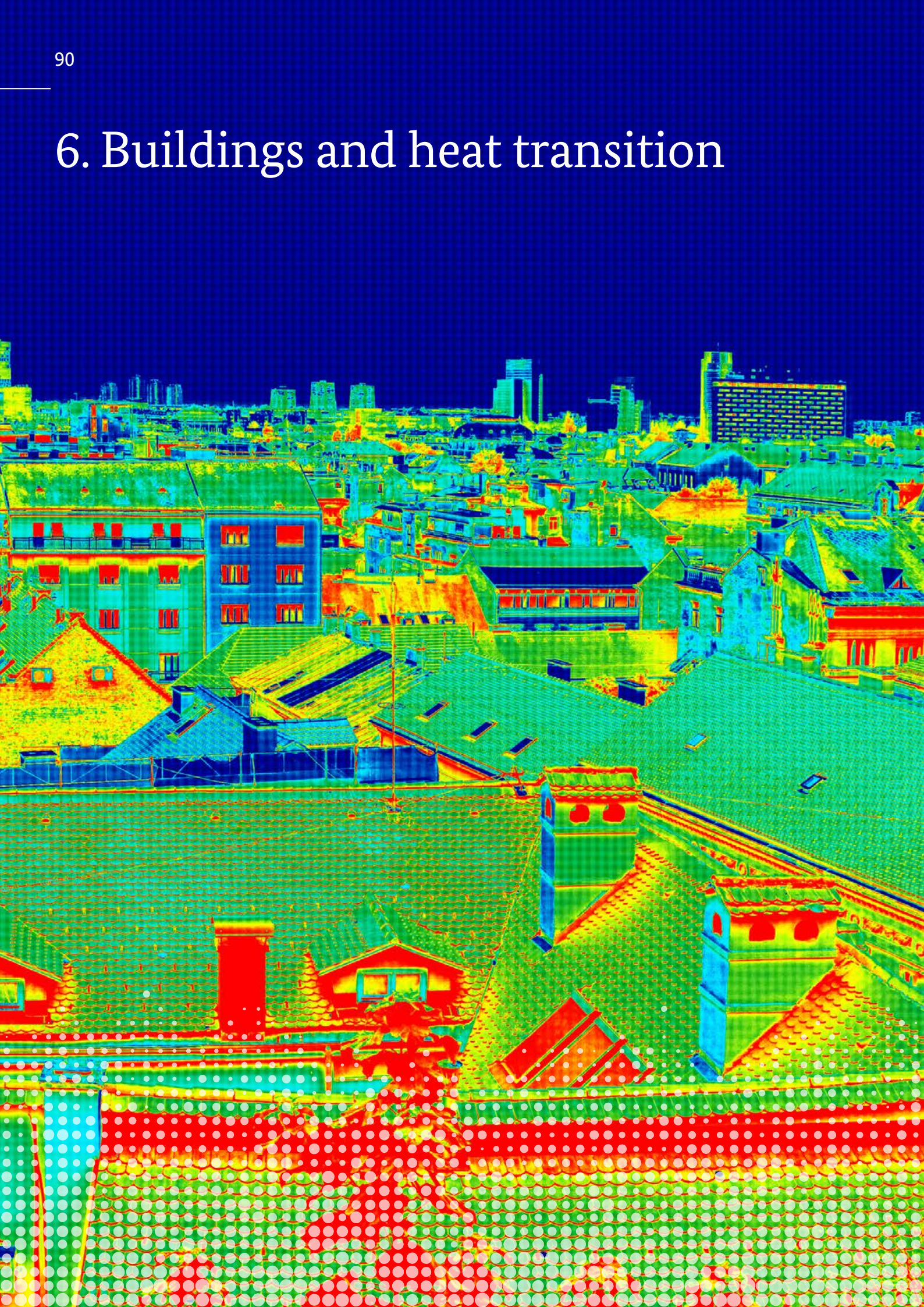
Continuation: Energy Savings Meter pilot programme

Character of the instrument	Funding programme		
Target group	Start-ups, energy industry, contractors and business enterprises implementing energy-saving projects with end customers		
Energy sources concerned	Grid-bound energy sources (electricity, gas, heating, cooling, oil, biomass and primary energy)		
Maturity of the instrument	1 May 2016 until 31 December 2022		
Implementation	BAFA		
Last evaluation	May 2019		
Next evaluation	Still pending		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.012	0.029	0.37
Final energy savings (in PJ)	0.010	0.019	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.001	0.001	No information available

Energy management systems			
Brief description	The aim of the Energy Management Systems funding guideline is to increase the spread of energy management systems in industry in accordance with ISO 50001. The guiding principle in this case is that only by identifying energy consumption can effective savings measures be identified and subsequently implemented. The ISO 50001 standard follows the Plan-Do-Check-Act cycle and is designed to achieve continuous improvement of the company's energy performance. It has been demonstrated that business enterprises that have implemented an energy management system in accordance with ISO 50001 implement measures that pay for themselves very quickly. A basic assumption is that, depending on the industry, business enterprises with a reporting system can save up to 10% of their primary energy consumption.		
Current status 2019	Phased out on 31 December 2017. The funding for measurement, control and regulation technology for energy management systems was transferred to the new Module 3 of the federal funding for energy efficiency in industry (since 2019).		
Character of the instrument	Funding programme		
Target group	Companies		
Energy sources concerned	Fuels and electricity		
Maturity of the instrument	1 July 2013 until 2017		
Implementation	BAFA		
Last evaluation	-		
Next evaluation	-		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.729	0.729	No information available
Final energy savings (in PJ)	0.456	0.456	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.039	0.035	0.083

Monitoring of the central measures for funding energy savings in the building sector is outlined in Chapter 6.

6. Buildings and heat transition



Where do we stand?

Non-renewable primary energy consumption (primary energy demand) in the building sector decreased by 5% in 2018 compared with the previous year and increased by 3.3% in 2019 compared with the previous year. Compared with the base year 2008, however, there is a reduction of 23.6%.

Final energy consumption in the building sector decreased by 5.1% in 2018 compared with the previous year and increased by 4.2% in 2019 compared with the previous year. Compared with the base year 2008, however, consumption has fallen by 10.9%.

In 2018 and 2019, the share of renewable energy sources in heat consumption was 14.3% and 14.5%, respectively. This means that the 2020 target of 14% has already been exceeded ahead of schedule.

The decarbonisation of the supply of heat to buildings, industry and the CTS sector (heat transition) is indispensable for achieving the energy and climate targets.

What is new?

In order to accelerate the energy transition in the building sector, the reduction of primary energy demand is to be accelerated. To this end, both energy efficiency and the use of renewable energy sources are to be funded.

In 2019, with the Climate Action Programme 2030, additional measures were adopted to achieve the ambitious energy and climate targets in the building sector. The basis is a mix of increased funding, information and advice, CO_2 pricing and regulatory law, as well as targeted energy research. The measures include the introduction of tax incentives for energy-efficient modernisation of buildings, the introduction of a replacement premium for oil heating systems, higher funding rates for energy-efficient modernisation in the existing funding programmes, the funding of serial modernisation, the extension of the “Energy-efficient urban redevelopment funding programme”, the further development of concepts for energy audits and public relations work, a pioneering role for federal buildings in energy efficiency, climate protection and sustainable construction, the further development of applicable energy standards, the further development of urban development funding (StBauF), in addition to the extension of the “Energy Transition Construction” research initiative through the new “Regulatory Sandboxes for the Energy Transition” funding pillar and the further development of the “Future Building” research initiative into an innovation programme.

The Federal Government adopted the Energy Efficiency Strategy 2050 (EffSTRA) on 18 December 2019. The EffSTRA sets a medium-term energy efficiency target of minus 30% primary energy consumption in 2030 compared with the base year 2008 and bundles energy efficiency measures in a new National Action Plan on Energy Efficiency (NAPE 2.0), which also includes the building sector.

In 2020, the Federal Government adopted the Long-Term Renovation Strategy (LTRS) for public and private buildings. With this strategy, the Federal Government, in accordance with EU requirements, is setting out a

roadmap for the national building sector with indicators and indicative milestones for achieving the long-term energy and climate targets and identifies ways and incentives to renovate the national building stock.

An important building block is the new Federal Funding for Efficient Buildings (BEG), which will bundle the existing building funding programmes (CO_2 Building Modernisation Programme, Market Incentive Programme (MAP), Energy Efficiency Incentive Programme (APEE) and Heating Optimisation Funding Programme (HZO)) commencing in 2021 in a new system that meets the needs of the target groups.

Another important building block is the new Buildings Energy Act (GEG), which entered into force on 1 November 2020. The GEG creates a new, uniform, coordinated set of regulations specifying the energy requirements for new buildings, existing buildings and for the use of renewable energy sources to supply heating and cooling to buildings. The European specifications for the overall energy performance of buildings will be implemented in full and the regulation covering the lowest energy building incorporated into harmonised Energy Conservation Legislation. The current energy requirements for new buildings and modernisations continue to apply and will not become more stringent.

In the case of the heat transition, the Heating Network Systems 4.0 model project programme was launched in 2017. It provides funding for particularly cost-efficient heating networks that are fed to a large extent from regenerative heat sources, in addition to the appropriate innovations required.

As part of the Combined Heat and Power Act (KWKG), the fourth auction for innovative combined heat and power (CHP) systems was held in December 2019 (award volume: 20,514 kW). These can be operated flexibly and in a way that is extremely beneficial to the electricity market and networks.

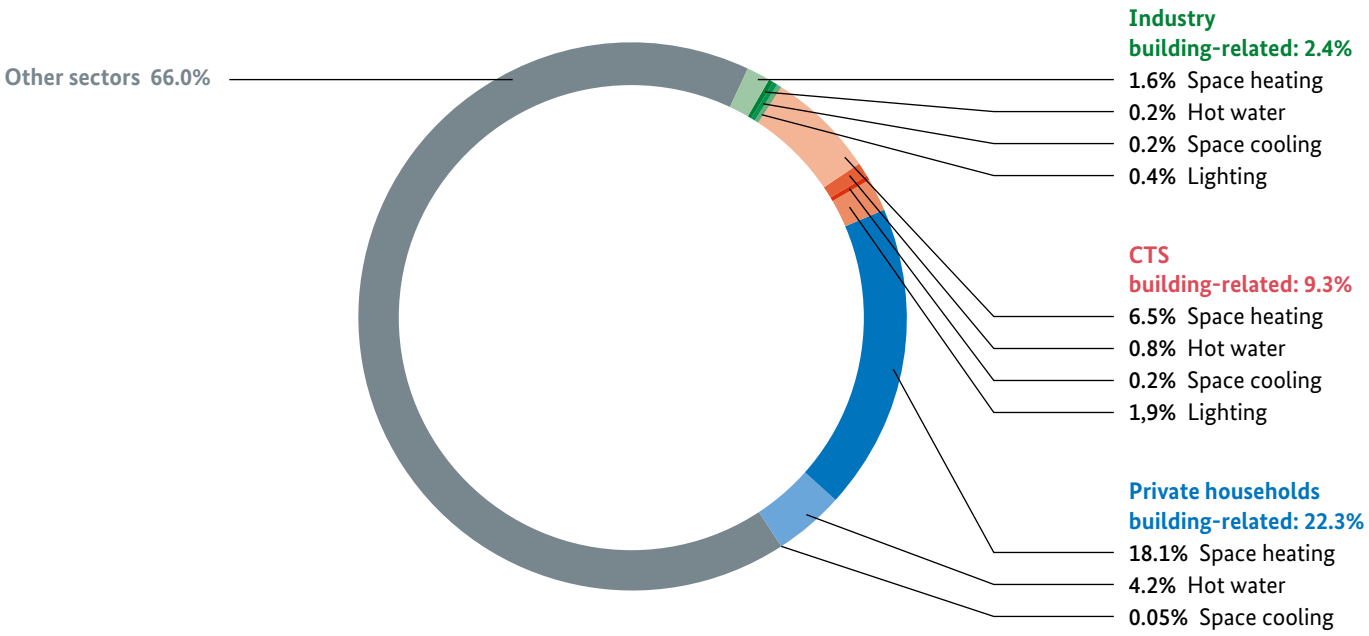
	2018	2019	2020	2030
RENEWABLE ENERGY				
Share of heat consumption	14.8%	14.7%	14%	
EFFICIENCY AND CONSUMPTION				
Non-renewable primary energy consumption in buildings (i.e. primary energy demand) (compared with 2008)	-26.0%	-23.6% →		-55%
Heat consumption in buildings (compared with 2008)	-14.4%	-10.9%	-20%	

6.1 Buildings-related energy consumption

The buildings sector plays a key role in the energy transition. The share of buildings-related final energy consumption compared with the total final energy consumption was 33% and 34% in 2018 and 2019, respectively. Private households accounted for the majority of this share, followed by the commerce, trade and services (CTS) sector and industry (see Diagram 6.1).

Final energy consumption in buildings, also referred to below as heat demand, was up in 2018 and down in 2019, in each case compared with the previous year. Buildings-related final energy consumption for heating (heat demand) includes the consumption levels for space heating (heating), space cooling and the provision of hot water. The electricity consumption for (permanently installed) lighting in non-residential buildings is also included. The heat demand (not temperature adjusted) in 2018 and 2019 was 2,956 PJ and 3,079 PJ respectively, representing a decrease of 5.1% and an increase of 4.2% respectively compared with the previous year. Energy consumption in the building sector is subject to major fluctuations due to temperature. For this reason, conclusions and recommendations for action ought to be based on temperature-adjusted values or on three-year mean values, for example.

Diagram 6.1: Share of buildings-related final energy consumption compared with the total final energy consumption in 2019



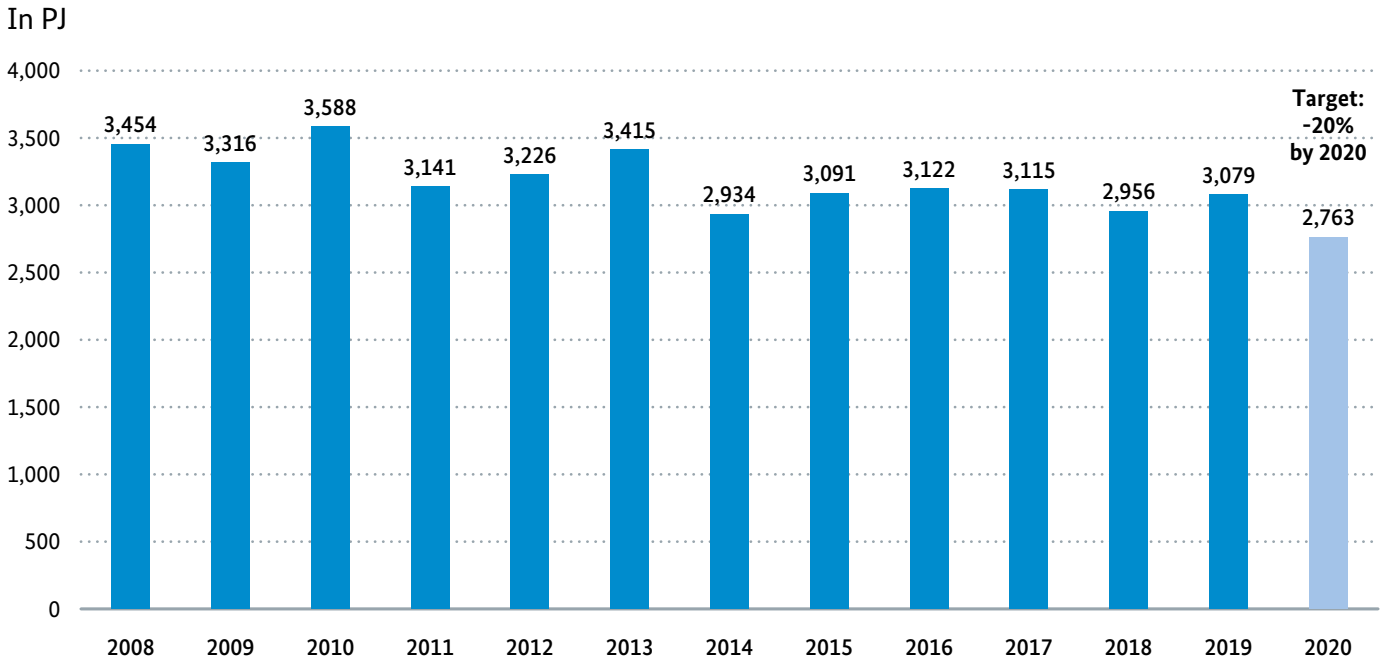
Source: AGEB 09/2020

Even though heating demand was up in 2019, it had been down 10.9% overall since 2008. This means that heating demand had fallen by an average of around 1% per year over this period. In order to meet the 20% reduction target by 2020 compared with the 2008 level, heat demand would have had to fall by 9.1 percentage points from the 2019 level. Achieving such a decrease by 2020 was considered unlikely.

Energy efficiency in the building sector increased in 2018 compared with the previous year and remained unchanged in 2019 compared with the previous year. The ratio of final energy consumption of private households and living space reflects the final energy efficiency in the building sector. In 2018, final energy consumption of private households decreased compared with the previous year, while living space increased at the same time. In 2019, rising final energy consumption by private households was accompanied by a further increase

Diagram 6.2: Target profile: Development of final energy consumption for heating

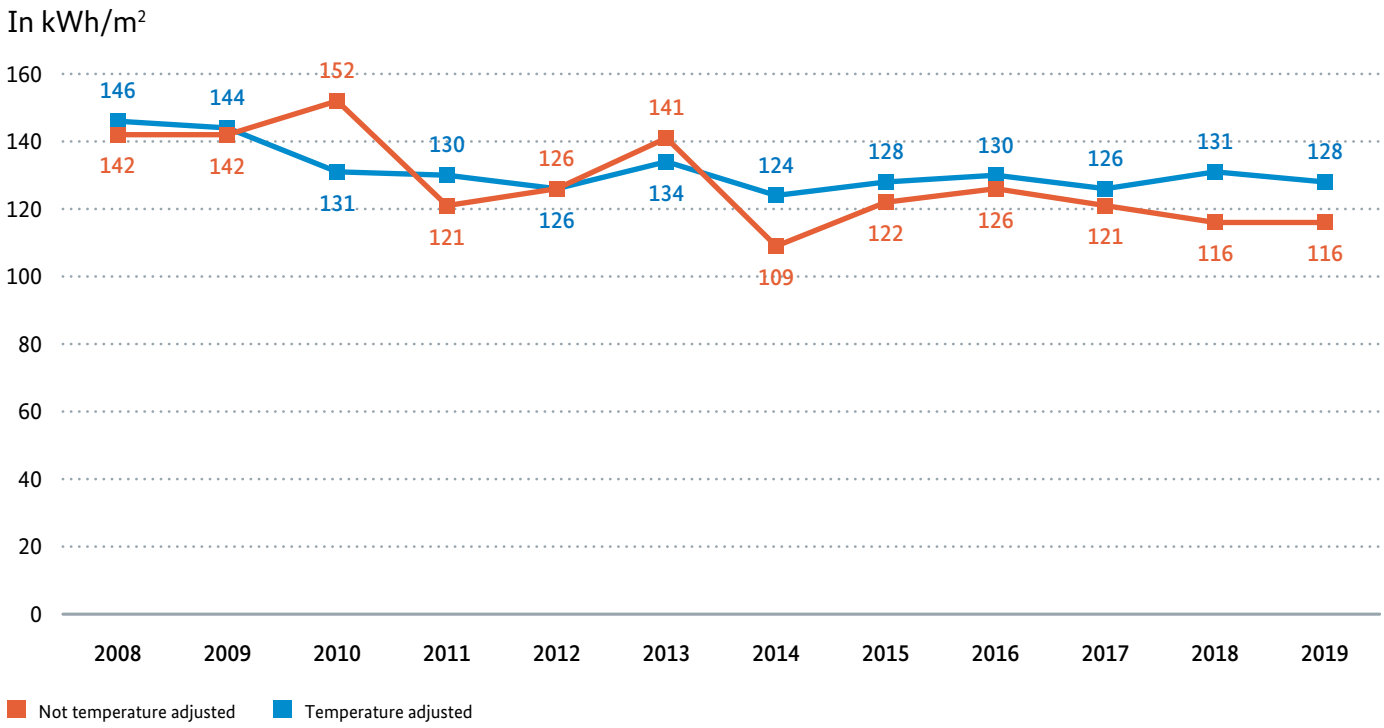
Target 2020	Reduction of buildings-related final energy consumption (heat demand) by 20% (compared with 2008)
Status 2019	-10.9%



Source: AGEB 09/2020

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

Diagram 6.3: Development of specific final energy consumption for the generation of space heating in private households



Source: AGEB and StBA 09/2020

in living space. As a result, energy efficiency in the building sector, also referred to as specific final energy consumption for space heating per unit of residential floor space for private households, was up 4.1% (116 kWh/m²) in 2018 compared with the previous year and remained unchanged in 2019. Adjusted for weather effects, energy efficiency in the building sector declined by around 4% in 2018 compared with the previous year (131 kWh/m²) and subsequently increased in 2019 by 2.3% (128 kWh/m²).

Compared with 2008, energy in the residential building sector is now used much more efficiently. On average, 15.3% less energy was needed to heat one square metre in 2019 than in 2008 (see Diagram 6.3). This means that, on average, energy in the residential building sector was being used more and more efficiently and as a result, despite an increase in residential floor space, there was an overall decline in heating demand.

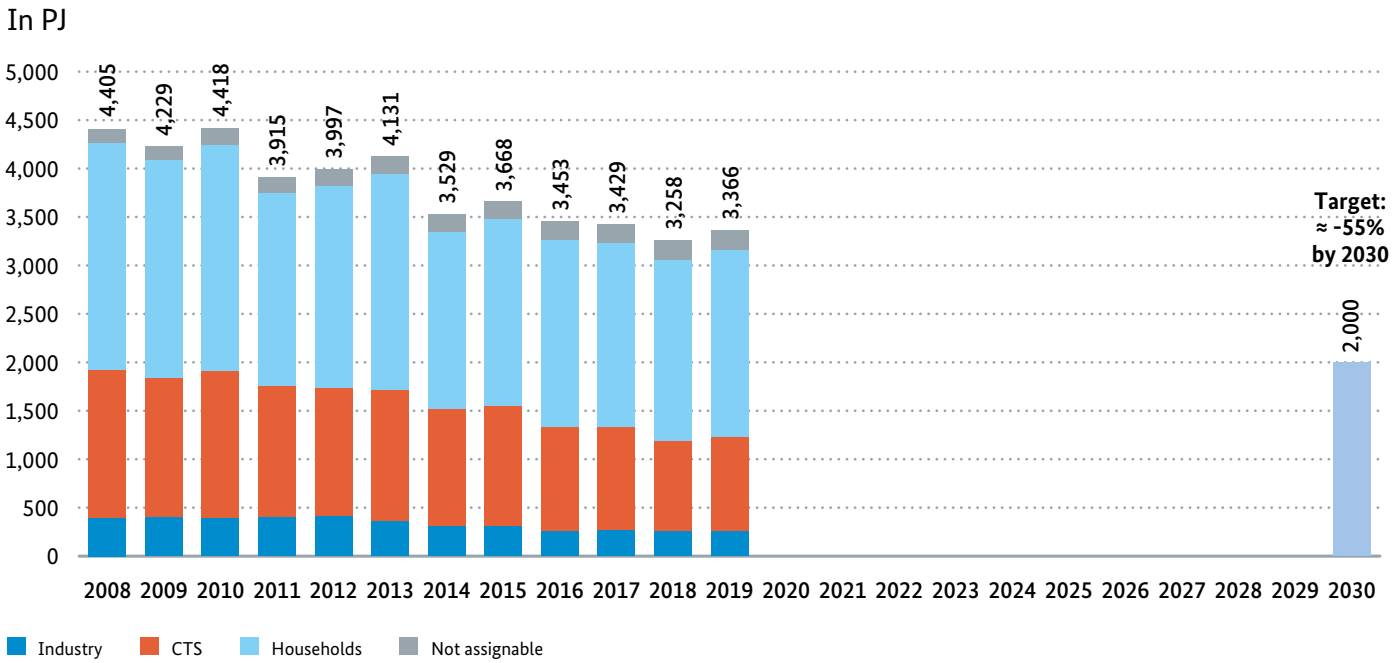
6.2 Non-renewable primary energy consumption (primary energy demand)

Non-renewable primary energy consumption (primary energy demand) of buildings was down 5% in 2018 and went up 3.3% in 2019, in each case compared with the previous year. In addition to the provision of heating, cooling and hot water (addition to lighting in non-residential buildings), the non-renewable primary energy consumption indicator also factors in non-renewable expenditure for the production, conversion and transport or distribution of the individual energy sources. Non-renewable primary energy consumption, however, does not include energy from renewable energy sources. This means it can be reduced by improving energy efficiency and also by increasing the share of renewables required to cover the heating demand. In 2019, non-renewable primary energy consumption was 3,366 PJ compared with 3,258 PJ in the previous year.

Since 2008, non-renewable primary energy consumption has decreased by 23.6%. This corresponds to an average annual reduction of 2.1% and shows that Germany is moving in the right direction in its efforts to reduce primary energy demand by a combination of energy efficiency and the use of renewable energy sources (see Diagram 6.4).

Diagram 6.4: Target profile: Development of non-renewable primary energy consumption

Target 2030	Reduction in non-renewable primary energy consumption of around 55% (compared with 2008)
Status 2019	-23.6%



Source: In-house data from the BMWi based on AGEB 09/2020

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

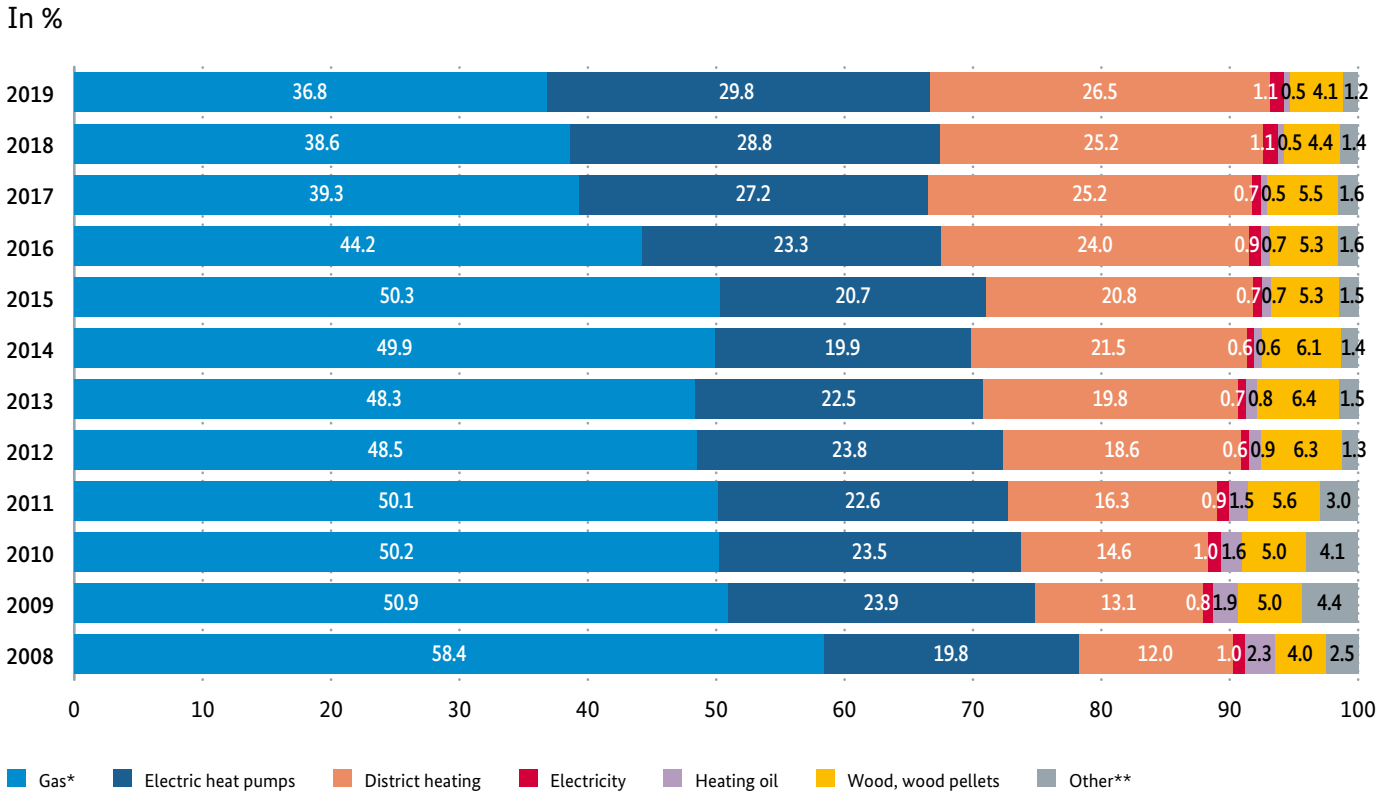
6.3 Modernisation and investment in the building sector

In 2019, building permits were issued for the construction or modernisation of a total of some 352,000 residential units, of which around 287,000 were actually completed. This corresponds to an increase of almost 4% in terms of approvals and 2% in completed projects compared with the previous year. Of the 352,000 approved residential units, 311,000 were new buildings and 41,000 were modernisations (88% and 12% respectively). At the same time, new construction projects for around 86,000 residential units received financial support in 2019 through the KfW "Energy-efficient Construction" funding programme, as part of the CO_2 Building Modernisation Programme. This means that some 28% of the new residential units that were approved in 2019 received federal funding and were thus built to a higher energy efficiency standard than the Energy Conservation Ordinance (EnEV) specifies. As a result of the KfW Energy-efficient Modernisation funding programme, the energy efficiency of a total of around 280,000 residential units was increased in 2019. Energy-efficient construction unlocks the potential for economic solutions, while at the same time increasing the international competitiveness of the construction industry.

The use of renewable energy sources (RES) for the generation of heat, the installation of around 56,600 RES heating systems, primarily in residential buildings, was funded in 2019 through investment grants issued by the Federal Office of Economics and Export Control (BAFA) under the Market Incentive Programme for Renewable Energies in the Heating Market (MAP). This represented an increase of around 16% compared with the previous year. The technologies used were solar thermal, biomass and heat pumps. The total amount of investment grants paid in 2019 was €197.2 million. This corresponds to an increase of around 14% compared with the previous year. The investment volume of these measures amounted to around €875 million. In 2019, as part of KfW "Renewable Energies Programme – Premium" to support the Market Incentive Programme for Renewable Energies in the Heating Market (MAP), no less than 1,604 applications for investment grants submitted for large-scale facilities based on renewable energy sources were approved with a total volume of €162 million. This represents a 10% increase in the number of applications and a 17% in terms of the loan volume approved compared with the previous year. Furthermore, in 2018 and 2019, a total of around 135,000 energy audits and around 155,000 energy audits respectively were financially supported via Federal funding programmes in the residential and non-residential building sector, in private households and in SMEs to assist in making decisions on modernisation measures.

New buildings are increasingly being equipped with climate-friendly heating systems. The installation of GHG-intensive oil heating systems, for example, has fallen continuously since 2010. In contrast, there has been a steady increase in heat pumps in new buildings, especially in recent years (2016–2019). The supply of heat through a heat network connection is also playing an increasingly important role (see Diagram 6.5 and Chapter 13).

Diagram 6.5: Development of the heating structure in new residential building in Germany between 2000 and 2019, share of energy sources



* incl. biomethane, **incl. wood until 2003

Source: BDEW 08/2020

Transparency and participation: Everyone can participate in the heat transition.

Lower energy costs, more living comfort, a higher property value and a valuable contribution to climate protection – energy efficiency and the use of renewable energy sources in private residential buildings is worthwhile. The BMWi supports such efforts with attractive funding programmes. Since 2000, around 5.2 million residential units have been modernised or newly constructed, for example, as part of the CO_2 Building Modernisation Programme.

The BMWi also offers a wide range of advisory services on energy efficiency and the use of renewable energy sources in the buildings sector to increase the individual skills of the energy consumers themselves and help them avoid mistakes when making investments. A professional energy audit, for example, identifies specific potential are where efficiency can be improved and savings made and presents details of the costs associated with their implementation and, if necessary, how they can be financed or funded. The BMWi platform www.deutschland-machts-effizient.de provides

a consumer-friendly overview of all Federal efficiency funding programmes in the building sector. The extensive information on energy efficiency and savings focuses on building-related topics such as energy-efficient construction and modernisation.

The Energy Transition Platform Buildings, founded in 2014, offers stakeholders from the property sector, commerce, industry and consumers as well as the public sector the opportunity for a joint discussion of the diverse potentials of the building sector as well as the existing challenges. The tenth meeting of the platform took place at the end of 2019.

The Energy Transition Construction research network acts as an open forum for experts designed to intensify the sharing of experience at the interfaces of energy research with industry, commerce and politics. It is an important source of impetus for new funding strategies and supports the transfer of innovation into building practice. Information on the results of research projects and a project map with more than 1,200 projects are available on the specialist portal at www.energiewendebauen.de.

The Efficiency House Plus initiative, which was launched in 2011, is designed to provide information on energy-efficient, sustainable and future-oriented construction to people and groups in society who are directly affected in a practical and easy to understand manner. It encourages them in exemplary fashion to think about new approaches to design and construction in the future and to work together to meet the energy and climate goals in the building sector. More at www.forschungsinitiative.de/effizienzhaus-plus/.

Since 2017, in what was formerly the Efficiency House Plus research project run by the Federal Government, the federally owned information and competence centre for sustainable building has provided the general public with detailed information on possible approaches to climate-friendly construction. The Federal Government uses this platform to offer a forum for dialogue on the subject to anyone interested. Further information can be found at www.bauen-der-zukunft.de.

In 2019, the Federal Government created the Specialist Portal for Energy-Efficient Construction and Modernisation (FEBS, www.febs.de). The FEBS website provides detailed information for experts working in the field of energy-efficient building construction and modernisation. This includes Energy Conservation Legislation, advice on energy-related topics and financing options, in addition to planning and implementation. The specialist portal serves as a source of reference on all aspects of energy-efficient construction and modernisation and also provides tips and tools for working with building contractors. In addition, the FEBS service centre is a point of contact that provides reliable, high quality answers to technical questions over the phone or in writing. To ensure that the service is continuously optimised, information and information is also shared with professionals working in the industry. The overall package – website, service centre, publications and dialogue – is designed to improve the quality of energy-efficient construction and modernisation with the assistance of experts in the field.

6.4 Key measures implemented to date

With the Long-Term Renovation Strategy (LTRS), a roadmap was laid down for the national building sector with indicators and measures designed to achieve the long-term energy and climate goals. The strategy integrates the electricity, heating and efficiency sectors and thus creates a clear framework for action to bring about the energy transition in the building sector. The LTRS builds on the Energy Efficiency Strategy for Buildings (ESG) from 2015 and the National Action Plan on Energy Efficiency (NAPE). The LTRS identifies measures in the building sector in order to provide incentives for the energy-related modernisation of the national building stock, specifically for both private and public residential and non-residential buildings.

The CO_2 Building Modernisation Programme, the Market Incentive Programme for Renewable Energies in the Heating Market (MAP) and the Energy Efficiency Incentive Programme (APEE) were also very successful in 2019. For example, the KfW funding programmes for energy-efficient construction and modernisation that was launched as part of the CO_2 Building Modernisation Programme are very much in demand. One feature of the MAP worth noting is the extremely large number of subsidised high-efficiency heat pumps that make up the largest share of the subsidised systems. The subsidy programme for innovative fuel cell heating systems, which is funded by the APEE, has also seen a steady increase in the number of applications submitted.

With its Energy Efficiency and Heat from Renewable Energies funding strategy, the BMWi has pursued the goal of linking up the funding programmes even more effectively by 2020 and making them more service-driven. Moreover, with the coming into effect of the Federal Funding for Efficient Buildings (BEG), funding provided for the energy-efficient modernisation of buildings under the Climate Action Programme 2030 will be restructured as of 2021 and further developed for specific target groups. The current building programmes (CO_2 Building Modernisation Programme, Market Incentive Programme for Renewable Energies in the Heating Market (MAP), Energy Efficiency Incentive Programme (APEE) and Heating Optimisation Funding Programme (HZO)) will be bundled and combined in a single funding programme with the BEG, which has brought together energy efficiency and renewable energy sources under one roof for the first time. The existing funding elements are being modernised and expanded (including more ambitious efficiency house levels in terms of their modernisation and parallel loan and grant funding across all sectors for non-residential buildings, with consideration given to aspects of digitisation and sustainability). This will reduce the complexity of the funding landscape and provide even stronger incentives for investments in energy efficiency and renewable energy sources, thus making a decisive contribution to achieving the 2030 energy and climate targets in the building sector.

Energy audits are key elements of the Federal Government's energy efficiency and climate protection policy. By increasing the number of certified energy auditors in the Energy auditing services for residential buildings and Energy auditing services for SMEs programmes to include qualified energy auditors, such as craftsmen and chimney sweeps, consumers now benefit from a larger number of qualified auditors and consultants. Energy audits continue to be unbiased and of high quality. Information on the occupation and professional qualifications of new energy auditors and consultants must be published in the list of energy efficiency experts for federal funding programmes.

The Federal Government adopted the Energy Efficiency Strategy 2050 (EffSTRA) on 18 December 2019. The EffSTRA sets a medium-term energy efficiency target of -30% primary energy consumption in 2030 compared with the base year 2008 and bundles energy efficiency measures in a new National Action Plan on Energy Efficiency (NAPE 2.0). For the building sector, among other things, a large number of measures accompanying the Climate Action Programme 2030 will be initiated, such as the funding of serial refurbishment in the building sector and tax incentives for energy-efficient modernisation of buildings (see Chapter 5).

In June and July 2020, respectively, the Bundestag and Bundesrat passed the Buildings Energy Act (GEG) introduced by the BMWi and BMI. When it entered into force on 1 November 2020, the GEG replaced the Energy Conservation Act (EnEG), the Energy Conservation Ordinance (EnEV) and the Renewable Energies Heat Act (EEWärmeG). The GEG creates a new, uniform, coordinated set of regulations specifying the energy requirements for new buildings, existing buildings and for the use of renewable energy sources to supply heating and cooling to buildings. The European specifications for the overall energy performance of buildings will be implemented in full and the regulation covering the lowest energy building incorporated into harmonised Energy Conservation Legislation. The current energy requirements for new buildings and modernisations continue to apply and will not become more stringent.

Monitoring of the key measures for funding energy savings in the building sector

CO_2 Building Modernisation Programme: Non-residential Buildings			
Brief description	Under the programme, energy-saving modernisation measures for non-residential buildings are funded through low-interest loans, sometimes in combination with repayment grants, or through direct grants. Funding is available for individual measures (e.g. heating, ventilation, insulation) and combinations of measures (heating and ventilation package) in addition to overall packages to achieve a KfW Efficiency House standard (modernisation and new construction), for which characteristic values for the primary energy demand of the building and the overall thermal insulation of the building envelope must be met.		
Current status 2019	No fundamental changes to the funding conditions.		
Character of the instrument	Funding programme		
Target group	Owners, first-time buyers and builders of non-residential buildings		
Energy sources concerned	Natural gas, heating oil, coal, liquid gas, biomass, electricity and district heating		
Maturity of the instrument	2007 to 2021 (transition to BEG)		
Implementation	KfW		
Last evaluation	2020		
Next evaluation	2021 (planned)		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	6.823	7.949	No information available
Final energy savings (in PJ)	5.163	6.009	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.418	0.434	No information available

CO_2 Building Modernisation Programme: Residential Buildings			
Brief description	Under the programme, energy-saving modernisation measures for residential buildings are funded through low-interest loans, sometimes in combination with repayment grants, or through direct grants. Funding is available for individual measures (e.g. heating, ventilation, insulation) and combinations of measures (heating and ventilation package) in addition to overall packages to achieve a KfW Efficiency House standard (modernisation and new construction), for which characteristic values for the primary energy demand of the building and the overall thermal insulation of the building envelope must be met.		
Current status 2019	Changes to individual funding constraints (period with no commitment fee, amount of commitment fee) as of June 2019, no changes to content.		
Character of the instrument	Funding programme		
Target group	Owners, first-time buyers and developers of residential buildings and condominiums		
Energy sources concerned	Natural gas, heating oil, coal, liquid gas, biomass, electricity and district heating		
Maturity of the instrument	2006 to 2021 (transition to BEG)		
Implementation	KfW		
Last evaluation	9 October 2018		
Next evaluation	The evaluation of funding years 2018–2020 is currently underway. The values for funding years 2018 and 2019 have been based to date solely on projections and may have to be adjusted subsequently as a result of the evaluation.		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	116.68	122.15	No information available
Final energy savings (in PJ)	85.43	89.36	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	8.02	7.85	No information available

Market Incentive Programme for the Funding of Measures for the Use of Renewable Energies in the Heating Market (MAP)			
Brief description	The MAP funds investments or systems for the use of renewable energy sources, primarily in existing buildings. The MAP consists of two programme components: 1) investment grants via BAFA for small solar thermal systems and biomass systems as well as efficient heat pumps and 2) repayment grants in conjunction with KfW loans in KfW's Renewable Energies – Premium or Deep Geothermal programme for large solar thermal systems, biomass heating plants, certain types of efficient heat pumps, biogas pipelines, deep geothermal systems, local heating networks for heat from renewable energy sources (conditional on KWKG funding) and large heat storage systems for heat from renewable energy sources.		
Current status 2019	All funded measures had been implemented by the cut-off date of 31 December 2019.		
Character of the instrument	Funding programme		
Target group	Private households, business enterprises and municipalities		
Energy sources concerned	All energy sources		
Maturity of the instrument	2000 to 2021 (transition to BEG) Exception: Funding of heat networks until further notice		
Implementation	BAFA and KfW		
Last evaluation	2018		
Next evaluation	Bid selection is underway for the 2019 and 2020 evaluations.		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	3.993	3.993	5
Final energy savings (in PJ)	4.598	4.598	5
CO_2 savings (in millions of tonnes of CO_2 equivalent)	2.135	2.406	2.373

Energy Efficiency Incentive Programme (APEE)			
Brief description	The programme provides funding for the replacement of heating systems with the simultaneous optimisation of the entire heating system (fossil and renewable energy sources), the installation of ventilation systems in combination with an additional measure on the building envelope (e.g. windows) and the market introduction of fuel cell heating systems. The programme was integrated into the CO_2 Building Modernisation Programme and Market Incentive Programme.		
Current status 2019	As a result of the decisions taken within the framework of the Climate Action Programme 2030, the funding conditions were changed as of 1 January 2020.		
Character of the instrument	Funding programme		
Target group	Owners of residential buildings and apartments, and energy service business enterprises (contractors)		
Energy sources concerned	Natural gas, heating oil, coal, liquid gas, biomass, electricity and district heating		
Maturity of the instrument	2016 until further notice		
Implementation	KfW and BAFA		
Last evaluation	9 October 2018		
Next evaluation	Underway		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	6.922	9.984	No information available
Final energy savings (in PJ)	5.050	7.287	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.418	0.558	No information available

National efficiency label for old heating systems			
Brief description	The national efficiency label for old heating systems is intended to inform home owners about the efficiency status of their old heating appliances and motivate them to replace inefficient heating appliances. When attaching the efficiency label, the local chimney sweep, plumber or energy consultant makes an individual assessment of the heating appliance, informs the home owner about the significance of the label and leaves a flyer with details on advice and funding possibilities.		
Current status 2019	In 2018 and 2019, almost 2.175.000 efficiency labels were attached to old heating systems and invoiced to BAFA by the local chimney sweeps. Local chimney sweeps are legally obliged (according to § 17 EnVKG) to attach the label and receive compensation for the above-mentioned activity according to the amount of work involved.		
Character of the instrument	Information		
Target group	Households and small commerce, trade and services (CTS)		
Energy sources concerned	Gas and oil		
Maturity of the instrument	2016 open end		
Implementation	BAFA		
Last evaluation	2019		
Next evaluation	Scheduled for 2023		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.872	1.511	4.6 bis 13.9
Final energy savings (in PJ)	0.777	1.344	0.3 bis 2
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.065	0.112	0.0003 bis 0.001

Funding of heating optimisation by using high-efficiency pumps and hydraulic balancing			
Brief description	The aim of the Heating Optimisation Funding Programme is to replace as many as two million inefficient heating and hot water circulation pumps with high-efficiency pumps each year by the end of 2020 and to optimise the operation of up to 200,000 existing heating systems each year through a process of hydraulic balancing. In order to increase this potential, the Heating Optimisation Funding Programme provides incentives for optimising existing heating systems with a grant of up to 30% of the net investment costs.		
Current status 2019	The implementation of the measure remains unchanged compared with previous years, while the call for funding remained at the same level. The programme was presented on relevant websites (e.g. BAFA, Germany makes it efficient) and advertised by means of flyers. In the fourth quarter of 2019, there was a backlog of submitted evidence of use that required processing.		
Character of the instrument	Funding programme		
Target group	Private individuals, business enterprises, municipalities, cooperatives and non-profit organisations		
Energy sources concerned	Gas, oil and electricity		
Maturity of the instrument	1 August 2016 until 31 December 2020		
Implementation	BAFA		
Last evaluation	22 October 2020		
Next evaluation	1st quarter 2021		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	1.494	1.794	No information available
Final energy savings (in PJ)	0.890	1.080	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.079	0.086	1.8

EnEff.Gebäude.2050 – innovative projects for a virtually climate-neutral building stock in 2050			
Brief description	The aim of the Energy Efficient Strategy for Buildings 2050 funding initiative is to showcase ambitious concepts for virtually climate-neutral buildings and neighbourhood approaches and thus encourage broader implementation. The guiding principle is that the projects should address the wide range of the challenges to achieving a virtually climate-neutral building stock, take into account current research findings and innovations and as pilot projects be seen as representative examples of a broad range of possible applications.		
Current status 2019	The programme came to an end on 31 December 2018. Ongoing projects were migrated to the 7th Energy Research Programme. None of the proposed projects has been completed to date.		
Character of the instrument	Funding programme		
Target group	Consortia of business enterprises and research institutes		
Energy sources concerned	All energy sources		
Maturity of the instrument	2016 to 31 December 2018. Ongoing projects were migrated to the 7th Energy Research Programme.		
Implementation	PTJ		
Last evaluation	Performance review 2020		
Next evaluation	The Energy Efficient Strategy for Buildings 2050 funding initiative has been included in the Federal Government's 7th Energy Research Programme since 1 January 2019. As such, it will be included in the evaluation of the 7th Energy Research Programme (i.e. the funding announcement Applied non-nuclear research funding in the 7th Energy Research Programme 'Innovations for the Energy transition' in conjunction with the 7th Energy Research Programme).		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	0.000	0.000	No information available
Final energy savings (in PJ)	0.000	0.000	No information available
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.000	0.000	No information available

Energy consulting			
Brief description	Advice on energy by consumer centres (vzbv), energy audits for non-residential buildings of municipalities and non-profit organisations (EBK), energy audits for SMEs (EBM), energy audits for residential buildings (on-site audits, tailored modernisation roadmaps) (EBW).		
Current status 2019	In the Energy audits for SMEs, Energy audits for non-residential buildings of municipalities and non-profit organisations and the Energy audits for residential buildings (on-site advice, tailored modernisation roadmaps) programmes, a total of 14,221 funding notifications were issued. The two funding notifications for energy advice provided by consumer centres cover a total of 143,653 appointments in 2019.		
Character of the instrument	Funding programme		
Target group	Private individuals, tenants and property owners, business enterprises, municipalities and non-profit organisations		
Energy sources concerned	Electricity and heat		
Maturity of the instrument	Instrument will be continued/open-end		
Implementation	BAFA		
Last evaluation	2017, 2018 and 2019		
Next evaluation	2022 / 2023		
Monitoring indicators	2018 (NAPE logic)	2019 (NAPE logic)	2020 Target indicator of the instrument
Primary energy savings (in PJ)	17.647	23.369	29.369
Final energy savings (in PJ)	11.843	15.683	19.683
CO_2 savings (in millions of tonnes of CO_2 equivalent)	0.927	1.140	1.39

6.5 Heat transition

The heating sector accounts for more than half of Germany's total final energy consumption (2018: 52.5%, 2019: 53.1%), with the building sector accounting for 2,956 PJ in 2018 and around 3,079 PJ in 2019, while process heat in the industrial sector accounted for around 1,739 PJ in 2018 and 1,700 PJ in 2019. At the same time, there is considerable potential available for improving efficiency and the use of renewable energy sources.

Newly installed renewable capacity in the electricity sector to date also benefits the heat transition. Electricity from renewable energy sources will be a key energy carrier of the future heating supply. It can be used directly in heat pumps for the efficient generation of heat or in the production of secondary energy carriers such as hydrogen and synthetic fuels. Electricity from renewables should be used efficiently to limit the need to expand generation and grid capacities in the electricity sector. More efficiency and heat from renewable energy sources will help Germany to achieve its energy and climate targets for 2030 and to make the energy transition overall more efficient and cost-effective.

Heat networks play a key role in the decarbonisation of the heat supply. They offer the possibility of combining different technologies for climate-neutral heat generation – such as geothermal and solar thermal energy, large-scale heat pumps or waste heat utilisation. At the same time, they can also be used as heat storage facilities to provide the flexibility necessary for the transition to an energy-efficient heat supply. Particularly in densely built-up urban areas and historic town centres with structural restrictions, the grid-bound supply of heat to buildings makes it possible to integrate a high share of renewable energy sources and utilise the waste heat from industrial or com-

mercial enterprises. Renewable energy sources can also be made available extremely efficiently via heat networks, since numerous buildings or residential areas can be supplied simultaneously. When combined with large heat storage facilities, heat networks make it possible to store renewable heat to meet seasonal demand in an affordable manner.

The Pilot Project Heating Networks 4.0 funding programme was launched in July 2017. Systemic funding was introduced for the heating infrastructure for the first time with this programme, which focuses not only on individual technologies and components, but also on entire systems, enabling cost reductions and efficiency potential to be harnessed at the systemic level. Funding is provided for feasibility studies and implementation costs of heat networks that are characterised by a high proportion of renewable energy sources, the efficient utilisation of waste heat and a significantly lower temperature level compared with conventional heat networks. The low temperature level minimises energy losses, increases the yields from renewable heat generation systems, such as heat pumps and solar thermal systems, and makes them more energy and cost efficient. Such innovative systems can also provide additional flexibility for the electricity market by combining heat pumps and large-scale heat storage systems to meet seasonal demand and store energy for the long term. The programme is currently being further developed into the Federal Funding of Efficient Heat Networks.

Further incentives for a low-carbon heat supply are to be created with the auction for innovative CHP systems, which was issued for the first time in June 2018. These consist of a highly efficient new or modernised CHP plant, a component for the provision of innovative renewable heat and an electrical heat generator (e.g. waste-incineration CHP plant combined with a heat pump). The aim of developing innovative CHP systems is to show how future CHP plants can be used to integrate renewable heat and renewable electricity by reacting flexibly in two ways – firstly, in periods when there is a high feed-in of heat from renewables, the CHP plant heat production is reduced, which saves fuel and reduces emissions. In periods when there is a high feed-in of electricity from renewables, the CHP plant reduces electricity production and saves fuel and emissions. When there is a very large supply of electricity from renewable energy sources and thus low or negative market prices, the electric heat generator can additionally ease the pressure on the electricity market. The technology transforms rigid, heat-related minimum generation capacity into flexible electricity generation capacity and demand. To solve the problem of acute grid congestion, the technology is also used in the Utilisation before limitation scheme. In December 2019, the fourth auction was issued with an award amount of 20,514 kW.

Key measures implemented to date in the heat transition

- Market incentive programme for heat from renewable energy sources
- Pilot Project Heating Networks 4.0 funding programme (low-temperature heat networks with heat storage to meet seasonal demand); developed further into the Federal Funding of Efficient Heat Networks
- Funding of innovative CHP systems in the Combined Heat and Power Act (KWKG) (see Chapter 9)

7. Transport

Where do we stand?

In 2019, final energy consumption in transport continued to develop counter to the targets of the Energy Concept, with an increase of 1.1% compared with the previous year and 7.2% compared with the base year 2005. Under the present circumstances, it is assumed that the 2020 target (minus 10%) is unlikely to be achieved until after 2030. The effects of the Covid-19 pandemic have not been taken into account.

With the exception of rail transport, Germany is still at an early stage with regard to the electrification of vehicle drive systems. In spite of this, the number of vehicles with alternative drive systems is increasing. There was a significant increase of 56.7% in the number of electric vehicles with more than two wheels in 2019 compared with the previous year, for example. The current focus is on accelerating the expansion of the required infrastructure.

Another way of reducing final energy consumption is to shift traffic from road to the more climate and environmentally friendly rail and waterway transport.

What is new?

In September 2018, the Federal Government launched the National Platform Future of Mobility (NPM). In six working groups, each of which addresses specific issues relating to the future of mobility. Their task is to formulate recommendations for action in the fields of climate protection in transport, alternative drive technologies and fuels for sustainable mobility, digitisation for the mobility sector, securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification, connecting mobility and energy networks, sector integration, in addition to standardisation, norms, certification and type approval.

The measures recommended in the Rail Freight Masterplan are being continuously implemented in order to permanently boost the rail freight sector. One important measure is the proportional financing of approved train path charges with additional federal funds.

On 30 June 2020, the “Rail Future Alliance” with representatives from politics, business and associations adopted the “Railway Masterplan” and a “Rail Pact” with the aim of doubling the number of railway passengers and shifting more freight transport to environmentally friendly rail, in addition to increasing its share of the modal split to at least 25% by 2030.

With the Environmental Bonus and the Innovation Premium, the amendment to the Charging Station Ordinance and other measures to support the development of a nationwide charging infrastructure, the Federal Government is continuing its efforts to make electric mobility suitable for the mass market. The Federal Government adopted a Charging Infrastructure Master Plan in November 2019.

Research initiatives, among other things, address the energy transition in the transport sector with the help of regeneratively produced fuels and sector coupling (as in the Efficiency House Plus Initiative). Other initiatives focus on LNG and electric propulsion/drive technologies for ships and heavy goods vehicles (HGV).

The climate protection measures (Climate Action Programme 2030 and Climate Protection Act), the measures approved in the Energy Efficiency Strategy 2050, and the measures included in the economic stimulus package to deal with the economic consequences of the Covid-19 pandemic all represent further steps being taken towards achieving the CO_2 and energy savings targets in the transport sector.

To implement the National Hydrogen Strategy, the Federal Ministry of Transport and Digital Infrastructure (BMVI) will in future have an additional €1.6 billion at its disposal to fund hydrogen and fuel cell applications in transport.

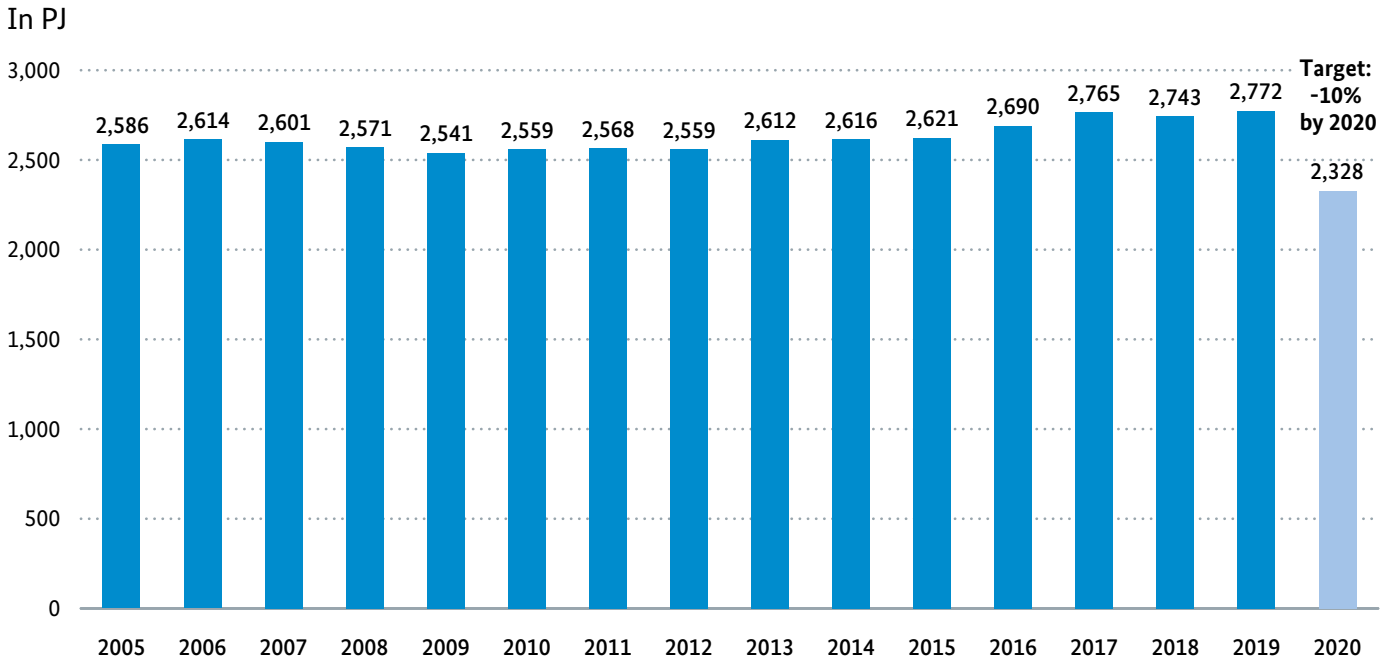
	2018	2019	2020	2030	2040	2050
EFFICIENCY AND CONSUMPTION						
Final energy consumption in transport (compared with 2005)	6.1%	7.2%	-10% →			-40%

7.1 Energy consumption in the transport sector

Final energy consumption in the transport sector declined in 2018 and increased in 2019 in each case compared with the previous year. Taking all transport modes into account, final energy consumption in the transport sector was down 0.8% in 2018 to 2,743 PJ and was up 1.1% to 2,772 PJ in 2019 in each case compared with the previous year (see Diagram 7.1). This means that the transport sector accounts for some 30% of total final energy consumption in Germany.

Diagram 7.1: Target profile: Development of final energy consumption in the transport sector

Target 2020	Reduction of final energy consumption by 10% (compared with 2005)
Status 2019	7.2%



Source: AGEB 08/2020

Trend	● ○ ○ ○ ○
Measures	Consumption/efficiency/climate protection, electric mobility/alternative fuels/fuelling and charging infrastructure, shift to environmentally friendly modes of transport

As Table 7.1 shows, energy consumption in 2019 increased in road transport compared with both the previous year and 2005, and in air transport (international and domestic) compared with 2005. Energy consumption was up 1.5% in the rail sector and 1.1% for inland waterway transport compared with the previous year. However, both modes of transport show a significant decline in consumption compared with 2005. A direct comparison to 2005 is not possible due to a data revision for rail, but a decline is considered likely.

Table 7.1: Energy consumption in 2019 by transport mode and changes compared with the baseline year (2005) and the previous year (2018)

	2019 in PJ	2019 share in %	Change compared with 2018 in %	Change compared with 2005 in %
Road	2,274.6	82.0	1.4	5.8
Air transport*	434.8	15.7	-0.6	26.2
Rail	52.1	1.9	1.5	-33.4
Inland waterways	10.7	0.4	1.1	-20.9
Total	**2,772.2**	**100**	**1.1**	**7.2**

Source: AGEB 08/2020

* including international air transport

Final energy consumption in transport has increased by a total of 7.2% compared with the baseline year 2005. On average, final energy consumption in transport has thus increased by around 0.5% annually since 2005. In order to achieve a 10% reduction in final energy consumption by 2020 compared with 2005, it would have to be reduced by a total of 16% in the remaining months of the year. This is very unlikely.

Transport performance in 2018 and 2019 recorded an increase of 0.6% for passenger transport in each case compared with the previous year, while freight transport was up 0.3% and 0.9% respectively compared with the previous year. To calculate transport performance, the number of passengers or the freight volume transported is multiplied by the total distance travelled in a given period. Transport performance in passenger and freight transport has increased by 7.5% and 21% respectively since 2005.

The specific energy consumption for vehicles has declined slightly since 2005, while stagnating for trucks. The average consumption per 100 km for passenger cars and light commercial vehicles was 7.4 litres in 2018 and 2019, and 5.5 litres for new vehicles.

Efficiency gains are distributed unevenly among the modes of transport. A comparison of specific consumption in passenger transport between fuels (road) and electricity (rail) shows the greatest efficiency gains are found in rail transport, which clearly exceed the efficiency gains in road transport: according to figures published by the German Environment Agency (calculated using the TREMOD model), an increase in efficiency of 6.5% in road transport from 2005 to 2018 is compared with an 34.8% increase in efficiency in rail transport.

The average fuel consumption of newly registered passenger cars and light commercial vehicles declined compared with 2005, but increased again in 2017 and 2018 in each case compared with the previous year. Between 2005 and 2016, average fuel consumption was down 24.3% overall for petrol-engined vehicles and 26.2% for diesel-engined vehicles, and then rose again by 1.8% and 6.3% respectively by 2018, as figures provided by the Federal Motor Transport Authority show. The reflect the trend in the manufacturers' data based on type approval only. They do not take into account the discrepancy with day-to-day real-world consumption figures, which has increased considerably in recent years. The Federal Govern-

ment therefore welcomes the fact that the new WLTP type approval for passenger cars and light commercial vehicles with improved test procedures and parameters is now gradually being used to make sure that the results of CO_2 type tests are more representative of everyday driving profiles. Taking WLTP figures as the basis for calculating fuel consumption results in a 20% higher average consumption in 2019 compared with the previous year, which were measured in accordance with the old NEDC test procedures (petrol engines: increase of 19.3%, diesel engines: 23.5%).

Overall, final energy consumption in the transport sector is developing counter to the goals of the Energy Concept. Efficiency improvements to date have been unable to compensate for the increase in energy consumption in the transport sector that has resulted from the significant increase in the volume of traffic overall. For this reason, with its Mobility and Fuel Strategy and Climate Action Programme 2020, the Federal Government as early as 2014 created a mix of funding, advice, financing and an improved regulatory framework, the purpose of which was to reduce final energy consumption in the transport sector (BMVBS (2013)). The focus today has turned to the use of technical innovations through R&D funding and programmes designed to get them to market (see Chapter 14), in addition to unlocking the potential of digital solutions (see Chapter 13). In autumn 2019, with the adoption of the Climate Action Programme 2030 and the Energy Efficiency Strategy 2050, the Federal Government went a step further and approved an additional package of measures designed to achieve the energy and climate targets in the transport sector.

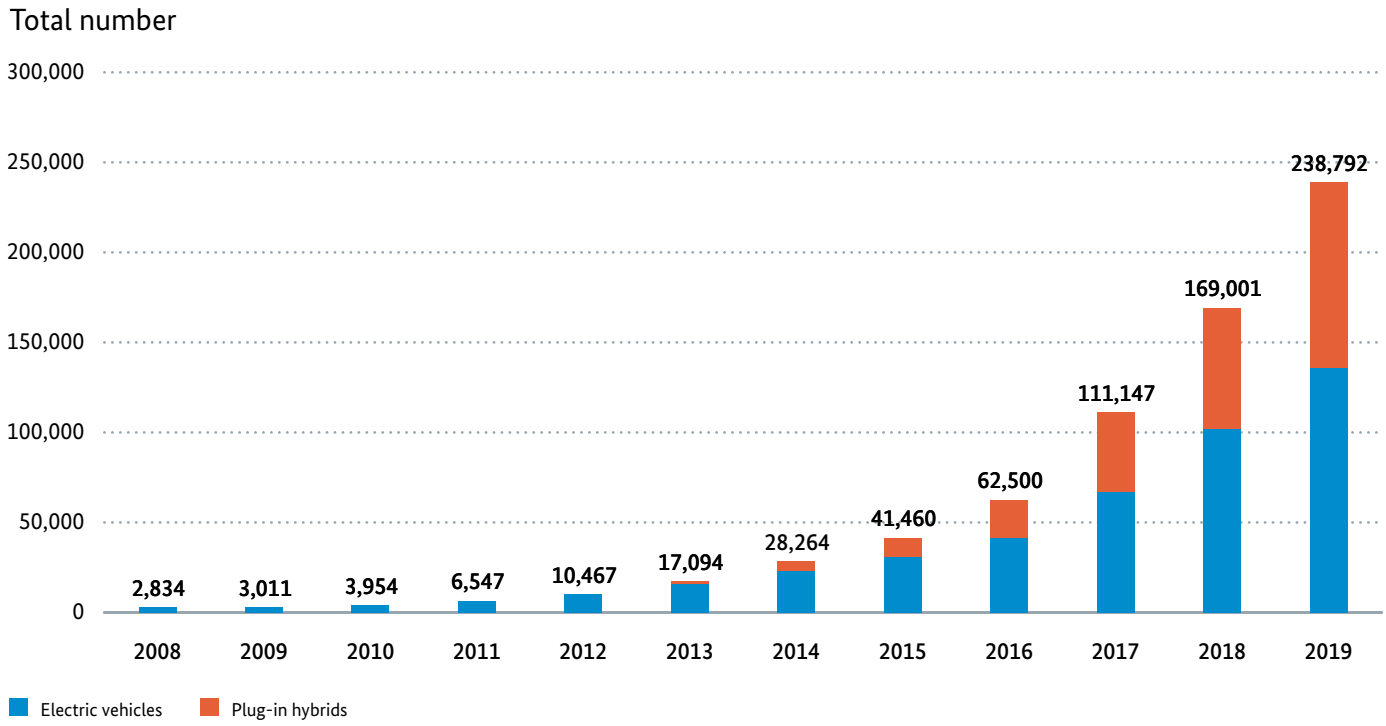
7.2 Alternative fuels and innovative drive technologies

Electric mobility is already making carbon-free or low-carbon and energy-efficient travel possible, provided that 100% of the electricity is sourced from renewable energy. Its share of the traffic volume, however, remains relatively low overall. The number of vehicles fitted with an electric drive system is increasing significantly, even though the overall market share remains low. As Diagram 7.2 shows, almost 238,800 battery electric vehicles with more than two wheels were registered in 2019 (an increase of 41.3% compared with the previous year), of which 102,795 were plug-in hybrids. Their market share, however, was still less than 2% of the total number of vehicles with more than two wheels. Moreover, increasing numbers of electric vehicles with more than two wheels, two-wheelers with electric drives such as pedelecs and e-bikes can now be seen on German roads.

In 2019, the share of biofuels in fuel consumption amounted to 4.9%. This results in the avoidance of around 7.8 million tonnes of CO_2 equivalent in the transport sector. In the coming years, biofuels from residual and waste materials can also make a much greater contribution to reducing CO_2 emissions.

Furthermore, hydrogen produced using renewable energy sources can also be made available for the transport sector. Hydrogen can be used for the production of low-carbon, synthetic fuels (methane, dimethyl ether (DME), oxymethylene ether (OME), etc.), for example, or used directly for the operation of fuel cells. Competition between the various sectors for the use of renewables must also be taken into account. The use of electricity-based fuels, especially in air, maritime and inland waterway transport, is indispensable.

Diagram 7.2: Total number of electric vehicles with more than two wheels

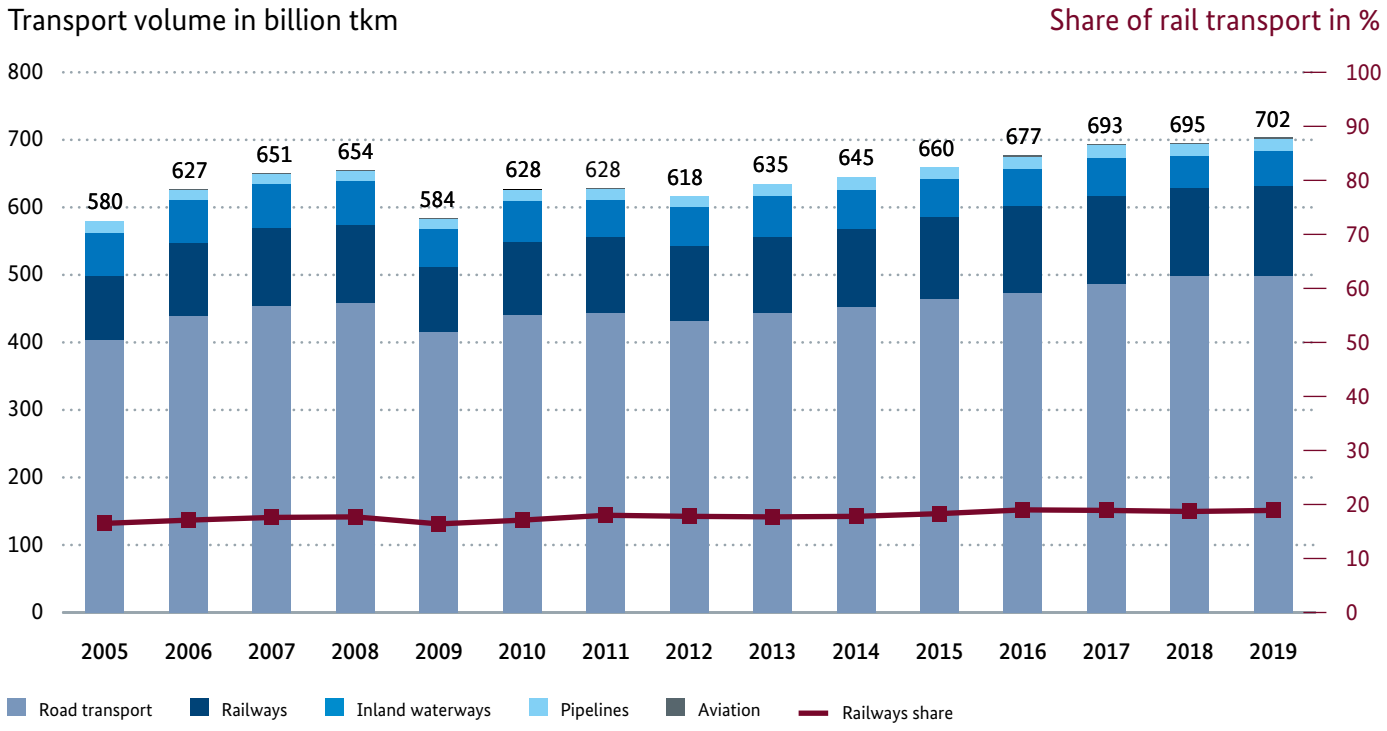


Source: Federal Motor Transport Authority 02/2020; from 2012, including rechargeable hybrid vehicles and range extender vehicles

7.3 Shift to environmentally friendly modes of transport

In the course of the last few years, rail freight transport performance has increased overall, but its share of total freight transport performance has stagnated. As a result of the strong growth in freight transport performance in the last few years and the dominant role of road freight transport, CO_2 emissions and the final energy consumption of freight transport in Germany have gone up. A change in the modal split (distribution of traffic volume between the transport modes) in favour of rail as a mode of transport will help to reverse this situation and achieve the climate goals. To this end, investments will have to be made in the corresponding infrastructure, rolling stock and logistics concepts, as a large proportion of trains already run on electricity and thus to a large extent are already energy efficient. The share of renewables in the traction current mix also continues to grow. Rail freight transport performance was down 0.9% to 130 billion tonne-kilometres in 2018 compared with the previous year, subsequently rising by 2.2% in 2019 to 132.8 billion tonne-kilometres, which was 39.2% up on the 2005 level. In recent years, the amount of rail freight transported as a share of the total freight transport performance has fluctuated slightly between 17.9% and 19%; in 2018 and 2019, it was 18.7% and 19.0% respectively. With the Rail Pact that was concluded on 30 June 2020 as part of the Rail Future Alliance, the Federal Government and the transport sector have set themselves the goal of increasing the share of rail freight transport to at least 25% by 2030. In the course of the 2035

Diagram 7.3: Share of rail freight transport in total freight transport performance



Source: BMVI (2020a)

transport forecast, an examination will be made to determine, among other things, what measures will be necessary to change the modal split in favour of rail and at what cost, and what environmental effects can be achieved as a result.

Although the transport performance of local public transport is increasing overall, its share in total passenger transport remains virtually unchanged. In Germany, people travel short distances primarily by car and these account for the majority of consumption and emissions in passenger transport. In 2019, according to figures published by the Federal Statistical Office, a total of 11.62 billion passenger journeys were made using scheduled local and long-distance bus and train services, compared with 11.57 billion in 2018. This represents an increase of 0.4%. On average, 31.83 million passenger journeys per day were made on scheduled services in 2019, compared with 31.70 million in 2018. The number of passengers travelling on scheduled services has increased continuously since 2004, the first year for which comparable data is available. In 2019, the number of passengers was almost 1.5 billion higher (15.0%) than 15 years earlier. Particularly strong increases were recorded on regional train services (41.8%) and trams (22.8%) during this period. The share of local public transport in total passenger transport has remained constant at just under 10% for several years (2019: 9.6%).

7.4 Key measures implemented to date

The future of mobility is sustainable, connected and increasingly energy-efficient – and this true for both rail and car travel. With the active participation of representatives from politics, business and civil society, the National Platform Future of Mobility (NPM) is developing ideas and concepts to ensure sustainable, climate-friendly and affordable mobility in the future. The NPM's work began in September 2018. In six working groups, each of which addresses specific issues relating to the future of mobility. Their task is to formulate recommendations for action in the fields of climate protection in transport, alternative drive technologies and fuels for sustainable mobility, digitisation for the mobility sector, securing Germany as a place for mobility, production, battery cell production, primary materials and recycling, training and qualification, connecting mobility and energy networks, sector integration, in addition to standardisation, norms, certification and type approval.

The energy transition in transport will only succeed with a significant increase in the share of alternative and innovative drive technologies and fuels. Vehicles fitted with alternative drive systems are one of the keys to achieving sustainable and climate-friendly mobility. At its core is electric mobility as the transport mode of the future. Electric drive systems make it possible to recover kinetic energy. The factors that will ultimately be decisive for the application of electric mobility are energy efficiency and, above all, cost effectiveness, in addition to the user's specific mobility needs. The Federal Government's energy concept is counting on a rapid spread of electric vehicles. They can be either battery-driven or based on an on-board fuel cell that converts hydrogen into electrical energy. The task now is to further accelerate market development. The Environmental Bonus, which has been in force since 19 February 2020, has been extended until 31 December 2025 and significantly increased, and is now valid retroactively for all vehicles registered as of 5 November 2019. Since July 2020, with the coming into force of the Innovation Premium, the state's share in the funding of electric vehicles has doubled. In addition, electric mobility will be funded by halving the tax assessment basis for the private use of electric and hybrid electric vehicles with respect to company car taxation as specified in the German Income Tax Act. The goal is to make Germany the lead market and lead provider for electric mobility and to locate the entire value creation chain in this country.

Electric buses also play an important role in reducing fuel and energy consumption, CO_2 and pollutant emissions in the transport sector. In recent years, the Federal Government has funded numerous projects to support the electrification of road-based local public transport, with the aim of establishing low-emission or zero-emission vehicles on the market more quickly. An increasing market supply and a strongly rising interest of transport business enterprises can be observed, particularly in the field of battery electric buses. A study commissioned by the BMVI has concluded that hybrid trolleybuses also have excellent potential for use on very busy routes (DLR et al. (2016a)). The Federal Government already supports the use of hybrid trolleybuses in cities and the purchase of plug-in hybrid and battery buses on a large scale. To provide further funding for plug-in hybrid and electric buses in local public transport, the electricity tax rate was reduced from €20.50/MWh to €11.42/MWh with an amendment to the Electricity Tax Act on 1 January 2018. For heavy goods

vehicles (HGV), further emission reductions can also be achieved by using electric drive technology.

Converting heavy goods vehicles (HGV) to alternative drive systems is a perquisite for achieving the energy and climate targets in the transport sector. Three core measures were agreed on in the Climate Action Programme 2030. They concern funding for the purchase of low-carbon trucks, the development of refuelling and charging infrastructure, and the introduction of an effective carbon surcharge on the truck toll beginning in 2023. In the set of measures for low-carbon trucks, the list of drive technologies includes the battery, hydrogen fuel cell, hybrid trolleybus and CNG/LNG (provided the source is renewable biomethane). According to the associated set of measures named 'Expansion of refuelling, charging and overhead line infrastructure', vehicle funding is to be supplemented by concepts for demand-driven infrastructure expansion. In November 2020, the Federal Ministry of Transport and Digital Infrastructure (BMVI) drew up a roadmap of measures in the form of the overall concept for climate-friendly commercial vehicles, which addresses the three core measures mentioned above. Since 2018, the BMVI's Energy-efficient and/or low-carbon heavy commercial vehicles funding programme has provided funding for toll-paying heavy goods vehicles (HGV) powered by natural gas (CNG, LNG), batteries and hydrogen. The funding of commercial vehicles with electric drive systems is to be expanded quite significantly. The funding is already supplemented by a toll exemption for trucks fitted with alternative drive systems. With support from the BMU, field trials of hybrid trolley trucks are currently underway under real-life conditions.

Increasing the use of renewable energy sources will make mobility will become climate and environmentally friendly. The share of renewables in the transport sector, including electricity consumption from renewable energy sources, was 5.6% and 5.5% in 2018 and 2019 respectively and is to be increased further (see Chapter 4). The share of biofuels was around 86%. Their use is to be increased further by 2020 as a result of the targets laid down in Directive 2009/28/EC. With increasing electric mobility, the importance of electricity from renewable energy sources for transport and its contribution to climate contribution will also increase. A prerequisite is that the use of renewables in the generation of electricity also continues to increase (see Chapter 4). This will lower the specific carbon dioxide emissions of the electricity used in electric cars and thus the GHG and air pollutant emissions from the transport sector. According to calculations by the German Environment Agency (UBA), the environmental impact of these transport-related emissions and the resulting environmental costs are considerable (UBA (2018)). Mobility based on electricity from renewable energy sources can significantly reduce these costs.

Renewable fuels are also the focus of the energy concept and are increasingly used for modes of transport that cannot be electrified for technical or economic reasons. Aviation and shipping in particular will only be able to free themselves from their dependence on fossil fuels in the long term by using sustainable fuels based on renewable energy sources. Since biomass potential is limited, the majority of these fuels would have to be produced on the basis of electrical energy generated using renewable sources. There is an area of great potential in terms of volume, in addition to the potential for increasing efficiency and reducing costs in production. This applies in particular to the electrolysers used to produce hydrogen. The Federal Government will continue to increase its research efforts (especially in the field of materials and surface research for electrolysers) in order

to leverage the potential for increasing efficiency as soon as possible. Moreover, it is very likely that the market ramp-up of renewable fuels in aviation and shipping will also lead to economies of scale and increases in efficiency.

The number of fuel cell vehicles already available on the market is growing, but a breakthrough will need some more time. In the mobile application of fuel cells combined with hydrogen technology in the vehicle, the electric drive system is supplied with electricity via a fuel cell, which is operated with hydrogen as the secondary energy carrier. There are currently about 600 hydrogen fuel cell vehicles in Germany. The Federal Government has funded hydrogen and fuel cell technology for over 10 years now. A total of €1.4 billion was invested by the Federal Government and industry between 2006 and 2016. Numerous projects have been successfully implemented in the fields of road, rail, air and water transport. Funding is to be continued from 2016 to 2026. Some 40% of the funds are to be made available for research and development, demonstration and market preparation, with the remaining 60% to support market activation activities, each for a limited period of time. In 2015, representatives of the German hydrogen and fuel cell sector from industry and scientific institutions declared their willingness to invest more than €2 billion in research and development and in the market ramp-up of related products over the next ten years. The Federal Government also intends to provide a stable funding scheme of up to €1.4 billion over the same period.

The infrastructure for alternative drive systems and fuels requires accelerated expansion and uniform standards. In the current process of setting up a demand-based charging infrastructure that will be necessary for battery electric vehicles, in addition to hydrogen filling stations for hydrogen fuel cell vehicles, the following progress has been made:

- On 4 March 2020, the Federal Cabinet approved the draft of a law on the development of a building-integrated charging and wiring infrastructure for electric mobility (Building Electromobility Infrastructure Act, GEIG). Under certain conditions, new buildings and existing buildings undergoing major modernisation in future will have to be equipped with a wiring infrastructure (suitable conduits for electrical and data cables) and at least one charging point.
- The Condominium Modernisation Act (WEMoG), which simplifies the installation of a charging infrastructure for commonhold associations in apartment buildings, entered into force on 1 December 2020.
- Most charging sessions take place at home or at a person's place of work. Privately-owned normal charging points are able to provide most of the range covered on a daily basis. Since 24 November 2020, the Federal Government has provided funding for private charging points and the associated installation work required with a €900 grant from KfW. A funding guideline on the funding of the charging infrastructure at the workplace is currently being prepared and will be published in spring 2021. For routes on which an EV will require recharging, a publicly accessible fast charging infrastructure is necessary. There is no comprehensive fast charging network in place throughout Germany as yet. Around 33,100 public and semi-public charging stations for electric cars were included in the BDEW charging station register in November 2020. This represents an increase of 19% since April 2020. Every tenth charging station is listed as a fast charger. More than three quarters of the charging stations are

operated by the energy industry. Fast charging stations are currently to be found primarily on trunk roads connecting major cities. According to the BMVI, around 300 of approximately 400 locations on the country's autobahns had been equipped with fast-charging stations and the corresponding parking spaces by the end of 2017. The process of equipping those locations with fast-charging stations that currently have none continues. In 2021, the Federal Government intends to set up a fast charging network for Germany for people travelling long distances and fast charging stations in densely populated areas by issuing a call for auctions for a total of 1,000 locations. The intention is to have several charging stations at each location, with a minimum capacity of 150 kW.

- According to surveys conducted by the Initiative for Natural Gas-Based Mobility, the CNG filling station network consisted of around 850 stations at the beginning of 2019, most of which had been integrated into existing filling stations. The first LNG filling station for trucks was opened in Ulm in 2016. More than 20 additional LNG refuelling stations are currently planned in Germany on the basis of a Connecting Europe Facility (CEF) funding instrument. There were around 40 LNG refuelling stations in operation by the end of 2020. LNG bunkering has also been provided in a number of ports.
- With the support of the Federal Government's National Hydrogen and Fuel Cell Technology Innovation Programme (NIP), a network of hydrogen filling stations for passenger cars has been set up in Germany in the course of the last few years to ensure that the basic supply is covered in metropolitan areas and along the connecting autobahns and main highways. In December 2020, there were 87 hydrogen filling stations available for hydrogen fuel cell vehicles. The hydrogen filling station infrastructure in Germany is being set up by the industry. The business enterprises involved in the programme have created the organisational basis required to set up a nationwide network of hydrogen filling stations and the associated nationwide supply of hydrogen. In the National Strategic Framework, the Federal Government has laid down a target for the development of some 400 hydrogen filling stations by 2025, based on the ramp-up of vehicles.

Further measures designed to support the development of a nationwide charging infrastructure. Following the amendment to the Charging Station Ordinance, users can obtain and pay for electricity at all publicly accessible charging stations using a common web-based payment system. In order to increase the acceptance of electric mobility and to encourage the purchase of an electric vehicle, an adequate charging infrastructure is needed in urban and rural areas. With its Charging Infrastructure for Electric Vehicles programme in Germany, the Federal Ministry of Transport and Digital Infrastructure has been promoting the establishment of a nationwide needs-based charging infrastructure for battery electric vehicles with at least 15,000 charging stations throughout Germany between 2017 and 2020. This programme will be extended with an investment of €500 million until 2025. With the Electrically Mobile funding initiative for electric mobility, the charging infrastructure is to be set up on a major scale and its integration into existing distribution networks is to be tested. A legal opinion issued by the Federal Government has provided clarity with regard to pricing at charging stations and the legitimacy of a number of charging tariff models on the market.

The National Charging Infrastructure Control Centre began its work in October 2020. On behalf of the Federal Ministry of Transport and Digital Infrastructure (BMVI), it coordinates and manages the activities required for expanding the charging

infrastructure in Germany under the umbrella of the federally owned NOW GmbH. In order to better understand the demand for charging stations, it collects relevant data. It has contact to all the key players and shares its knowledge with them.

Automated and connected driving (AVF) will redefine private transport, freight transport and public transport. Automated and connected driving is a future technology at the interface of mobility and digital progress. On the one hand, it can contribute to increasing traffic safety and efficiency, in addition to reducing emissions. On the other hand, it can create new business opportunities in the service and mobility sectors and new opportunities that will allow the mobility impaired to participate in mobility. On the basis of its "Strategy for Automated and Connected Driving (AVF)", the Federal Government has implemented measures in various fields of action, such as infrastructure, legislation, innovation, interconnectivity, cyber security and data protection, and societal dialogue. These include the Eighth Act amending the German Road Traffic Act, which provides more legal certainty for consumers and industry with regard to innovations relating to highly or fully automated driving functions. On the basis of recommendations presented by the Ethics Commission for Automated and Connected Driving, the Federal Government has also approved an action to create ethical rules for self-driving computers. The 'ICT for electric mobility: intelligent applications for mobility, logistics and energy' technology programme promotes emission-free, automated logistics, fleet and transport applications in the commercial sector based on artificial intelligence methods. With the planned legal framework for autonomous driving, further legal bases are to be created for the introduction of corresponding systems for normal driving situations in order to establish Germany as a leading provider of autonomous driving technologies. In inland waterway transport, the Federal Ministry of Transport and Digital Infrastructure is promoting digitisation, and specifically automated and connected driving, by setting up digital test beds. This will enable the industry to test systems and continue the development towards highly automated, or even fully automated navigation for inland waterway transport.

The Federal Government supports the industry's plans to set up battery cell production of its own. In practice, this means that Germany and France, together with other European states, as part of a new European industrial strategy, intend to support the production of battery cells for electric cars in Europe. The aim of the funding that is planned for the project is to create an alliance for the manufacture of the latest generation of battery cells, in addition to the required value-added networks from setting up the battery raw material supply chain to battery recycling. This must be accompanied by an increase in battery cell research. As part of the economic stimulus package of 3 June 2020, funding for battery cell production was increased again by €1.5 billion to €3 billion. The funding will be used to finance German projects as part of the EU's Important Projects of Common European Interest (IPCEI) framework.

The Federal Ministry of Transport and Digital Infrastructure is involved in the IPHE (International Partnership for Hydrogen and Fuel Cells in the Economy) as a global forum to bundle and coordinate the activities of various sectors on an international scale. One key area being dealt with, for example, is laying down reliable international sustainability standards and (proof of) origin for electricity from renewable energy sources and also for green hydrogen and its derivatives. Standards of this kind will have to be created at European level for the entire single market.

Climate protection measures and measures in the economic stimulus package to deal with the economic consequences of the Covid-19 pandemic – funding of alternative drive systems and fuels, in addition to the associated charging and refuelling infrastructure

- Purchase premium for commercial vehicles fitted with alternative drive systems: around €1.2 billion (2021 to 2023)
- Funding for investments in charging and refuelling infrastructure for passenger cars and commercial vehicles from the Energy and Climate Fund amounting to around €4 billion (2020–2023)
- Funding for alternative fuels amounting to around €1 billion (2020–2023)
- Additional funding for the expansion of the charging station infrastructure, the funding of research and development in the field of electric mobility and battery cell production amounting to €2.5 billion
- Implementation of the National Hydrogen Strategy with a total financial volume of €7 billion (for national projects), including a funding programme for the production and use of sustainable electricity-based fuels for air and sea transport with a total volume of close to €600 million

Shifting areas of passenger and freight transport to rail and public transport is a key factor for the energy transition in the transport sector. A change in the modal split in favour of rail and public transport could make a significant contribution to achieving the savings targets in final energy consumption and reducing CO_2 emissions in the transport sector (42% reduction in greenhouse gas emissions by 2030 compared with 1990 in accordance with the Federal Climate Change Act and 20% reduction in final energy consumption by 2030 compared with 2005). Together with the Rail Pact that was signed on 30 June 2020, the Deutschlandtakt, Germany's nationwide synchronised timetable, is to make a long-term contribution to doubling passenger numbers in passenger rail transport and increasing the share of rail freight transport to at least 25% of total freight transport by 2030.

To improve the competitive position of rail freight compared with road haulage, digitised and automated rail freight operations are needed. One of the key areas for achieving the modal shift target by 2030 is the digitisation of rail (command and control technology on the rail network, digital signal boxes, digital rail operations, etc.), which is to be accelerated. The automation of freight transport and automated driving on rail systems are to be supported through research and funding. Key measures include the digitisation and automation of train composition (test bed in Munich North launched in 2020), the Europe-wide introduction of digital automatic coupling and the Federal Government's Future of Rail Freight programme, with the testing and market launch of innovative technologies for rail freight transport. In addition, the Federal Government is supporting the new construction and expansion of multimodal transport (MT) transhipment terminals and private sidings with financial subsidies for construction of the infrastructure (digitisation of multimodal transport (MT) terminals and automation of operations to reduce transhipment times and the dwell times of all modes of transport; multimodal access points to rail near the customer's premises and close to transport hubs).

The implementation of the Rail Freight Masterplan will provide a further boost to the rail

freight sector. The Masterplan recommends a total of 66 measures that need to be implemented. The guideline for the funding of rail freight transport through the proportional financing of approved train path charges is an important measure and provides to reduce prices in rail freight transport and to shift freight from road to rail with the aid of additional federal funding. The guideline entered into force in December 2018. Another measure from the Rail Freight Master Plan is the funding of charges for access to service facilities, which was launched in December 2020 and focuses on single wagonload transport, which is intended to improve the competitiveness of rail freight transport.

In order to make greater use of the opportunities offered by public transport in competition with private transport, it must be given systematic support throughout the country. The responsibility for the planning, design, organisation and financing of local public transport, including local passenger rail services, lies with the Länder and the municipalities. However, the Federal Government supports the Länder and municipalities to a considerable extent by providing financing for local public transport. In 2016, for example, it significantly increased the regionalisation funds to €8.2 billion, while the regionalisation funds provided in 2018 amounted to around €8.5 billion. Regionalisation funds will be increased again as of 2020 as part of the Federal Government's Climate Action Package, and a one-time payment of additional funds was made in 2020 amounting to €2.5 billion to compensate for damages resulting from the Covid-19 pandemic. The amount in 2031, taking into account the automatic annual adjustment of 1.8%, will then come to around €11.3 billion. The Federal Government also supported the Länder in 2020 with a one-off increase in regionalisation funds amounting to €2.5 billion to cushion the impact of the Covid-19 pandemic. Federal financial assistance under the GVFG federal programme is to be increased from around €333 million per year to €1.0 billion per year from 2021, with a further increase to €2.0 billion for 2025, and with an automatic increase of 1.8% per year as of 2026. Additionally, from 2020 onwards, the Länder will receive a higher share from VAT revenue as a replacement for the unbundling funds that expired at the end of 2019.

Public transport is expected to make a greater contribution to achieving the energy transition goals in future. In the Climate Action Programme 2020, the Federal Government has therefore set out to strengthen the contribution of public transport to climate protection and to make it more climate-friendly overall. Last but not least, the Federal Government promotes corporate mobility management and innovations in local public transport, such as an improved passenger information systems and electronic ticketing. Such activities are supported by the Digital Networking in Local Public Transport initiative. In order to substantially increase long-distance rail services that will enable more passengers to benefit from direct long-distance services, implementation of the Deutschlandtakt synchronised intercity timetable is to be accelerated. The Deutschlandtakt will ensure that train services are better coordinated, thereby reducing transfer and travel times – from regional routes to the main transport corridors. It will integrate local and long-distance transport services and will be implemented together with the federal states, which are responsible for local rail passenger transport. The infrastructure measures that are needed will be completed in stages, starting in 2020. In addition, the expansion of the road, urban and metro networks, plus the electrification of urban bus transport, will have to be further accelerated.

In October 2018, the Federal Ministry of Transport and Digital Infrastructure launched the Rail Future Alliance with representatives from politics, business and trade associations. With the Rail Transport Masterplan and the Rail Pact adopted by representatives from politics, business and trade associations on 30 June 2020, the goal is to double the number of rail customers travelling on rail passenger services by 2030, to shift more freight to environmentally friendly rail transport and to increase its share in the modal split to at least 25%.

In order to achieve this goal, substantial investments in the rail infrastructure will be necessary in the years ahead. High financial burdens that still exist as a result of current projects have minimised the flexibility required to implement new projects in recent years, so that postponing the start of new projects in the past was unavoidable. With the significant increase in investment funds to €2.0 billion by 2023, which is now anchored in the financial planning, a large part at least of the most important measures to remove bottlenecks in the first priority category of the current requirement plan (Top 12), including such major projects as the Frankfurt am Main – Mannheim – Karlsruhe – Basel, Hanau – Würzburg/Fulda – Erfurt, Hamburg – Hanover (Alpha E), Hof – Regensburg routes as well as all major nodes and the Rhine-Ruhr Express, can now be swiftly implemented. This also means that the financing of the Fehmarnbelt Fixed Link with hinterland connections, which is to be constructed on the basis of an international treaty with the Kingdom of Denmark, is secured. With a total funding requirement of more than €80 billion included in the requirement plan for the years 2021 onwards (of which Top 12: €42 billion), there will be a shortfall of just under €30 billion, based on the current budget line for the completion of all projects by the mid-40s, including a shortfall of some €12 billion by 2030. The approach that must be rigorously pursued, therefore, is a strategic prioritisation of the key measures. To be able to begin at least with the most important measures to remove bottlenecks by 2030, a further continuous increase and long-term stabilisation of the level of the budget line will be necessary in the coming years. The investment level of the requirement plan would have to be increased again in stages to around €3 billion per year, which corresponds to the values implemented in terms of the requirement plan in the 1990s. If this targeted level is to be reached in the second half of the 2020s at the latest, the budget line will also have to be increased by an average of €0.2 billion per year as of 2024 onwards. Among other things, the Federal Government will make around €4.7 billion available for the implementation of the Digital Rail for Germany starter package in yearly tranches until 2030. This aim is to implement that the European Train Control System (ETCS) and Digital Signal Boxes in three selected projects. In the Stuttgart metropolitan region, the system will demonstrate its performance on the city's high-frequency raid transit network, on high-speed train services on the Cologne-Rhine/Main high-speed line and on international services along the Scandinavian-Mediterranean trans-European corridor. In August 2020, the BMVI and DB Netz AG signed a financing agreement to this effect for the Stuttgart metropolitan region. Further agreements are planned for 2021. According to Deutsche Bahn (DB) AG, the new technologies promise to deliver significantly more capacity in the rail network, higher quality and punctuality, lower maintenance and operation costs due to the modern, uniform system architecture, European interoperability of the systems and improved energy efficiency.

Accelerating the implementation of these projects is necessary so that the various infrastructure measures can go into operation in the very near future. At the beginning of 2020, the Bundestag and Bundesrat passed two acts submitted by the BMVI on measures to accelerate the planning and building of infrastructure in the transport sector: one act to establish a framework for accelerated planning approval for specific major infrastructure projects and another act to further accelerate planning and approval procedures. This means that twelve infrastructure projects can be approved by means of individual measures acts instead of official administrative acts. In the area of rail transport, there are seven projects that will be accelerated as a result. This initiative is supplemented by the Investment Acceleration Act passed by the Bundestag in November 2020. In the case of rail transport, this means that certain construction measures will no longer require approval through a planning approval procedure. These measures include the electrification of railway lines, the equipment with digital signalling and safety technology, barrier-free conversions, the raising or extension of platforms and the construction of noise barrier systems. This also includes the construction of sidings of up to 2,000 metres in length, as well as feeder and industrial trunk lines of up to 3,000 metres in length.

Climate protection measures and measures included in the economic stimulus package to deal with the economic consequences of the Covid-19 pandemic – boosting rail transport and local public transport

- Funding amounting to €11 billion (until 2030) for Deutsche Bahn (DB) AG in the form of an equity increase, in addition to construction cost subsidies for infrastructure investments, e.g. for projects designed to implement stages of the Deutschlandtakt. In addition, funds of up to €5 billion in 2021 to compensate for damages relating to the Covid-19 pandemic
- Additional staff at the Federal Railway Authority (EBA) responsible for planning approvals and licences
- Reduction of the VAT rate on long-distance passenger trains from 19% to 7% from 1 January 2020 (as part of the Covid-19 aid package, a further reduction of the VAT rate from 7% to 5% from 1 July 2020 to 31 December 2020). And consequently: an increase in air traffic tax (since 1 April 2020)
- Prevention of dumping prices for airline tickets (price not below applicable taxes, surcharges, fees and charges) in the revision of Regulation (EC) No 1008/2008
- Increase and automatic adjustment of regionalisation funds amounting to €5.2 billion (until 2031), plus additional funds to compensate for damage resulting from the Covid-19 pandemic (one-time in 2020 amounting to €2.5 billion)
- Increase in funding under the Municipal Transport Infrastructure Financing Act (GVFG) to €2 billion per year (from 2025) and federal funding rates of up to 90%
- Pilot projects for local public transport season tickets: funds for municipal model projects to boost local public transport totalling €300 million (2020–2023)
- Funds for the funding of buses with alternative drive systems amounting to more than €1 billion (2020–2023, federal share)

Rail freight:

- Additional funding amounting to €175 million for extending the train-path price support to beyond 30 June 2023

- Funding amounting to €160 million from 2020 to 2023 for the funding of charges for access to service facilities in rail freight transport with a focus on single wagonload transport
- Supporting the Federal Government's Future of Rail Freight programme with €40 million (in the years 2020 to 2023)

As one of the most important infrastructure planning tools, the Federal Transport Infrastructure Plan (BVWP) has the potential to drive the shift to efficient and low-emission modes of transport. The 2030 Federal Transport Infrastructure Plan (BVWP), which was adopted in 2016, forms the basis for the maintenance/replacement and upgrading of the federal transport infrastructure. The 2030 Federal Transport Infrastructure Plan (BVWP) and the upgrading acts for roads, railways and inland waterways derived from it have a certain influence on energy consumption in the transport sector and thus on achieving the goals of the energy transition by 2030 and beyond. The implementation of new-build and upgrading projects on the rail and inland waterway networks that are included in the first priority category of the Federal Transport Infrastructure Plan (BVWP) will lead to a shift in traffic flows, so that energy consumption and thus CO_2 emissions will be reduced. Overall, the 2030 Federal Transport Infrastructure Plan (BVWP) will result in up to 0.4 million tonnes of CO_2 being avoided per year. This corresponds to roughly 0.2% of the current emissions of the transport sector. The 2030 Federal Transport Infrastructure Plan (BVWP) for the first time mentions the country's cycling infrastructure, in particular federal participation in the construction of a network of fast bike highways.

Climate protection measures and measures included in the economic stimulus package to deal with the economic consequences of the Covid-19 pandemic – cycling promotion campaign

- Additional funding of €900 million included in the federal budget (financial plan to 2023)
- For the first time, the Federal Ministry of Transport and Digital Infrastructure will also be in a position to fund infrastructure projects of the Länder and municipalities locally
- Implementation of specific measures based on a special town and country financial assistance programme in accordance with an agreement between the Federal Government and the governments of the Länder and two more additional programmes, namely the German cycling network and the funding of pilot cycling projects

Climate protection measures and measures included in the economic stimulus package to deal with the economic consequences of the Covid-19 pandemic – carbon pricing (for transport and heating)

- Fixed price system from 2021 to 2025 (€25/tonne up to €55/tonne of CO_2)
- Emissions trading with a corridor between €55/tonne and €65/tonne as of 2026 (review in 2025)
- To cushion hardship: an increase in the commuter allowance to 35 cents/km from the 21st kilometre travelled (2021 to the end of 2026)

Transparency, participation and acceptance in the transport sector

mFUND research initiative

With its mFUND research initiative, the Federal Ministry of Transport and Digital Infrastructure is providing €150 million in funding to promote digital data-based innovations for Mobility 4.0 until 2020.

- The aim is to make mobility across all modes of transport more efficient, safer and environmentally friendly, and to open up new business areas by making administrative data available to the general public.
- Within the mFUND funding line 2 (projects with funding of up to €3 million), a total of four calls for funding applications have been published to date; applications for funding within funding line 1 (funding of up to €100 thousand) may be submitted at any time and with no deadline.
- The implementation of the mFUND is accompanied by events such as mFUND conferences, start-up pitches, hackathons, and internet communications.
- They provide opportunities for creative individuals from start-ups, associations and universities to meet and makes networking possible between the various players involved from politics, business and research.

Public involvement in the 2030 Federal Transport Infrastructure Plan

The Federal Ministry of Transport and Digital Infrastructure has significantly broadened the involvement of experts and the general public in preparing the 2030 Federal Transport Infrastructure Plan (BVWP) compared with previous federal transport infrastructure plans. This applies to all preparatory phases:

- The evaluation methodology and the guidelines of the Federal Transport Infrastructure Plan (BVWP) for the planning and forecast phase have been laid down since 2011 in a transparent process involving experts and the general public. An updated traffic forecast for the year 2030 was also prepared.
- From 2012 onwards, the evaluation phase included the examination and assessment of the projects that had been submitted, among others, by associations and members of the general public.
- During the participation, coordination and decision-making phase when drafting the 2030 Federal Transport Infrastructure Plan (BVWP), the Federal Ministry of Transport and Digital Infrastructure consulted, among others, the Länder, government departments, trade associations and members of the general public.

Key measures implemented to date in the transport sector

General

- New World Harmonised Light Vehicle Test Procedure (WLTP)
- Further development of 2013 Mobility and Fuel Strategy
- Launch of National Platform Future of Mobility
- Strategy for automated and connected driving
- Action plan to create ethical rules for self-driving computers
- Reform of EU regulations on reducing CO_2 emissions from new passenger cars and light commercial vehicles

- EU regulations on reducing CO_2 emissions from heavy goods vehicles (HGV)
- EU regulations on national GHG emissions reduction targets for sectors outside the scope of the ETS from 2021–2030 (see Chapter 3)
- Measures implemented in the transport sector included in the Climate Action Programme 2030/Federal Climate Change Act (see Chapter 8)
- Further development (CO_2 component) of the German HGV toll/adjustment of the EU Directive on Road Charging
- Sustainable Urban Mobility research agenda
- Funding programmes for energy-efficient and/or low-carbon heavy goods vehicles (HGV)
- "MobilitätsWerkStadt 2025" municipal pilot project funding announcement
- "MobilitätsZukunftsLabor 2050" future mobility project funding announcement

Electric mobility – alternative fuels – refuelling and charging infrastructure

- Market incentive package for electric mobility
- Local electric mobility funding programme
- Regulation on minimum technical requirements for the safe and interoperable installation and operation of publicly accessible charging stations for electric vehicles (Charging Station Ordinance)
- Masterplan Charging Infrastructure
- Funding guideline for public charging infrastructure
- Renewable Mobile funding programme
- Second Act amending Energy Duty Act and Electricity Tax Act
- Toll charge exemption for electrical (currently unlimited) and LNG heavy goods vehicles (HGV) (until the end of 2023)
- Taskforce on LNG in heavy goods vehicles (HGV)
- H2 Mobility project
- Maritime Technologies for the next Generation funding programme (until the end of 2017)
- Maritime Research Programme (since 1 January 2018)
- Draft of law on the development of a building-integrated charging and wiring infrastructure for electric mobility (Building Electromobility Infrastructure Act, GEIG)

Shift to environmentally friendly modes of transport

- Launch of Rail Future Alliance Rail Future Alliance with representatives from politics, business and trade associations, adoption of Rail Master Plan and Rail Pact
- Implementation of Rail Freight Masterplan
- Funding of investments in rail infrastructure
- Boosting rail freight transport, e.g. by funding train path charges and charges for access to service facilities, in addition to funding innovation
- National Cycling Plan (NRVP)
- Funding of investments in cycling pilot projects
- 2030 Federal Transport Infrastructure Plan (BVWP)
- Hydrogen and Fuel Cell Technology 2016–2026 Federal Government programme – from market preparation to competitive products
- Funding of combined transport (inter- and multimodality)
- Funding the shift of urban and commuter road traffic to rail – to improve air quality in cities

8. Greenhouse gas emissions

Where do we stand?

In 2019, according to the German Environment Agency, a total of 35.1% fewer greenhouse gas emissions (excluding land use changes) were emitted compared with 1990. This means that emissions in 2019 were down 5.4% compared with 2018. One of the main reasons for this was a further significant drop in GHG emissions in the energy sector. Emissions from transport and buildings, however, were up compared with the previous year.

The impact of the Covid-19 pandemic on the 2020 target (reduction of at least 40% compared with 1990) cannot yet be estimated. It is considered likely that the pandemic will lead to further reductions.

In November 2016, in light of the results of the Paris Climate Agreement (see Chapter 3), the Federal Government adopted the Climate Action Plan 2050. It is the Federal Government's long-term national strategy, providing key guidance for the period time 2020 and sets specific targets for the individual emission sectors until 2030. These sectoral targets are also in line with current EU targets.

What is new?

The Cabinet Committee on Climate Protection, the so-called Climate Cabinet, was formed in 2019. In order to be certain of achieving the 2030 sector targets of the Climate Action Plan 2050, the Federal Government adopted the Climate Action Programme 2030 with numerous greenhouse gas reduction measures as well as the Federal Climate Change Act.

Based on the Climate Action Plan 2050, the Federal Climate Change Act stipulates annual emission levels for all sectors until 2030. The Federal Government will continue to oversee the implementation of the measures of the Climate Action Programme 2020 and assess their mitigation effect. The Climate Action Report 2019 was subsequently adopted by the Cabinet on 19 August 2020.

The status of implementation of the programmes of measures, i.e. the Climate Action Programme 2030, in addition to any possible future emergency programmes and measures of the Federal Government pursuant to Section 8 of the Federal Climate Change Act, will be evaluated on the basis of future climate action reports. All measures will be scientifically evaluated with regard to their economic, ecological and social impacts.

	2018	2019	2020	2030	2040	2050
GREENHOUSE GAS EMISSIONS						
Greenhouse gas emissions* (compared with 1990)	-31.5%	-35.1%	at least -40%	at least -55%		Greenhouse gas neutrality

* The targets indicated for 2020, 2030, 2040 and 2050 represent Germany's currently existing, political greenhouse gas reduction targets.

Last year, the Federal Government adopted annual emission levels for all sectors in the Federal Climate Change Act, which are included in the table below (see Table 8.1).

Table 8.1: Sector-specific annual emission levels

Annual emission volume (million tonnes of CO_2-eq.)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy sector	280		257								175
Industry	186	182	177	172	168	163	158	154	149	145	140
Buildings	118	113	108	103	99	94	89	84	80	75	70
Transport	150	145	139	134	128	123	117	112	106	101	95
Agriculture	70	68	67	66	65	64	63	61	60	59	58
Waste management and other	9	9	8	8	7	7	7	6	6	5	5
Total	**813**										**543**

Source: Federal Climate Change Act of 12 December 2019 (BGBl. I p. 2513), Annex 2 to Section 4.

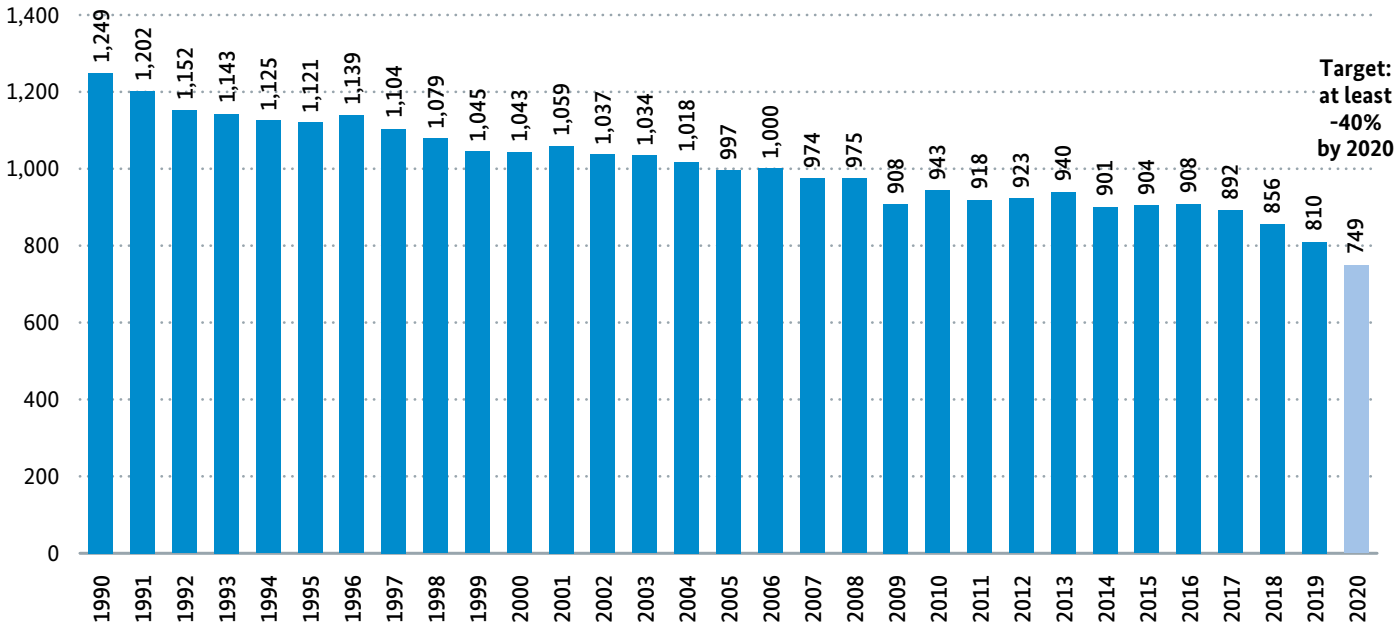
8.1 Total greenhouse gas emissions

By 2019, according to calculations by the German Environment Agency (UBA), total greenhouse gas emissions in Germany had fallen by 35.1% since 1990. In 2019, some 810 million tonnes of greenhouse gases (CO_2 equivalent (CO_2-eq.)) were released (see Diagram 8.1). This represented a decline of around 46.1 million tonnes compared with 2018, or 5.4%, due primarily to the reduction in emissions from the energy sector. Germany's greenhouse gas emissions account for about one fifth of the European Union's annual greenhouse gas emissions.

Diagram 8.1: Target profile: Greenhouse gas emissions in Germany

Target 2020	Reduction in greenhouse gas emissions of at least 40% (compared with 1990)
Status 2019	-35.1%

In million t CO_2-eq.



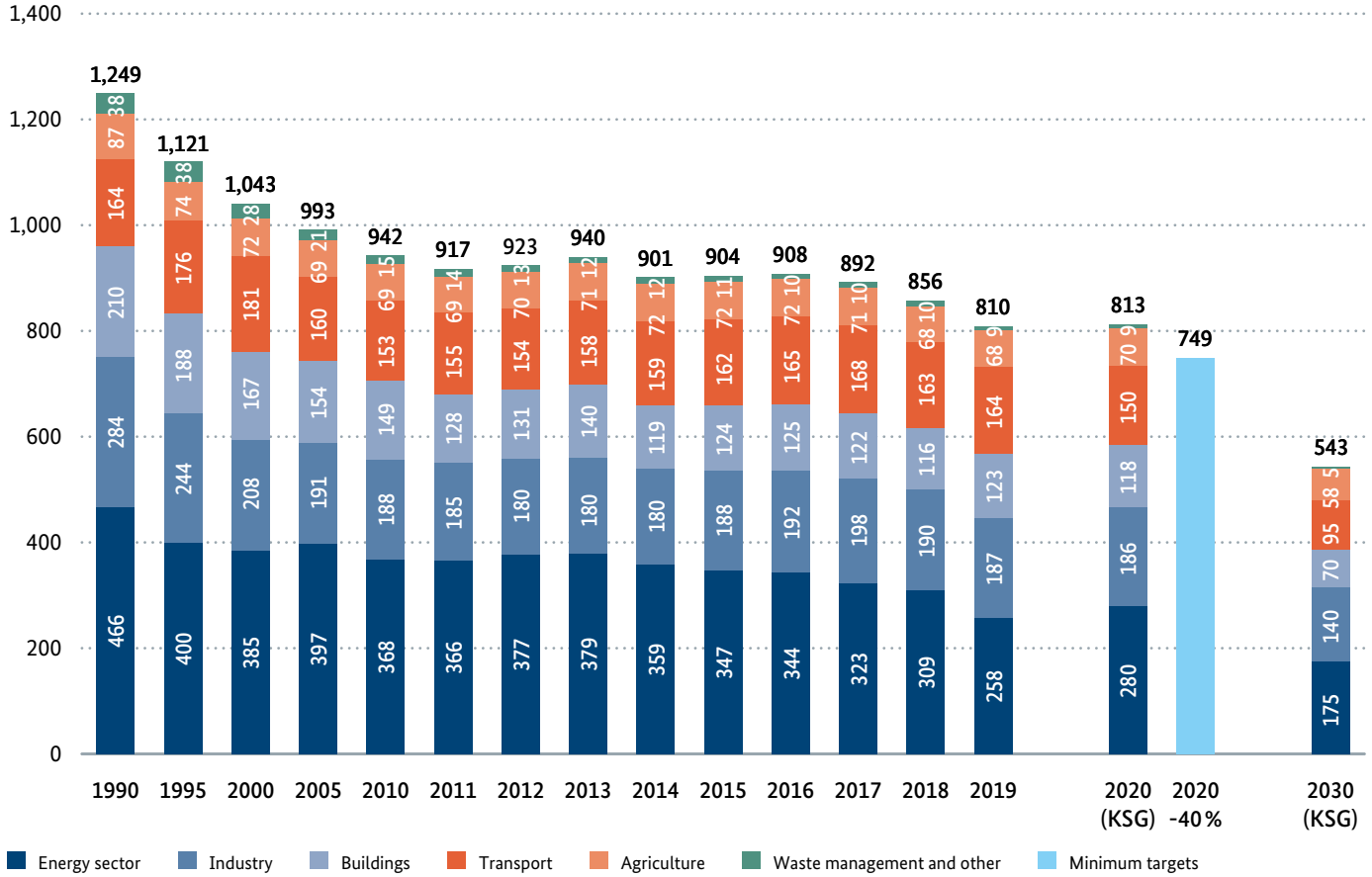
Source: UBA 01/2021

Trend	●●●●○
Measures	Climate Action Programme 2020

At 31.9%, the energy sector accounted for the largest share of total emissions in 2019. The second largest emitter was industry at 23.1%, followed by the transport sector at 20.3% and the building sector at 15.2%. Agriculture contributes around 8.4% to total emissions. The remaining 1% or so is caused by the waste and other sectors (see Diagram 8.2).

Diagram 8.2: Greenhouse gas emissions by sector (based on Climate Action Plan 2050)

Emissions in million t CO_2



Source: UBA 01/2021

The transport sector released more greenhouse gas emissions than in the previous year. Overall, the transport sector in 2019 emitted more than 164.3 million tonnes of greenhouse gas emissions, which is 1.7 million tonnes more than in 2018. The consistently high level of emissions in the transport sector is due primarily to road transport and the increasing volume of cars and trucks with a subsequent increase in mileage overall.

Compared with 2018, however, greenhouse gas emissions in the energy sector in 2019 fell significantly once again by more than 51 million tonnes (16.6%). This means that the trend towards a significant reduction in emissions in this sector has once again accelerated considerably compared with previous years. This was due in particular to the high wind energy production and the resulting significant reduction in electricity production in coal-fired power plants.

When individual greenhouse gases are compared, carbon dioxide (CO_2) dominates, primarily as a result of combustion processes. The above-average decrease in other greenhouse gases has led to the share of CO_2 emissions increasing by 3.6 per-

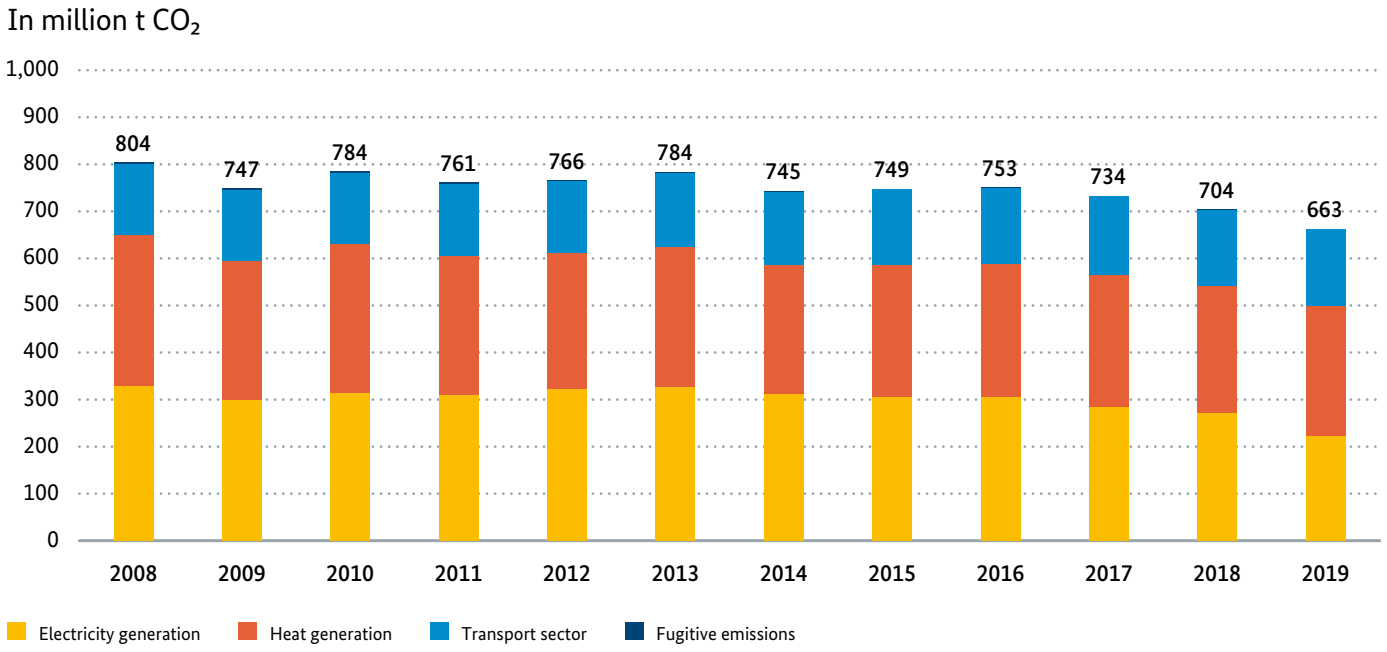
centage points since 1990 to around 87.9%. Methane emissions (CH4) accounted for about 6.1% in 2019 and nitrous oxide (N2O) emissions 4.3%, while fluorinated greenhouse gases, on the other hand, accounted for some 1.7%. This breakdown of greenhouse gas emissions is typical for a highly industrialised country.

8.2 Energy-related greenhouse gas emissions

According to calculations by the German Environment Agency, the release of energy-related greenhouse gases in Germany fell in 2019 by about 43.2 million tonnes of CO_2-equivalent (about 6%) to 677.4 million tonnes of CO_2-equivalent compared with the previous year. Some 83.6% of total greenhouse gas emissions, therefore, are energy-related. They are caused by combustion processes used for the generation of heat and electricity, by fuels in engines and fugitive emissions. Energy-related emissions, therefore, include emissions produced by the energy industry, the buildings and transport sectors, and include the energy emissions produced by the industrial and agricultural sectors. Since approximately 98% of the energy-related emissions consist of carbon dioxide, the following analyses and assessments focus on CO_2 emissions.

Overall, energy-related emissions have decreased significantly since 1990. The majority of these energy-related CO_2 emissions come from burning fossil fuels for the generation of electricity and heat, and also from the transport sector (see Diagram 8.3). The long-term perspective shows a declining trend. The reasons for this can be found primarily in the decommissioning of emission-intensive lignite-fired power plants in the 1990s and

Diagram 8.3: Energy-related CO_2 emissions of the electricity, heat and transport sectors, and fugitive emissions



Source: UBA 12/2020

their gradual replacement by more efficient power plants with a higher level of operational efficiency. Another reason for the decline is the expansion of renewable energy sources and the switch to lower emission fuels such as natural gas. On the other hand, there was an increase in emissions in the transport sector, households and small consumers. Other energy-related emissions consisting of fugitive emissions, e.g. due to line losses, remained more or less constant compared with the previous year (see Diagram 8.3).

It should be noted that the emissions adjusted for varying weather conditions (e.g. changes in heating performance) deviate from the actual emissions presented here. However, the weather-related level has no relevance for achieving the target, as this is based on the actual emissions.

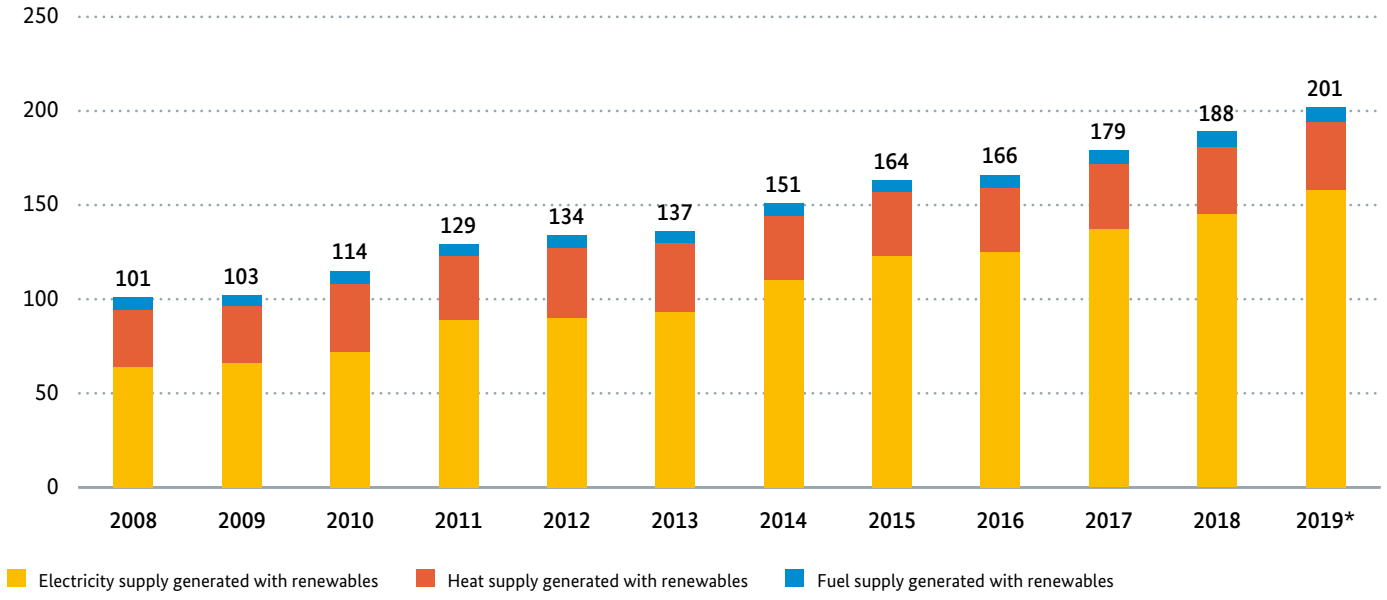
8.3 Greenhouse gas emissions avoided through the use of renewable energy sources

Replacing fossil fuels by renewables (see Chapter 4) will make a major contribution to achieving the climate protection targets. In 2019, this resulted in emissions of around 201 million tonnes of CO_2-equivalent being avoided, with the electricity sector accounting for 158 million tonnes of CO_2-equivalent. The use of renewable energy sources in the heating sector resulted in 36 million tonnes of CO_2-equivalent being avoided and using biogenic fuels almost 8 million tonnes.

The calculations for determining the emissions avoided by using energy from renewable sources are based on a net assessment. In this case, the emissions produced by the final energy supply from renewable sources are offset against the gross

Diagram 8.4: Greenhouse gas emissions avoided through the use of renewable energy sources

In million t CO_2-eq.

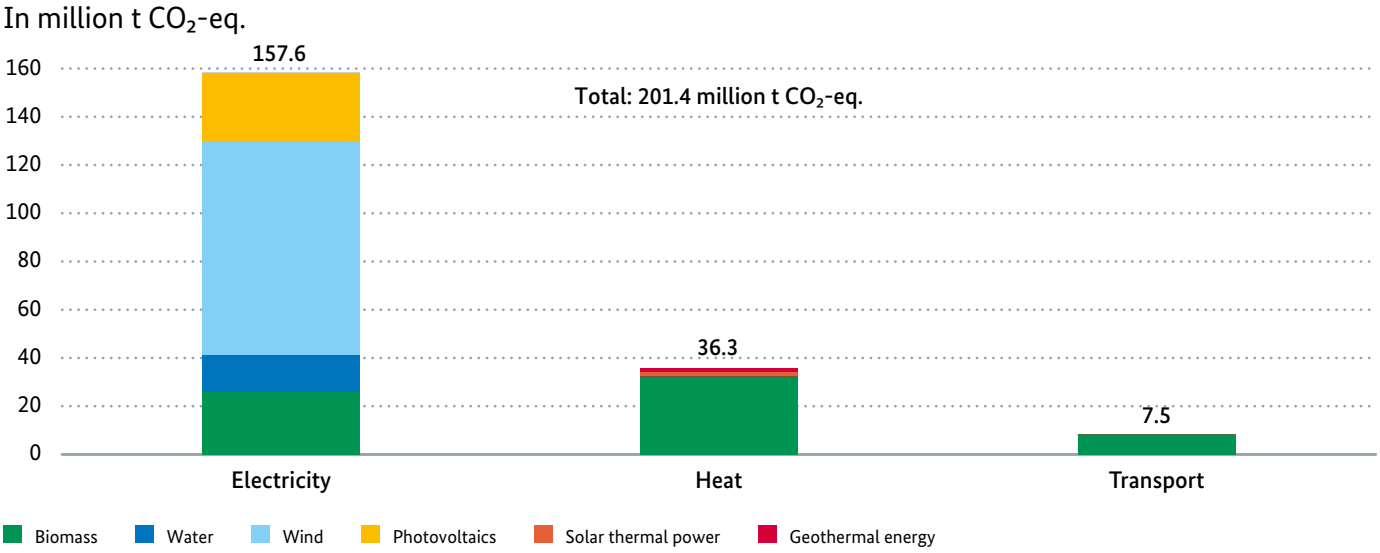


* Previous year's estimate/preliminary data
Source: In-house data from the BMWi based on UBA 08/2020

emissions avoided as a result of replacing the fossil fuels with renewables. Unlike the GHG emissions of GHG inventories, which are calculated in accordance with internationally binding rules, all the upstream process chains used for the extraction and supply of the fuels, in addition to production and the operation of the facilities (not including decommissioning/dismantling), are taken into account. The methodology used to calculate the emissions avoided by using energy from renewable sources is based on the requirements of the EU Renewable Energy Directive (2009/28/EC).

The largest percentage of emissions avoided by using energy from renewable sources is the result of wind energy, followed by biomass. Around 89 million tonnes of CO_2-equivalent were avoided in 2019 through the use of wind energy, 28 million tonnes of CO_2-equivalent through photovoltaics and 15 million tonnes of CO_2-equivalent through hydropower plants. Around 65 million tonnes of CO_2-equivalent were avoided in 2019, primarily as a result of using solid biomass, such as wood energy, and liquid or gaseous biomass in all three consumption sectors. This makes biomass the second largest source of renewable energy. In its Climate Action Plan 2050, the Federal Government states the following: Because the energy supply has to be almost entirely decarbonised by 2050 at the latest and because land is needed to produce food, the significance of the contribution to mitigating climate change made by bioenergy from cultivated biomass will be limited. In the Climate Action Programme 2030, taking all aspects into account, the maximum available biomass for biofuels in Germany is currently around 1,000-1,200 PJ/a. The use of residual and waste materials included in these figures makes an important contribution to the cross-sectoral energy supply. It should also be noted that the emissions produced by some biomass sources in the LULUCF sector (Land Use, Land-Use Change and Forestry) are not included when assessing the impact of the measures implemented to avoid emissions. Other sources of renewable energy (wind, photovoltaics, geothermal heat, etc.) will also gain in importance for the heating market as a result.

Diagram 8.5: GHG emissions avoided through use of renewables by energy source and sector in 2019



Source: In-house data from the BMWi based on UBA 08/2020

Decomposition analysis of energy-related greenhouse gas emissions with a focus on the expansion of renewable energy sources

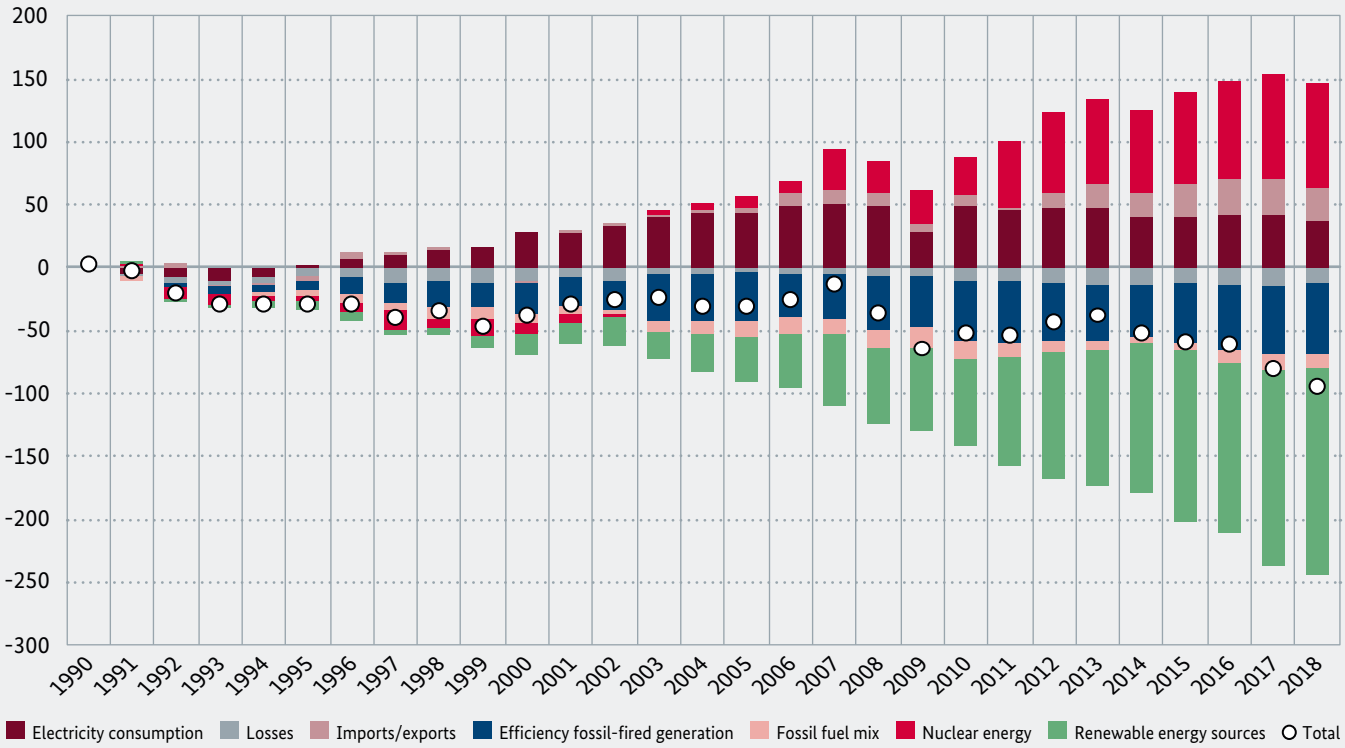
Emission trends in Germany are influenced to varying degrees by a number of different drivers, whereby the impact of a single driver can be both positive and negative. On the basis of a decomposition analysis of energy-related greenhouse gas emissions, the contributions of key drivers were examined for the electricity, heat and transport sectors (German Institute for Applied Ecology and Institute for Energy and Environmental Research Heidelberg, 2019). One of the aims of the study was to show why greenhouse gas emissions have not fallen significantly in recent years, despite the growing expansion of renewable energy sources.

Diagram 8.6 shows an example of the impact of the drivers examined in the electricity sector. The contribution of renewable energy sources to emission reductions in this sector is particularly high from 1990 to 2018, the period examined. However, emission-increasing effects (such as the increase in electricity consumption, the strong increase in exports and the nuclear phase-out) can also be seen, which means that the overall reduction in emissions in the electricity sector is significantly lower than the reduction effect achieved by using renewable energy sources.

Details of the methodology used and the results of the decomposition analysis of other sectors (space heating, industrial process and district heating, in addition to passenger road traffic and road haulage) are included in the publication published by the German Environment Agency (German Institute for Applied Ecology and Institute for Energy and Environmental Research Heidelberg, 2018).

Diagram 8.6: Decomposition analysis of CO_2 emissions from electricity since 1990

In million t CO_2



Source: UBA according to German Institute for Applied Ecology, based on AGEE-Stat and AGEB

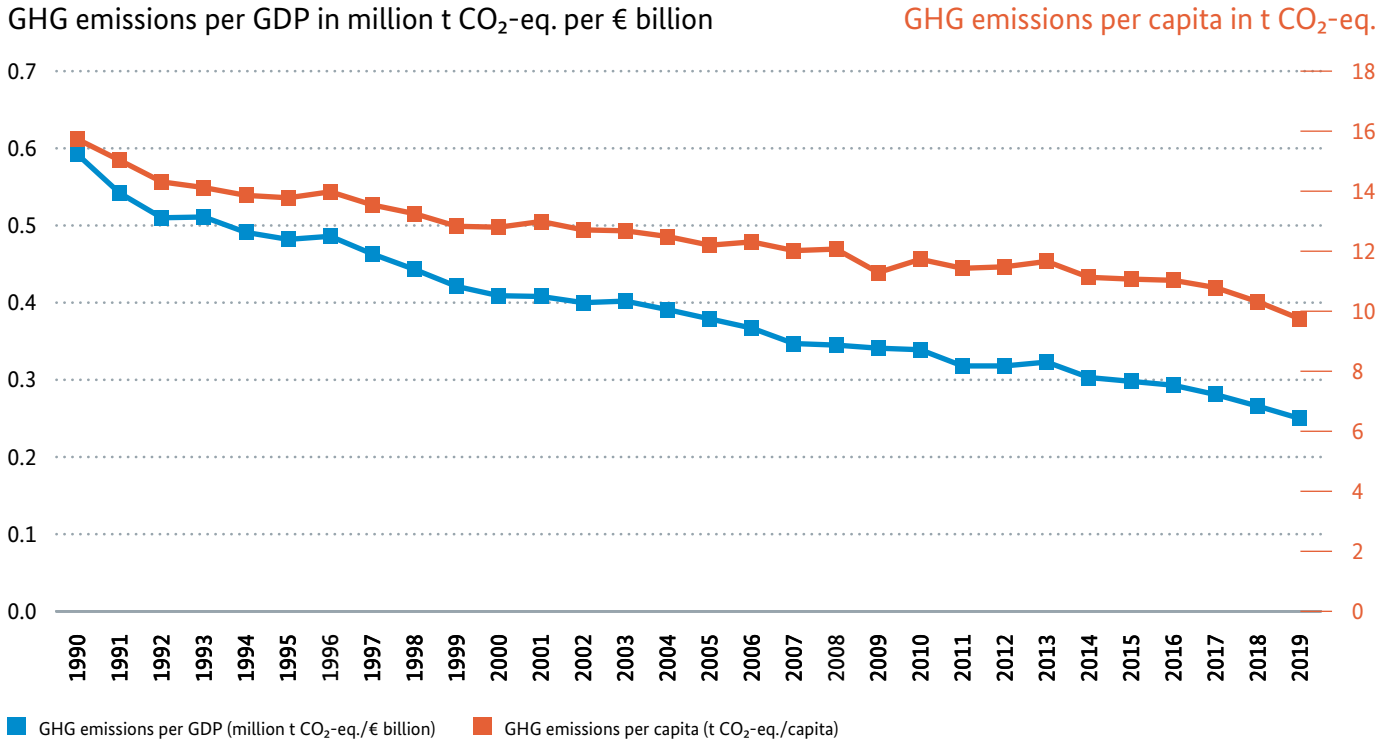
8.4 Greenhouse gas emissions and economic performance

Between 1990 and 2019, specific per capita greenhouse gas emissions went down by around 38% from some 15.7 tonnes to just under 9.8 tonnes of CO_2-equivalent (see Diagram 8.7). In the EU 28, specific per capita greenhouse gas emissions between 1990 and 2018 fell by approximately 25% from 11.7 to 8.7 tonnes of CO_2-equivalent. Whereas in Germany in 1990 around 0.59 million tonnes of CO_2-equivalent of greenhouse gases were released per billion euros of real gross domestic product, in 2019 it had dropped to just 0.25 million tonnes of CO_2-equivalent per billion euros of gross domestic product.

8.5 Key measures implemented to date

The key instrument for achieving the 40% target for 2020 is the Climate Protection 2020 action programme, a bundle of more than 110 individual measures, which was adopted by the Federal Government in December 2014. The starting point for the Climate Action Programme 2020 was a deviation to the target value of 5 to 8 percentage points that had been identified as a result of the 2013 Projection Report. The action programme is expected to make a contribution of 62 to 78 million tonnes of CO_2-equivalent to achieving the climate protection target in 2020. This total contribution is calculated on the basis of contributions made by the individual measures. In its Climate Action Report 2019, the Federal Government had

Diagram 8.7: Greenhouse gas emissions per capita and gross domestic product



Source: UBA 01/2021, Federal Statistical Office 01/2020, BMWi 03/2020

stated that the action programme would probably only achieve a reduction effect of 38 to 48 million t CO_2-equivalent by 2020. Due, among other things, to the Covid19 pandemic, the Federal Government now assumes that the projected greenhouse gas emissions for 2020 calculated at that time had probably been far too high.

The Climate Action Plan 2050, which was adopted by the Federal Government in November 2016, addresses the results of the 21st Conference of the Parties to the Framework Convention on Climate Change and is implemented as a modernisation strategy on three levels: the Climate Action Plan develops specific guiding principles for the individual action areas for the year 2050, provides leeway for innovation and strives for maximum sustainability. It describes robust transformative pathways for all action areas, highlights critical path dependencies and presents interdependencies. In particular, it underpins the interim GHG target for 2030 with sectoral targets, specific milestones and strategic measures, while taking into account impact and cost analyses.

Table 8.2: Contributions of key policy measures to achieving the 40% target

Key policy measures	Contribution to greenhouse gas emission reduction in 2020 in million tonnes of CO_2 equivalent	
	Contribution according to original estimate Status December 2014	Contribution according to current expert estimate (rounded values)
National Action Plan on Energy Efficiency (NAPE) excluding measures implemented in the transport sector	Approx. 25 to 30 (including energy efficiency buildings)	14.1 to 14.51 (including energy efficiency buildings)
Climate-friendly building and housing strategy and energy-related modernisation roadmaps for the Federal Government, Länder and municipalities	Total approx. 5.7 to 10 (including 1.5 to 4.7 in addition to NAPE)	Total 4.08 (including 1.73 in addition to NAPE)
Measures in the **transport sector**	Approx. 7 to 10	1.06 to 1.38
Reduction of non-energy related emissions in the following sectors:		
Industry, Commerce, Trade, Services	2.5 to 5.2	1.2 to 1.7
Waste management	0.5 to 2.5	0.24
Agriculture[1)]	3.6	0.68 to 2.37
Reform of emissions trading	-	3.5
Further measures, especially in the electricity sector	22	15,04 bis 19,56
Advice, education and personal initiatives for more climate protection		0.25 to 2
Total	62 to 78	37.5 to 47.96

Source: Climate Action Report 2019

1) The reduction contributions 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 used as the basis for the estimates included in the Climate Protection Report 2016.

For the period beyond 2020, the Climate Action Plan 2050 provides important orientation as a national long-term strategy for climate protection and sets specific targets for the individual emission sectors until 2030. Both the Action Programme 2020, the Climate Action Programme 2030 and the Climate Action Plan 2050 follow the guiding principle of climate protection as a social and economic modernisation strategy that is scientifically sound, technology-neutral and effective.

In response to the Covid-19 pandemic, the Federal Government adopted the Economic Stimulus and Crisis Management Package worth €130 billion in June 2020. Besides strengthening the economy, mitigating social hardship and supporting the Länder and municipalities, in addition to young people and families, the Federal Government has thus launched a package designed for the future and has strengthened climate protection through a variety of measures. These include measures designed to support public transport, electric mobility and the use of alternative drive technologies for buses and trucks. Investments in climate protection technologies are also to be promoted through the National Hydrogen Strategy and building modernisation programmes.

Transparency and participation in the field of climate protection

Climate protection can only succeed if all members of society are involved. To this end, the greatest possible transparency in communicating the climate protection policy is as essential as having the opportunity to become involved in policy-making. Accordingly, the Federal Government has involved civil society in the development, implementation and examination of its climate protection measures. The Climate Protection Action Group was set up in 2015, with up to 200 representatives of various associations meeting for a full-day session in Berlin every six months. On 15 thematic benches, they engage with each other in discussion between the plenary sessions in order to identify the pros and cons of the various arguments put forward and present them to the group. In the past, the transport, buildings, agriculture, industry, SMEs, trades and crafts, municipalities, financial sector, banks and environment benches presented position papers on how the respective associations were committed to climate protection and what demands they had of the Federal Government.

The adoption of Germany's long-term strategy, the Climate Action Plan 2050, was preceded by an extensive participatory process with associations, municipalities, Länder and members of society. Extensive participation is also planned for the update of the long-term strategy. The Länder will participate via the Conference of Environment Ministers, the Federal Government/Länder Working Group on Climate Protection and Sustainability and the Climate Protection Committee.

Acceptance of the climate protection policy

According to a representative Environmental Awareness Study conducted in 2018 (BMU/UBA 2019), 64% of the respondents consider environmental and climate protection to be very important; a significantly greater number than in the past. The majority of respondents regard it as being of paramount importance that greenhouse gas emissions are reduced quickly in the course of the energy transition. The survey also shows that the energy transition is progressing too slowly for most (81%) of the respondents.

Among other things, the increase in energy efficiency through the use of new technologies (95%), the expansion of renewable energy sources (92%), the reduction of climate-damaging subsidies (90%), the increase in the price of CO_2 emission rights (86%), government support for energy savings in residential buildings (88%), higher taxation of products that are particularly harmful to the climate (84%) and the funding of electric vehicles (79%) receive a high level of approval. Despite this excellent starting position for climate protection policy, it is still important that the interests of the members of society in the case of individual local climate protection measures are taken seriously and that social injustice is avoided. Some 74% of the respondents consider more participation in the planning and approval processes related to the energy transition to be important. Ensuring an affordable energy supply for everyone meets with the approval of 94%. Furthermore, 76% of those surveyed in 2018 think that the costs of the energy transition in Germany are not distributed evenly.

Key measures implemented to date in the area of climate protection

- Measures to achieve the 40% target (see Table 8.2)
- Federal Climate Change Act 2019
- Climate Action Plan 2050 and Climate Action Programme 2030 (see Chapter 8.2)

Part II: Targets and policies affecting the energy transition

The part of the Monitoring Report discusses additional targets and energy policy framework in which the energy transition is being implemented. It specifically focuses on the following aspects:

9. Power plants and security of supply

Where do we stand?

Germany has a secure supply of electricity. Energy demand in Germany is covered at all times, thus guaranteeing a high level of security of supply.

The installed renewable capacity continued to increase in 2018 and 2019.

The electricity market 2.0 has proven a success.

What is new?

At the end of 2019, the Philippsburg 2 nuclear power plant was shut down – another step on the way to phasing out nuclear energy in Germany.

The Niederaußem E and F, and the Jänschwalde F lignite-fired power plants were put on security standby in 2018, followed in 2019 by the Jänschwalde E and Neurath C lignite-fired power plants. The Lünen 6 and 7, and the Ensdorf 1 and 3 hard coal power plants were finally decommissioned in 2018. This subsequently led to a reduction of CO_2 emissions in the electricity sector.

On 3 July 2020, the German Bundestag and Bundesrat passed the Coal Phase-out Act. The Act on the Phase-out of Coal-fired Power Plants and the Structural Reinforcement Act for Mining Regions entered into force for the most part on 14 August 2020. Essentially, this means that the energy and structural policy recommendations of the Commission with respect to "Growth, Structural Change and Employment", will be implemented and coal-fired electricity generation will end in a socially equitable, predictable and economically viable manner. The phase-out path envisages that coal-fired power plants will be gradually taken off the grid and decommissioned with fixed target dates in 2022 (15 GW each of hard coal and lignite), 2030 (8 GW hard coal and 9 GW lignite) and 2038 (0 GW).

The amendment to the Combined Heat and Power Act, which was passed in July 2020, supports Germany's coal phase-out with various incentives for switching from coal to gas generation and for the use of renewable energy sources to generate heat.

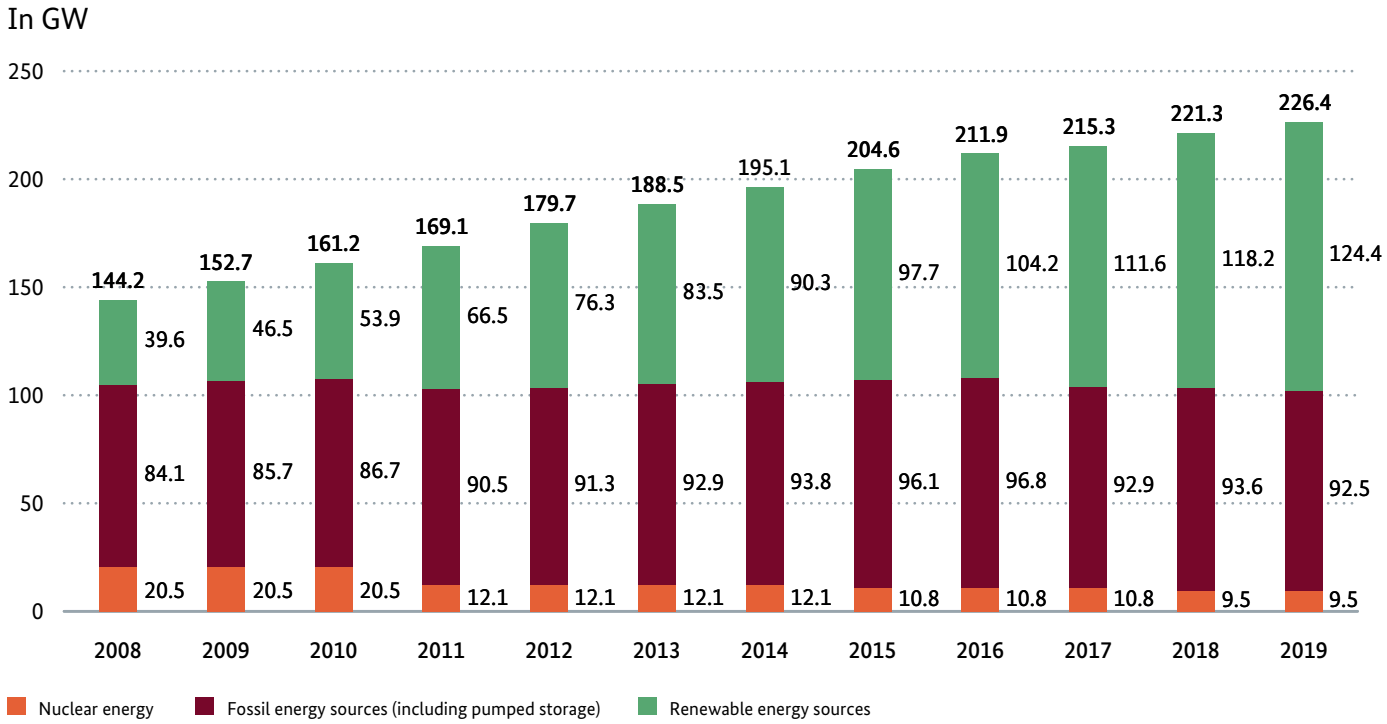
SMARD, the information platform on the electricity market, has been online since 2017. It offers up-to-date and easy-to-understand electricity market data and thus increases transparency on the electricity market. In addition, the core energy market data register has been available online since January 2019 and provides information on all electricity and gas generation systems in Germany.

SECURITY OF SUPPLY	To cover the energy demand in Germany efficiently at all times.
NUCLEAR ENERGY PHASE-OUT	To shut down the last nuclear power plants at the end of 2022.
COAL PHASE-OUT	To phase out coal-fired electricity generation in Germany by 2038 at the latest in a socially balanced, predictable and economically viable manner.

9.1 Power plants

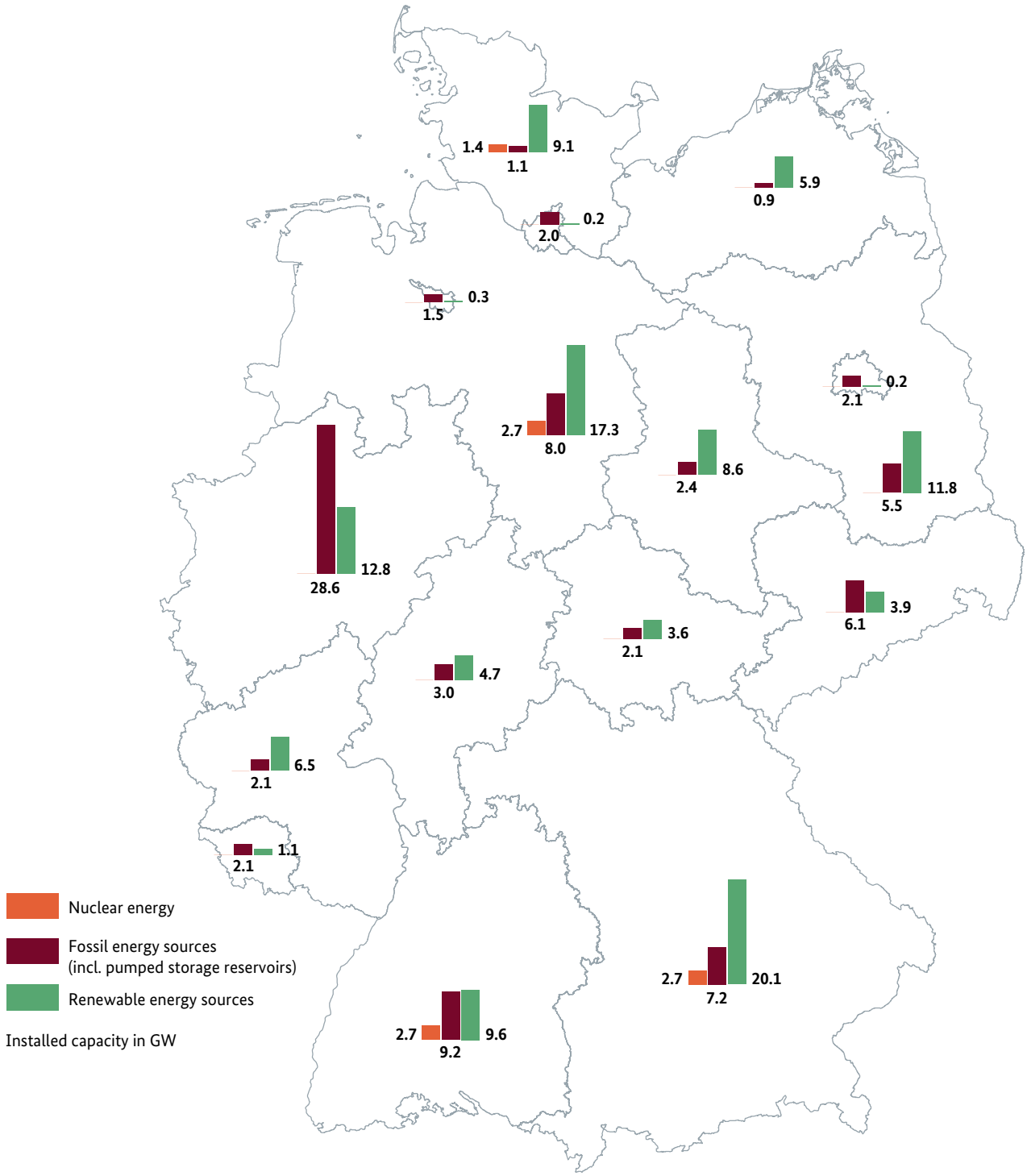
The installed renewable capacity continued to increase in 2018 and 2019. Overall, the net nominal capacity of electricity generation plants connected to the German electricity grid increased by 82.2 GW between 2008 and 2019 (see Diagram 9.1). In 2018 and 2019, the nominal capacity of renewable energy-based electricity generation plants was 118.2 GW and 124.4 GW respectively, which was 5.9% and 5.2% higher respectively than in the previous year. The highest growth was registered for solar energy (+8.6% compared with 2018), but biomass (+4.1% compared with 2018) and wind energy (+3.4% compared with 2018) also increased. The share of the nominal capacity from renewable energy sources increased to 53.4% of the total power plant capacity in 2018 and 54.9% in 2019 (see Chapter 4). Since the energy supply depends on natural conditions, especially when using wind and solar energy, and therefore the entire installed capacity cannot be called up at all times, significantly more capacity is required to generate a specific amount of electricity when using wind energy and photovoltaic plants than with the previous conventional power plant fleet. Installed capacity alone is therefore not an indicator of security of supply. The latter is discussed in Chapter 9.4.

Diagram 9.1: Installed capacity of electricity generation plants connected to the German power grid



Source: BNetzA 10/2020. Diagrams shown refer to net nominal capacity

Diagram 9.2: Distribution of power plant capacity among the German Länder in 2019



Source: BNetzA 10/2020

Renewable energy sources now dominate in ten German Länder (see Diagram 9.2). Nuclear power plants are currently still used to generate electricity in four of them. There are also foreign electricity generation plants with a net nominal capacity of 4.3 GW connected to the German electricity grid. Bavaria and Lower Saxony have the main concentration of installed renewable capacity, while North Rhine-Westphalia is the frontrunner for conventional power plants. Compared with the total installed capacity, the following Länder have the highest share of renewables: Mecklenburg-Western Pomerania (87%), Schleswig-Holstein (79%), Saxony-Anhalt (78%) and the Rhineland-Palatinate (76%). The share of conventional power plants compared with the total installed capacity is highest in the city states of Berlin (91%), Hamburg (91%) and Bremen (79%).

Combined heat and power (CHP) is an important component of the energy transition. It plays a special role in conventional electricity generation and local heat supply. By simultaneously producing electrical energy and heat (e.g. for district heating), CHP plants use fuel more efficiently than if heat and power were produced separately. According to data published by the Federal Statistical Office, for example, around 36 PJ (equivalent to 10 TWh) of natural gas was saved by using highly efficient CHP processes from January to June 2018 (StBA (2018c)). The aim of the Combined Heat and Power Act (KWKG) is to expand the use of CHP further. The CHP Act (KWKG) sets expansion targets of 110 TWh of electricity generation for 2020 and 120 TWh for 2025. In 2018, CHP electricity generation already amounted to 115.7 TWh in fact and 114.0 TWh in 2019, representing 19.0% and 19.7% of Germany's total electricity generation respectively. Heat generation increased to 228.9 TWh in 2018 and 225.8 TWh in 2019, equivalent to a share of 16.7% (2018) and 16.1% (2019) of the heat-related applications in Germany's final energy consumption. This means that the target set for 2020 had been achieved three years earlier than anticipated and had even exceeded the target.

Pumped storage power plants are a well-established and proven large-scale form of storage. In 2019, pumped storage power plants with a net nominal capacity of around 11.3 GW were connected to the German grid, including pumped storage power plants in Luxembourg and Austria. In addition, Germany can also use the much higher water reservoir capacities in Scandinavia and the Alpine region through electricity market coupling.

Energy storage as a contribution to a more flexible electricity system

In future, an ever increasing share of our electricity will come from renewable energy sources. Wind energy and photovoltaics will make up the major share (see Chapter 4). For both of these forms of energy, the feed-in fluctuates according to the weather conditions and the time of day. An electricity system of the future will have to take this into account, which means that the electricity system will have to become more flexible. Together with other flexibility options, such as the European single market, sector coupling, flexible consumers and generators, storage facilities can contribute to the security of supply when renewables make up a high share of electricity generation. They can help to decouple generation and consumption and can also provide balancing capacity to keep the grid frequency stable.

In the short and medium term, the energy transition will not depend on the expansion of

electricity storage systems. Flexible consumers and peak load power plants – also in combination with innovative business models and digitisation (see Chapter 13) – can balance out fluctuations between electricity supply and demand even with very high shares of renewable energy sources. In addition, storage facilities to date have been more expensive than other flexibility options. However, in order to meet the foreseeable medium to long-term demand for storage, the Federal Government is already promoting the further development of technologies to unlock cost-cutting potential, among other things, as part of the 7th Energy Research Programme (see Chapter 14).

Relevant storage technologies include battery storage systems, pumped storage, compressed air storage and power-to-X products. Power-to-X products use RES-based electricity to generate heat, hydrogen or methane, among other things, which can then either be used directly or converted back into electricity. Power-to-heat technologies operated in tandem with CHP plants can double the flexibility. Power-to-gas offers the advantage of being able to store energy over a long period of time and in large quantities. Furthermore, taking a long-term view, the existing infrastructure – the gas grid and underground gas storage facilities – could also be used. In the case of options of this kind, however, it should not be forgotten that any energy conversion also involves losses. For this reason, the focus should always be on a storage system that is as efficient as possible.

Under the Energy Industry Act (EnWG) or the Renewable Energy Sources Act (EEG), electricity storage systems, among other things, have the status of a final consumer with regard to offtake and in principle, therefore, are subject to the corresponding payment obligations. In reality, however, the situation is such that many storage facilities are exempt from most of these obligations if they feed the stored electricity back into the public grid. As a basic principle in the Electricity Market 2.0, competition should determine how individual flexibility options are used, with the decisive factors being efficiency and cost-effectiveness.

In the course of the last few years, the primary control reserve market has increasingly become the focus of attention for large-scale battery storage. By the end of 2019, according to (preliminary) industry data, a total capacity of 453 MW were installed in Germany. This is equivalent to around two-thirds of the current demand for primary control power in Germany.

9.2 Security of supply

The energy transition and the parallel phase-out of nuclear energy and coal-fired power generation present Germany with a major challenge. The switch to renewable energy sources means, on the one hand, that wind energy from the north must be transported to the centres of consumption in the south. This urgently requires the optimisation and higher utilisation and, above all, the rapid expansion of the electricity grids (see Chapter 12). On the other hand, the demand for electricity must also be met when wind and solar installations are unable to supply electricity due to the weather conditions. This can be achieved, among other things, through European electricity market integration, through storage facilities, through more flexibility on the demand side or through gas-fired power plants that can respond flexibly to volatile electricity generation.

Germany is one of the countries with the lowest power supply outages worldwide. This is also being achieved with an increasing share of renewable energy sources. A reliable supply of electricity is important for Germany's commercial and industrial sectors as it is for every member of society. In managing the energy transition, the BMWi attaches great importance to ensuring that the highest possible security of supply will also be maintained in the future.

Germany is fully integrated into the European electricity supply system. The electricity grids in Europe are interconnected. Cross-border electricity trading is leading to more efficient and cost-effective use of the European power plant fleet and is also making it possible to use large-scale balancing effects to compensate for the fluctuating generation of electricity based on wind and solar energy sources. Just as it would be far too expensive and complicated for every household in the country to cover its own electricity demand every single hour of the day and night, this is precisely what takes place in Germany as a whole. For this reason, Germany exchanges electricity with its neighbouring countries, so that in the end all domestic electricity customers are able to cover their consumption requirements more cost-effectively and more reliably.

There are still considerable overcapacities in the German and European electricity system. For investors, this means there is little point in investing in a new power plant. Prices on the electricity market, however, are now beginning to change. Gas-fired power plants that were taken out of operation are producing electricity again and offering their electricity on the market. It is interesting to note that market players are quick to react to generation capacity shortages.

By generating electricity and heat simultaneously, CHP plants contribute to a highly efficient energy supply. To the extent that new generation capacities become necessary with the phase-out of nuclear energy and coal-fired power generation, the expansion of CHP systems to meet the needs of the energy transition, in other words flexible and increasingly low-carbon gas-fired CHP plants, is the answer.

The Federal Government, however, is not relying solely on European electricity trading, market forces and the funding of CHP systems. It has taken the precaution of putting in place an additional threefold safeguard. Firstly, electricity traders are required to fulfil their supply obligations at all times. If they do not meet their obligations and their behaviour leads to deviations that affect system balancing, the electricity traders will incur high costs by being forced to purchase so-called balancing energy from the transmission system operators. Secondly, the security of supply is continuously assessed by continuous monitoring, and thirdly, different reserves are maintained for unforeseeable events.

Security of supply in Germany is guaranteed at a high level. To this end, the BMWi conducts continuous monitoring of security of supply (BMWi (2019c)). Monitoring also includes a detailed examination of how the electricity market and the available power plants will develop in the coming years (r2b energy consulting, Consentec, Fraunhofer-ISI, TEP Energy (2019)).

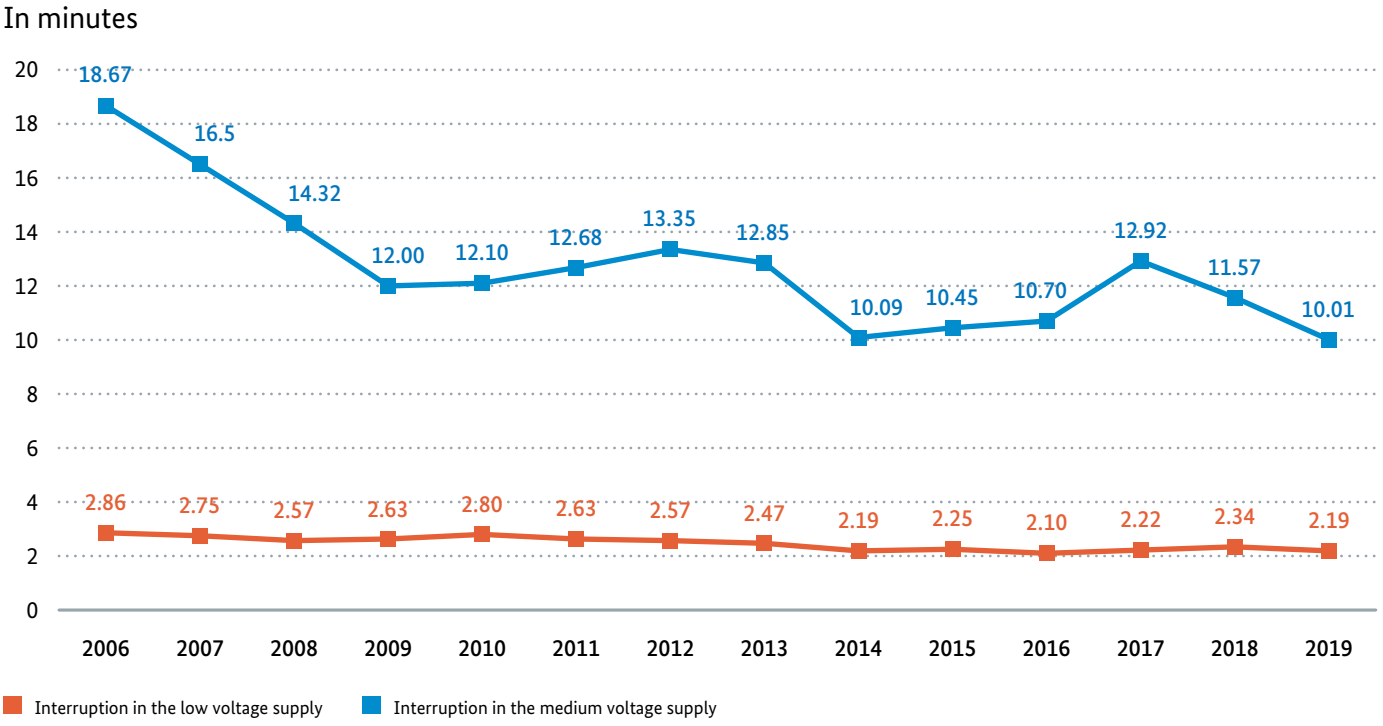
Monitoring also includes all foreseeable events and developments. For example, different weather conditions are taken into account, including the so-called cold, dark doldrums, when wind energy and solar energy hardly contribute to electricity generation for a longer period of time. The gradual

reduction of coal-fired power generation has also been included. In all the scenarios examined, Germany is able to meet the demand for electricity at all times.

Security of supply is also guaranteed in the electricity grids. A prerequisite for supplying consumers is the reliable availability of adequate transmission and distribution system capacities. However, in order to ensure the stability of the grids at the transmission level, despite stagnating grid expansion, grid operators must increasingly resort to system stability measures (see Chapter 12).

The duration of supply interruptions at distribution network level has been at a consistently low level for years – even when compared with levels in other countries. The Federal Network Agency prepares the System Average Interruption Duration Index (SAIDI), which it publishes every year. It indicates the average supply interruption duration per connected end consumer at the distribution system level. All unplanned interruptions lasting longer than three minutes are included in the SAIDI calculations. In 2018, the index was 13.91 minutes and in 2019, 12.20 minutes, respectively, below the respective values of the previous year and also reached a low in 2019. Since 2006, the SAIDI has fallen by more than 40%. The improvement in the SAIDI in 2018 compared with the previous year is also related to the fact that there was less impact due to weather events. The energy transition and the increasing share of decentralised generation capacity continue to have no negative impact on the quality of supply. When compared with other countries, Germany continues to be one of the leaders in terms of security of supply.

Diagram 9.3: Development of the SAIDI



Source: BNetzA 10/2020

The monitoring of security of supply will be intensified and further developed as a result of the Coal Phase-out Act, allowing new challenges to be identified at an early stage. Among other things, the overall methodology for monitoring the security of supply has been expanded and the sub-areas have been more closely interlinked in order to adequately reflect the special challenges of the coal phase-out. The Coal Phase-out Act stipulates that the monitoring of security of supply will become the responsibility of the Federal Network Agency as of 1 January 2021 and further developed. To this end, the Federal Network Agency will carry out analyses of its own on a continuous basis and for the first time publish a report on the monitoring of security of supply with regard to the market and grids by 31 October 2021. This will result in an integrated monitoring of security of supply in all areas relevant to security of supply (cross-cutting, comprehensive examination, in addition to differentiated, coordinated analyses). The monitoring of security of supply will be continuously reviewed and further developed. In this respect, the BMWi – together with countries of the so-called Pentalateral Energy Forum – is committed to intensifying monitoring at the level of the European Union. This includes the further development of the content and improvement of the methodological framework and, for example, the joint exchange of views as to what extent each EU Member State can contribute to joint security of supply.

Reserves are available on a large scale to provide additional security of supply. In order to take into account the increasing importance of security of supply in an appropriate manner, a safety net consisting of various reserves is now available for unexpected and unlikely events and developments. These include the capacity reserve at currently 1 GW, the security reserve at 2.7 GW, the grid reserve at 6.6 GW, in addition to special grid-connected resources amounting to 1.2 GW, which are to become operational by October 2022. This is particularly important because market players will not hedge against completely unforeseeable events. In the event that bottlenecks are nevertheless predicted during the monitoring process, the reserves can be increased in good time.

The Federal Government continuously examines all aspects of security of supply on a forward-looking basis in order to identify and implement whatever measures become necessary at an early stage. If measures are identified as being necessary to supervise the phase-out of nuclear energy and coal, for example, they will be implemented without delay.

Supply of natural gas

With an annual consumption of around 95 billion cubic metres, Germany is one of the largest sales markets for natural gas in the European Union and at the same time a key gas transit country. Germany imports approximately 90% of its annual consumption primarily from Russia, Norway and the Netherlands. As an interim technology when transferring from fossil fuels to renewable energy sources in the electricity sector, in particular, natural gas – used in CHP plants, for example – can play an important role. Natural gas can also offer benefits in the mobility sector compared with conventional liquid fuels. Overall, when compared with other fossil fuels, natural gas can be more climate-friendly, as the combustion of natural gas results in lower CO_2 emissions. Compared with electricity, natural gas can be stored in large quantities. With an effective natural gas storage volume of over 24 billion cubic metres, Germany has the largest storage capacity available in the EU. The optimisation, upgrading and expansion of the national natural gas infrastructure in line with

market needs are guaranteed by the Gas Network Development Plan (NEP Gas) of the gas transmission system operators, as specified in Section 15a of the Energy Industry Act (EnWG). The NEP Gas is a key component towards maintaining security of supply and the currently binding NEP Gas 2018–2028 provides for the construction of 1,364 kilometres of new pipelines and additional compressor capacity of 499 MW by 2028. The investment volume for the project amounts to some €7 billion.

In short, the extensive natural gas network, large storage volume, liquid trading markets and the diversified portfolio of supplier countries and import infrastructures ensure that German gas consumers enjoy a very high level of security of supply. This is supplemented by the excellent technical condition of the natural gas infrastructure, which is reflected in the SAIDI gas (System Average Interruption Duration Index), which reported a value of 0.98 in 2019 and was thus below the long-term average of 1.5 minutes. More detailed information on the supply of natural gas in Germany is included in the BMWi reports on Natural Gas Supply Security (BMWi (2020d)) and in the 2019 Monitoring Report published by the Federal Network Agency and the Federal Cartel Office on developments in the German electricity and gas markets (BNetzA, BKartA (2020)).

With the amendment to the Gas Network Access Ordinance (GasNZV), which entered into force in August 2017, the gas network access system was optimised and modified to take into account the challenges facing the energy industry, which have changed in recent years.

The amended Regulation on measures to safeguard the security of gas supply (EU) 2017/1938 extends the range of measures to ensure uninterrupted gas supply across the EU. The guiding principles of the Regulation include regional cooperation regarding crisis preparedness and mutual support and solidarity among Member States in dealing with gas supply crises. Member States are to include regional chapters in their risk analyses, preventive action and emergency plans and work on cross-border agreements on supportive gas deliveries in the event of a supply shortfall that the affected Member State cannot remedy through market-based measures.

An important component of the diversification of energy supply is the direct import of foreign liquefied natural gas (LNG) from a variety of different supply sources, via both the European and the German LNG infrastructure. On 13 June 2019, the regulation to improve the regulatory framework conditions for the development of LNG infrastructure in Germany entered into force. One obstacle was the connection of LNG facilities to the transmission network. Under the previous legal framework, plant operators had to build and pay for this grid connection themselves. In future, the transmission system operators will be required to build the pipelines between German LNG terminals and the transmission system. In order to ensure that pipelines are only built if and when LNG facilities are constructed, the transmission system operators and the LNG facility operators will have to coordinate their planning and construction progress closely. Furthermore, the LNG plant operator will be expected to pay 10% of the costs. The transmission system operator will be able to refinance 90% immediately via the gas network fees and pass this on to the grid users.

The first report of findings from the Gas 2030 dialogue process launched by the BMWi was published in October 2019 (BMWi (2019d)).

9.3 Nuclear energy phase-out

The shutdown of the Philippsburg 2 nuclear power plant at the end of 2019 was a further step towards the phasing out of nuclear energy. The remaining six nuclear power plants with a net nominal capacity of 8.1 GW will be phased out by the end of 2022 at the latest (see Table 9.1).

Table 9.1: Roadmap for phasing out the use of nuclear energy for electricity generation

Name	Shutdown by the end of	Net nominal power (MW)
Grohnde Gundremmingen C Brokdorf	2021	1,360 1,288 1,410
Isar 2 Emsland Neckarwestheim 2	2022	1,410 1,336 1,310
Total		**8,114**

Source: BNetzA

The funds to finance the long-term costs of nuclear waste management are available – this solves one of the key challenges associated with the nuclear phase-out. On 3 July 2017, the operators of the German nuclear power plants paid a total of around €24.1 billion into the accounts of the German Nuclear Waste Management Fund (KENFO) at the Deutsche Bundesbank, thus ending their liability for nuclear waste management costs relating to interim and final storage. The responsibility for the implementation and financing of interim and final storage was transferred to the Federal Government upon receipt of the full payments by the fund. The operating companies will remain fully responsible for the decommissioning and dismantling of the nuclear power plants, for ensuring that the radioactive waste is package correctly and for the financing required to complete the work involved. Placing the responsibility for the management and financing of all activities in each case in the hands of one entity is regulated in the Act on Reorganising Responsibility for Nuclear Waste Management, which entered into force in June 2017. KENFO will invest the paid-in funds in long-term investments to secure the financing of the costs for interim and final storage over a long period of time.

With the amendment to the Repository Site Selection Act in 2017, the criteria were defined for the search to find a repository site for high-level radioactive waste. The site selection is carried out in a staged, transparent, open-ended and science-based procedure. The recommendations of the Commission on the Storage of High-Level Radioactive Waste will be implemented and all three host rocks considered in Germany will be taken into account. Final disposal is to take place in deep geological formations with the option of reversibility as well as retrievability and recoverability of the waste. The selection criteria will be applied in a three-stage selection procedure to determine the site with the best possible safety for a period of one million years. The public is to be involved in all stages (Commission on the Storage of High-Level Radioactive Waste (2016)).

9.4 Coal phase-out

On 29 January 2020, the Federal Government for the phase-out of coal-fired power generation submitted a draft bill to the legislature for the Act to Reduce and End Coal-Powered Energy and Amend Other Laws (Coal Phase-out Act). The Act was passed by the Bundestag and Bundesrat on 3 July 2020 and entered into force for the most part on 14 August 2020. The legislative package will end coal-fired power generation in Germany in a socially balanced, predictable and economically

viable way. At the same time, it creates prospects for a secure and affordable electricity supply based on highly efficient gas-fired power plants that will make the transition to a greenhouse gas-neutral energy supply possible.

The Coal Phase-out Act essentially implements the energy policy recommendations of the Commission "Growth, Structural Change and Employment" (KWSB) (Commission on Growth, Structural Change and Employment (2019)). At the same time as the Coal Exit Act, the legislature also passed the Coal Regions Structural Strengthening Act, which by and large implements the Commission's structural policy recommendations. The Coal Phase-out Act contains provisions on the phase-out of hard coal and lignite-based electricity generation, amendments to the Combined Heat and Power Act and the Energy Industry Act, in addition to other regulations. The Coal Phase-out Act stipulates that coal-fired power plant capacity will be reduced from more than 40 gigawatts (GW) in 2019 to 30 GW – 15 GW for hard coal and lignite by the end of 2022. Between 2023 and 2030, more power plants will gradually be taken off the market. Ultimately, the aim is to have a total of only 17 GW of coal-fired power plant capacity – 9 GW lignite and 8 GW hard coal – on the market by 2030. The last coal-fired power plant in Germany will be taken off the grid in 2038 at the latest. In 2026, 2029 and 2032, the situation will be examined to determine whether it will be possible to bring forward all power plant closures planned for the period beyond 2030 by up to three years and subsequently bring forward the final date for complete phase-out to 2035.

The Coal Phase-out Act stipulates a variety of different instruments to reduce power plant capacity for hard coal and lignite. The reduction of hard coal-fired power generation is to be initially carried out through auctions and then through legislation to ensure a predictable and cost-efficient phase-out schedule. From 2020 to 2026, auctions are to be initially be held for hard coal plants and small lignite plants. The maximum price in the auctions will drop from €165,000/MW (2020) to €89,000/MW (2026). The auctions for decommissioning will be accompanied by regulations as of 2024 and replaced completely by decommissioning carried out through regulatory action with no compensation paid as of 2027. Decommissioning through regulatory action will take place by reverse age order; extensively modernised power plants will move backwards in the age ranking. Small plants with up to 150 MW output (often industrial power plants) will be decommissioned through regulatory action in 2030 at the earliest. The regulations on hard coal were approved under state aid law on 25 November 2020.

The reduction of lignite-based electricity generation is to be achieved through legislation, accompanied by a public-law contract, which the Federal Government negotiated with the operators and which requires the approval of the Bundestag before it can be concluded. The public law agreement is published on the BMWi website. The reduction of lignite-based electricity generation will be carried out in a binding, reliable and predictable manner by means of a clearly defined decommissioning path. The statutory regulations on compensation to be paid for the decommissioning of lignite-fired plants as well as the public law contract still require the conclusion of the state aid investigation; in all likelihood, the European Commission will open a so-called formal investigation procedure for this purpose.

To ensure that the coal measure also has a positive effect at European level, the Coal Phase-out Act includes a provision that makes it possible to

delete CO_2 certificates that have become available. In addition, the extension and further development of the Combined Heat and Power Act (KWKG) will provide power plant operators with incentives to convert from coal-fired electricity generation to flexible and more climate-friendly methods. By the same token, the Act also contains regulations on possible compensation for business enterprises with high electricity costs in the event of an increase in electricity prices due to the coal phase-out and on the payment of an adjustment allowance to older employees in the coal sector to ease their transition into retirement. The Structural Strengthening Act at the same time supports coal regions with up to €40 billion as compensation for the loss of jobs in the coal sector by investing in new, innovative business models.

9.5 Key measures implemented to date

The electricity market 2.0 is making the further expansion of renewable energy sources possible. The central guiding principle is and will remain the energy policy triad of security of supply, environmental compatibility and affordability. In 2016, the Electricity Market Act laid down the way ahead for competition between flexible generation, flexible demand and storage. In addition, electricity traders are being held accountable: anyone who sells electricity to customers must procure an identical quantity that will be simultaneously fed into the grid by the suppliers. In this way, the supply remains secure. Free price formation on the wholesale electricity market ensures there is adequate investment in the generating capacities required.

The amendment to the Electricity Network Access Ordinance, which entered into force in 2017, ensures that transmission system operators will in future not be able to unilaterally split Germany up into several electricity bidding zones. Germany operates as a single electricity bidding zone. This ensures that the conditions for grid access, electricity generation and electricity procurement remain the same throughout Germany. In a single electricity bidding zone, energy is traded with no regard for grid restrictions.

By October 2019, 13% of lignite capacity had been put on security standby. The Electricity Market Act provides for the gradual decommissioning of lignite-fired power plants with a net nominal capacity of 2.7 GW. Prior to final decommissioning, the power plants will initially be put on security standby for a period of four years, which will enable them to be used as a final backup system. Pursuant to Section 13g (8) Energy Industry Act (EnWG), the BMWi, in agreement with the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, submitted its report on the evaluation of the lignite security standby. The evaluation shows that using security standby as a strategic instrument is expected to avoid substantial CO_2 emissions by 2020. Total amount of emissions avoided as a result extends from 11.8 million tonnes of CO_2 to 15.0 million tonnes of CO_2.

Since October 2020, a capacity reserve has provided additional security for the electricity supply. This is regulated by the Omnibus Energy Act (EnSaG), which entered into force in December 2018, and the Capacity Reserve Ordinance (KapResV) of February 2019. The capacity reserve currently has a capacity of 1 GW available from power plants, storage facilities or controllable loads, which the transmission system operators keep in readiness for exceptional situations. The capacity reserve is only used outside the market in fact and only in the event that supply and demand are not covered, despite free price formation on

the electricity market. Facilities that are included in the capacity reserve cannot participate in the electricity market, to ensure there is no distortion of competition or price formation. The contract period in the capacity reserve is set at two years in each case. The transmission system operators have concluded contracts with the plants on the basis of an open auction, commencing on 1 October 2020. The capacity reserve has been initially approved under state aid law until 2025.

The aim of the amendment to the Combined Heat and Power Act (KWKG) that was passed by the Bundestag and Bundesrat in July 2020 is to expand the capacity of flexible, gas-fired CHP plants and to fund the use of renewable energy sources in the heating sector. The CHP Act (KWKG) provides incentives for investment in highly efficient, flexible and low-carbon power plants. By replacing coal with natural gas and building new CHP plants, an additional 4 million tonnes of CO_2 are expected to be saved in the electricity sector by 2020, as stipulated in the Climate Action Programme 2020. Since 2017, funding for new and modernised CHP plants with an electrical output of between 1 and 50 MW has been awarded by auction. The auction regulation entered into force in August 2017. In addition to CHP plants, funding for innovative CHP systems has also been auctioned in a new funding category since June 2018. Such systems combine particularly flexible CHP plants with renewable heat and electricity-based flexible heat generators, such as solar thermal systems or heat pumps. New, modernised and retrofitted CHP systems with an electrical output of up to 1 MW or over 50 MW will continue to receive funding rates set by law. In November 2018, the CHP Act (KWKG) was extended by a further three years until 2025 as part of the Omnibus Energy Act (EnSaG). This is intended to improve the basis for investment in new CHP plants. The amendment to the CHP Act (KWKG) of July 2020 supports even more funding for the flexible use of CHP plants and the integration of renewable energy sources in heat generation.

Since 2017, the Federal Network Agency's SMARD information platform has boosted transparency in the electricity market. The website at www.smard.de is available to anyone interested in the subject, and experts from the energy sector, business enterprises and the scientific community can access the central electricity market data (generation, consumption, wholesale prices, import and export as well as data on balancing energy) for Germany and, in some cases, for Europe for different periods (including in particular near real time) and have the data displayed in the form of visuals. SMARD is designed to make it easy for users to access information and contributes to a fact-based discussion about the energy transition and the electricity market.

The Core Energy Market Data Register (MaStR) also provides more transparency on the electricity and gas market. It has been available since 31 January 2019 and presents the master data of all grid-based energy supply facilities in the electricity and gas market in Germany and of their operators in the form of a uniform online database (www.marktstammdatenregister.de). By November 2020, some 1.7 million generation plants had been registered. According to a projection, about 500,000 registrations had still not been received by the end of the transitional period for report-

ing existing installations on 31 January 2021. The MaStR web service is intended to simplify and reduce reporting obligations and make data available with easier access and in better quality. MaStR data will also be used for SMARD. In 2020, key features of the register were introduced; for example, the possibility of registering a change of operator.

Key measures implemented to date in the field of power plants and security of supply

- Electricity Market Act
- Amendment to the Electricity Network Access Ordinance (StromNZV)
- Security standby
- Omnibus Energy Act (EnSaG)
- Capacity Reserve Ordinance (KapResV)
- Amendment to the Combined Heat and Power Act (KWKG)
- Amendment to the Regulation concerning measures to safeguard the security of gas supply (EU) 2017/1938
- Ordinance to improve the regulatory framework for the construction of LNG infrastructure in Germany
- Act reorganising responsibility for nuclear waste management
- Act amending the Act governing the search and selection of a site for a repository for heat-generating radioactive waste and other acts
- Act to reduce and end coal-powered energy and amend other laws (Coal Phase-out Act)
- SMARD – Electricity Market Data
- Core Energy Market Data Register (MaStR)

10. Affordable energy and fair competition

Where do we stand?

Final consumers spent slightly more overall on final energy in both 2018 and 2019 than in the previous year. This was attributable in part to the increase in prices, e.g. in 2018 on the international commodity markets and in both years for electricity. In terms of economic output, however, the share of energy expenditure declined in both years.

Expenditure on electricity as a percentage of GDP increased slightly in 2018; since 2010, however, only the 2017 figure has been lower than the 2018 figure.

The average electricity price for household customers remained almost constant in 2018 and rose slightly in 2019, despite falling grid fees and the EEG surcharge. This was due to higher prices for energy procurement and sales.

For industrial customers not covered by relief schemes, electricity prices increased by 2.7% in 2018. In 2019, there was a further increase of 4.4%.

Some of the relief schemes, particularly for electro-intensive companies that face strong international competition, under certain conditions may result in them qualifying for reduced payments to enable them to maintain their competitiveness.

The Grid Charge Modernisation Act (NEMoG), which entered into force in July 2017, regulates the gradual, nationwide standardisation of transmission system fees until 2023 and the abolition of the privilege of avoided grid fees as of 2018 (see Chapter 12).

As a result of changing over the award of EEG funding to competitive auctions, it was possible to achieve overall cost reductions for the further expansion of renewables. The slump in new onshore wind projects, however, has recently led to the bids in the auctions being aligned to the maximum price set by law.

Sustainable Development Goal (SDG) 7 of the United Nations 2030 Agenda, among other things, addresses universal, affordable and reliable access to modern energy services. This is also an important concern of the German Sustainability Strategy.

What is new?

In mid-July 2020, the amendment to the Renewable Energy Sources Ordinance was adopted by the Federal Cabinet with the approval of the Bundestag. Revenue from national carbon pricing and subsidies from the Economic Stimulus and Future Technologies Package will reduce the EEG surcharge to 6.5 ct/kWh in 2021 and to 6.0 ct/kWh in 2022 (see Chapter 4).

Refinancing this reduction of the electricity price is carried out using some of the revenues from the newly introduced national carbon pricing system for the heating and transport sectors, where there will be a subsequent tendency for consumer prices to increase in the next few years. This is intended as an incentive for consumers to do more to protect the climate and save fossil fuels.

AFFORDABILITY COMPETITIVENESS	To maintain the affordability of energy and to ensure Germany's competitiveness.

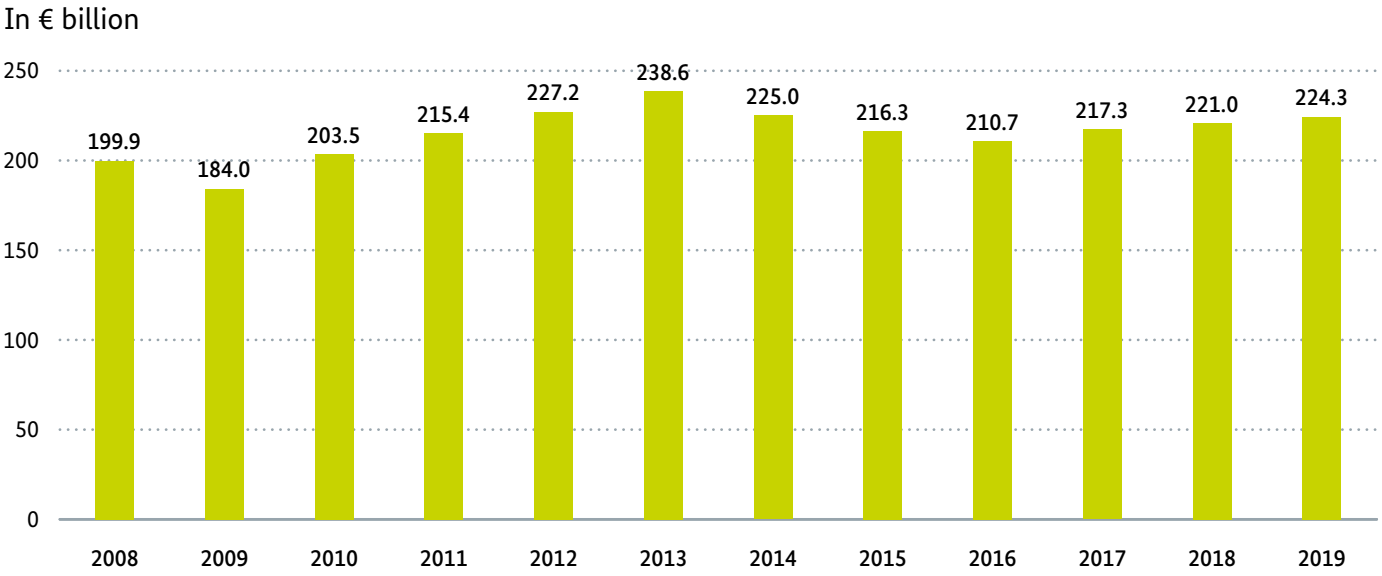
10.1 Final consumer expenditure for energy

Final consumer expenditure for final energy consumption increased from €217 billion to €221 billion in 2018 and again in 2019 to €224 billion. This can be seen from calculations based on the energy balance. If one looks at the development over a longer period of time, however, in addition to increases, there were also frequent decreases (see Diagram 10.1).

A macroeconomic view of energy expenditure provides information on the affordability of energy in general. To this end, the aggregate expenditure across all final consumers is considered. In addition, a comparison of the development of expenditure and the development of economic output provides an indication of the viability of energy expenditure for the national economy.

This means that final consumer expenditure for final energy consumption in relation to economic output was down slightly in both 2018 and 2019. The reason for this is that, in addition to energy expenditure, nominal gross domestic product also increased in 2018 and 2019 to an extent that more than compensated for the increase in energy consumption. The current share of final energy consumption expenditure in gross domestic product of 6.5% in 2019 is actually the lowest value since 2002.

Diagram 10.1: Final consumer expenditure for final energy consumption

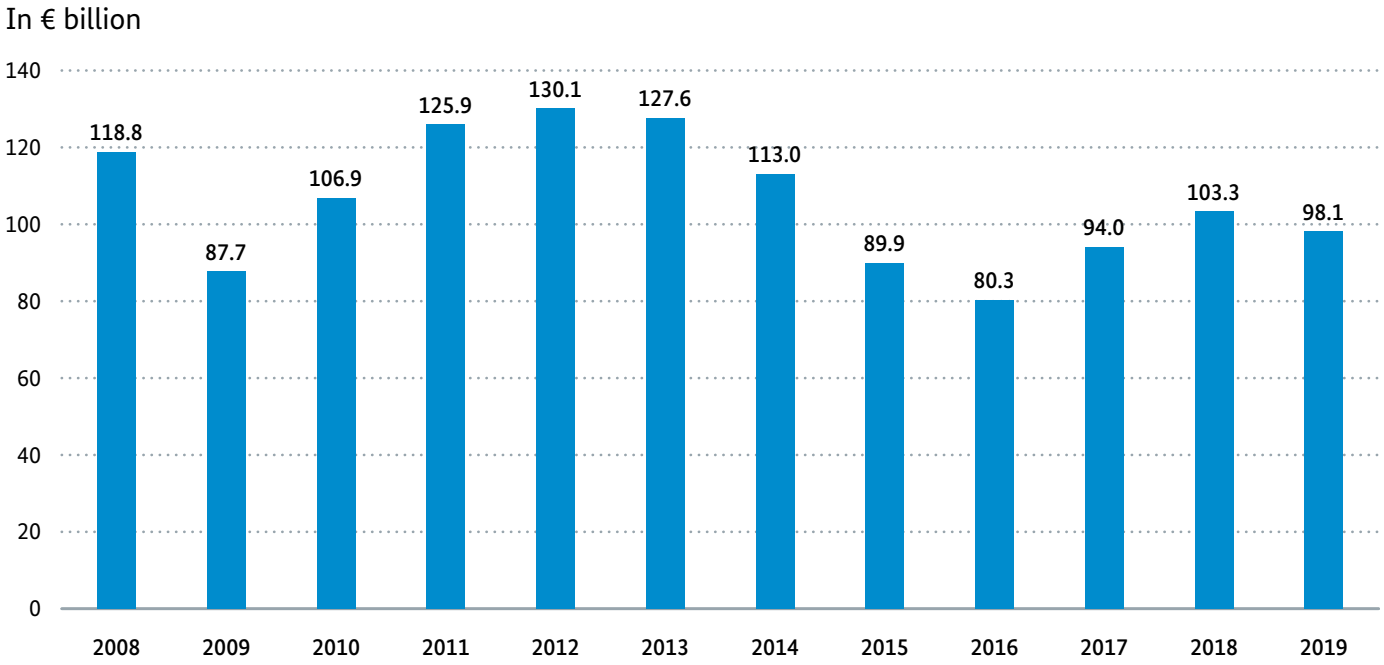


Source: In-house data from the BMWi based on AGEB and BAFA 09/2020

Macroeconomic expenditure on primary energy

Another influence on final consumer expenditure on energy is the expenditure for the generation of primary energy, which increased in 2018 once again compared with the previous year, in this case by 9.7% to a good €103 billion. In a ten-year comparison, however, it remains at a medium level (see Diagram 10.2). The increase in 2018 was primarily due to the enormous rise in import prices for fossil raw materials, while energy demand declined slightly. Energy costs subsequently increased from around €56.9 billion in 2016 to around €67.6 billion in 2018 due to the consumption of imported fossil primary energy sources. As import prices fell significantly, however, in 2019, this trend did not continue, despite the rise in import volumes (especially for gas) again. Overall, energy costs for the consumption of imported fossil-based primary energy sources amounted to around €65.2 billion in 2019. Correspondingly, final consumer expenditure for the provision of primary energy fell to €98.1 billion, which was only slightly above the level in 2017 and significantly below the average level of the last ten years at €106.9 billion.

Diagram 10.2: Macroeconomic expenditure for the provision of primary energy



Source: In-house data from the BMWi based on AGEB and BAFA 09/2020

Final consumer expenditure on electricity was up 5.5% in 2018 compared with the previous year, and only 2.2% in 2019, increasing from €79.2 billion to €81 billion (see Table 10.1). The increases were driven primarily by market-driven expenditure, specifically generation and distribution costs. In contrast, expenditure for government sponsored price components were down overall in both years, including the EEG surcharge in particular. Total grid fees were down in 2018 and were up again slightly in 2019. In terms of economic output, the share of expenditure on electricity increased slightly from 2.3 to 2.4% in 2018 and remained constant in 2019 (see Diagram 10.3). By comparison with the years since 2010, it thus remained below average – only the share in 2017 was lower.

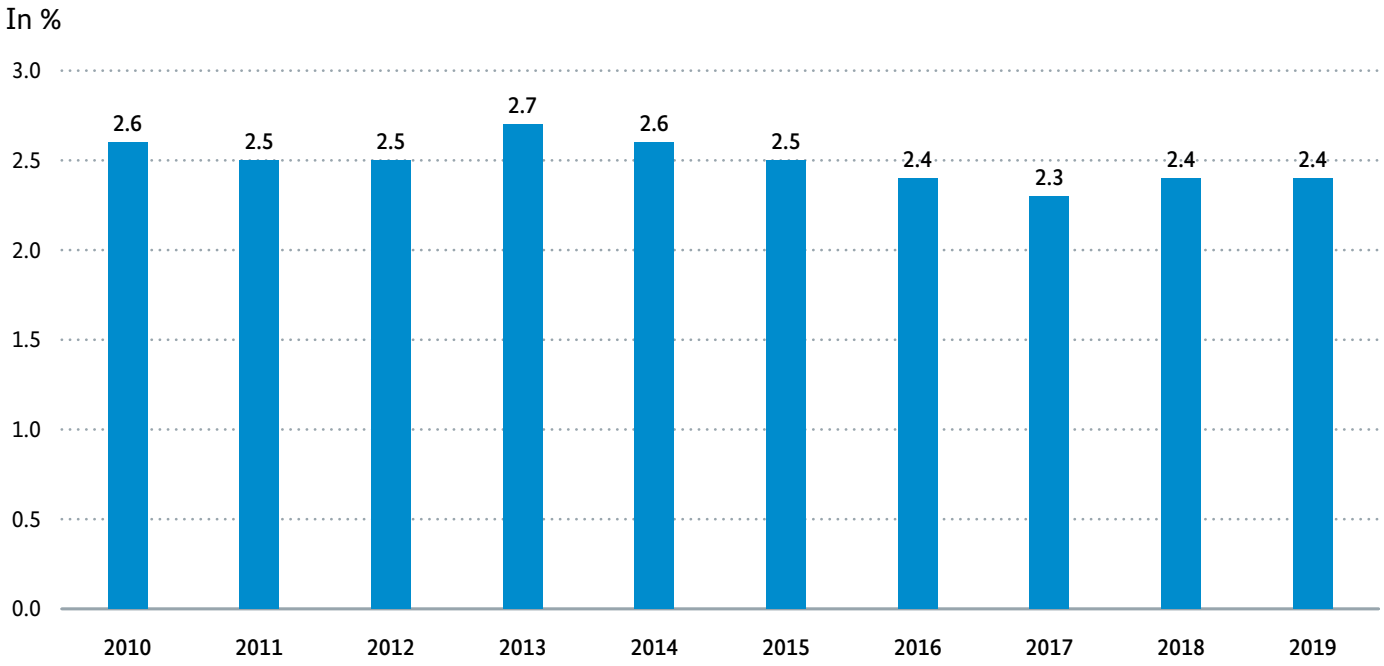
Table 10.1: Final consumer expenditure on electricity

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019*
Total expenditure (in € billion)	**65.6**	**68.6**	**69.5**	**76.6**	**76.0**	**75.3**	**74.2**	**75.1**	**79.2**	**81.0**
Government sponsored price components	**21.9**	**27.9**	**28.5**	**35.6**	**37.9**	**37.1**	**38.5**	**40.6**	**40.3**	**39.8**
Including:										
VAT	4.7	4.9	5.1	5.6	5.7	5.8	5.7	6.0	5.9	6.1
Electricity tax	6.4	7.2	7.0	7.0	6.6	6.6	6.6	6.9	6.9	6.7
Franchise tax	2.1	2.2	2.1	2.1	2.0	2.1	2.0	2.0	2.0	2.0
EEG surcharge	8.3	13.4	14.0	19.8	22.3	22.0	22.7	24.4	24.2	22.5
Cost apportionment under the CHP Act	0.4	0.2	0.3	0.4	0.5	0.6	1.3	1.3	1.1	1.0
Offshore liability surcharge and surcharge for interruptible loads	-	-	-	0.7	0.8	0.0	0.2	0.0	0.2	1.5
Government regulated price components	**15.2**	**15.4**	**16.5**	**18.1**	**17.9**	**18.0**	**18.8**	**20.8**	**19.9**	**20.2**
Including:										
Transmission system fees	2.2	2.2	2.6	3.0	3.1	3.5	3.8	5.3	5.7	4.9
Distribution system fees	13.0	13.2	13.9	15.1	14.7	14.5	14.9	15.5	14.2	15.3
Market driven price components	**28.5**	**25.3**	**24.5**	**22.9**	**20.2**	**20.2**	**16.9**	**13.7**	**19.0**	**21.0**
Including:										
Market value of EEG electricity	3.5	4.4	4.8	4.2	4.1	4.7	4.3	5.9	8.0	7.3
Generation and sales	25.0	20.8	19.7	18.6	16.0	15.4	12.6	7.8	11.0	13.8

Source: BMWi, in addition to calculations and estimates by the Expert Commission on the Energy of the Future Monitoring Process, based on StBA and TSO (12/2020). Calculations for the total expenditure are based on revenues from electricity sales less tax concessions from subsequent tax relief assessments. Value-added tax is only shown for private households due to the possibility of VAT deduction by business enterprises.

*Provisional values in some cases

Diagram 10.3: Share of final consumer expenditure for electricity in gross domestic product



Source: BMWi based on StBA and studies by the Expert Commission on the Energy of the Future Monitoring Process 12/2020

Debate on the costs of the energy transition

Any statements made about the costs of the energy transition receive a high level of public attention, because they are closely linked to the goals of ensuring that energy is affordable and that Germany's competitiveness remains secured. It is not uncommon, however, for a cost concept to be used that merely describes the level of financing of a specific action in the field of energy policy, such as the Renewable Energy Sources Act (EEG) and the EEG surcharge. Any interdependencies that may exist are rarely taken into account, any more than the 'big picture'. The expansion of renewables in the electricity sector, for example, would lead to a decline in prices on the electricity exchange, which in turn would lead to an increase in the EEG surcharge. Both of these developments would ultimately be reflected to some extent in the final consumer prices, where they would at least offset each other to some degree. Looking at the 'big picture', which is displayed in the graphics above and includes all the relevant sectors (heating, mobility and electricity), it can be seen that the energy costs borne by the members of society has fluctuated in the course of the last few years, but that overall there has been no increase in terms of an average macroeconomic view for a period of several years. At the same time, the 'real life' development is still significantly more favourable than the nominal development. This is not only because prices are rising, but also the incomes of a large number of people. If this aspect is taken into account by comparing the energy expenditure of individual members of society and business enterprises with the economic output in Germany as a whole (e.g. gross domestic

product), for example, it becomes apparent that the overall 'real life' burden has actually eased in recent years.

Quite apart from that, it is important that each individual measure is implemented efficiently in such a way that will enable the goals to be achieved cost effectively and that affordable energy can be guaranteed for all final consumers. Impact analyses are a great help in this respect and can include statements on individual cost items of today's electricity system or on energy price components.

Adding up individual cost items of the current electricity system or the electricity price (EEG surcharge, grid fees, etc.) can only give an incomplete and inadequate idea of the overall costs of the energy transition. Moreover, such an approach would give the impression that, if there were no energy transition, it would be possible to provide an energy supply at no extra cost. This is not the case however. On the contrary, in fact: in this case, the calculations would have to include the investments needed to continue to operate the current generation plants, which are mainly fossil-fired plants, in addition to the procurement costs for fuel imports. What this shows is that the prerequisite for carrying out a comprehensive cost analysis of the energy transition is an analytical comparison between an energy system including the energy transition measures and an energy system with no energy transition. This requires a model-based macroeconomic analysis, in which the energy supply today and in the future is compared with a hypothetical world with no energy system transformation.

With the aid of such a model analysis, it is possible, among other things, to estimate the investments for the implementation of the energy transition that would have to be made in addition to the current maintenance investments (e.g. BCG, Prognos (2018), GWS and Prognos (2018)). However, even these additional investments in the energy system are unable to provide a complete picture of the macroeconomic (net) costs of the energy transition, because they will also trigger additional employment and growth effects.

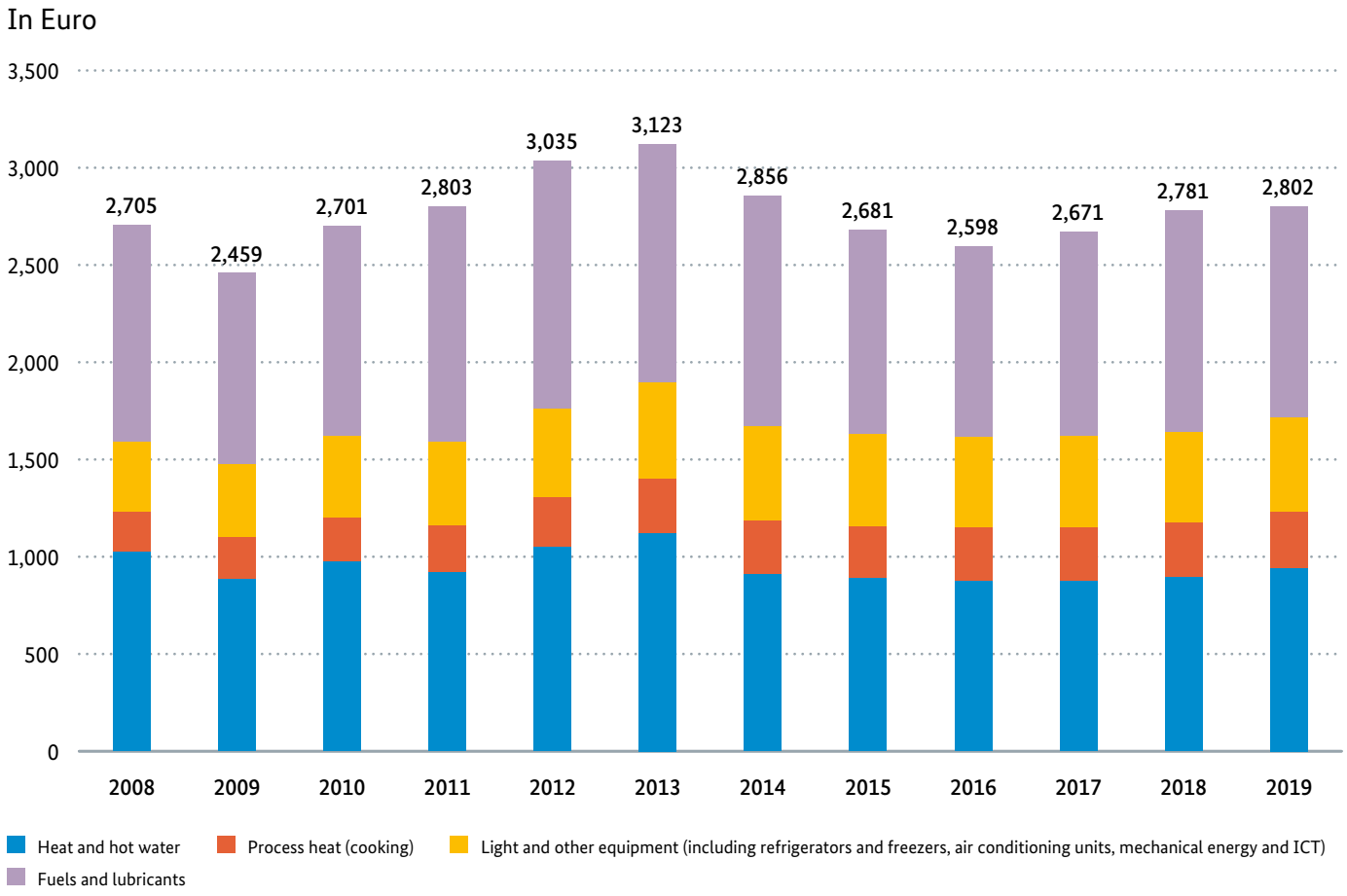
Furthermore, an energy system based on conventional energy sources is associated with climate and environmental impacts as well as health risks (GWS, Fh ISI (2018)). These knock-on effects cannot be fully expressed in terms of market prices and costs, but must nevertheless be borne by society as a whole. With the energy transition and an energy supply that is based increasingly on renewable energy sources and energy efficiency, these consequential costs of the current energy system will gradually be reduced. This is one of the benefits of the energy transition that would have to be included in a cost appraisal in order to obtain a complete picture.

For the Federal Government, affordability is one of the guiding criteria for an optimised implementation of the energy transition, besides security of supply and environmental compatibility. Affordability is also an important element of the Sustainable Development Goal 7 of the United Nations 2030 Agenda "Ensure access to affordable, reliable, sustainable and modern energy for all". It has been possible to slow down the cost dynamics of the EEG surcharge noticeably in recent years as a result of various amendments. Within the framework of the opportunities and challenges outlined above, monitoring the energy transition contributes to a broader and more in-depth analysis of the costs involved.

10.2 Affordable energy for private households

Private households spent slightly more on energy in 2019 than in the previous year, but in a ten-year comparison, expenditure was at a medium level. On average, the energy expenditure of a household in 2019 amounted to around €2,802 (see Diagram 10.4), which represents an increase of 4.4% compared with the previous year. This was primarily due to increased expenditure on heating and hot water, which was up 5.3%. For lighting/cooling/mechanical energy and ICT, in addition to so-called process heat, which is required for cooking, households spent on average 3.1% more than in the previous year. In contrast, expenditure on fuel was 4.3% lower than the previous year. In 2018, the total expenditure of a private household for energy was also up, with an increase of 4.1% compared with 2017.

Diagram 10.4: Average annual energy expenditure of a private household



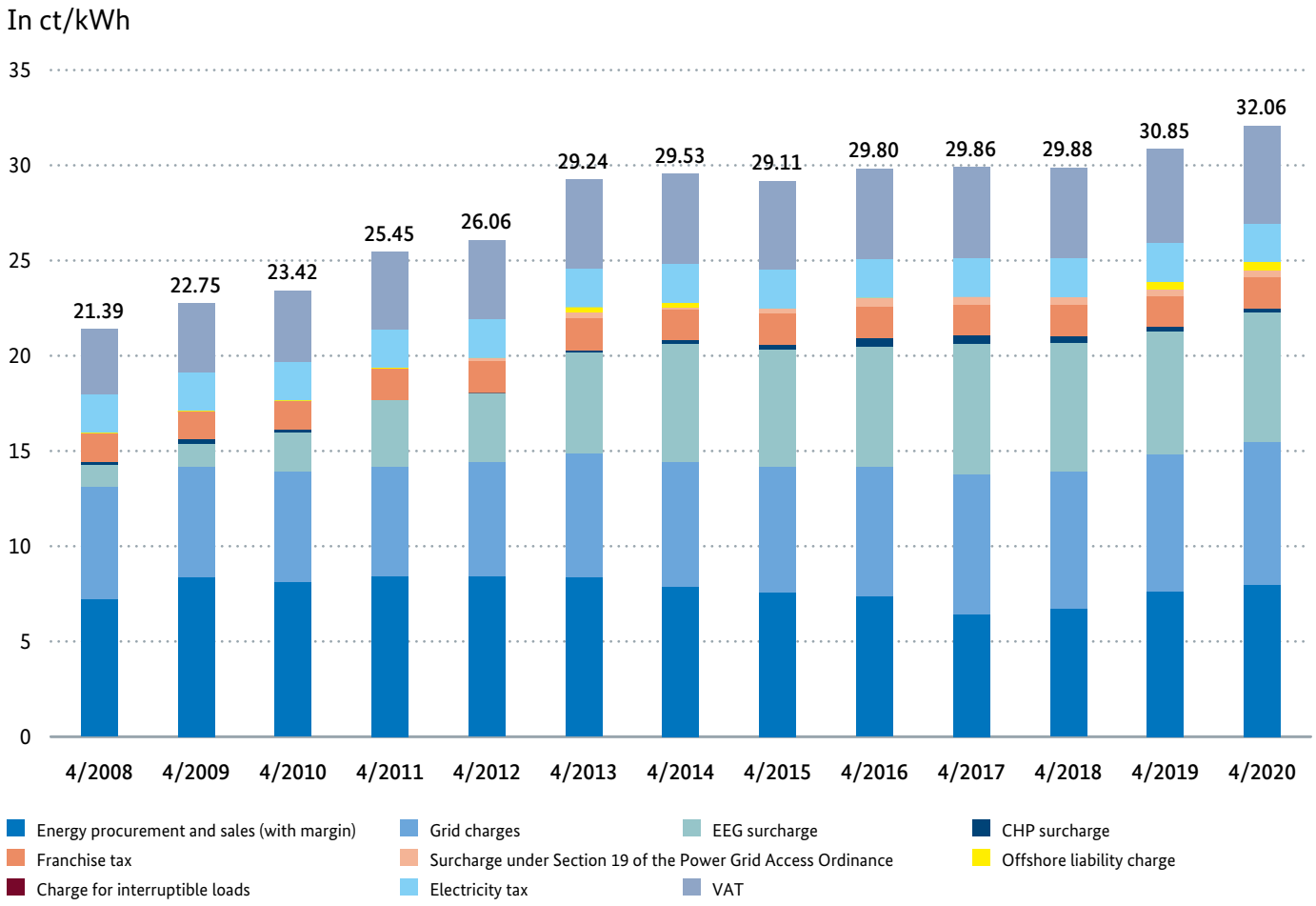
Source: Federal Statistical Office, sample survey of income and expenditure 1998, 2003, 2008, 2013, 2016 and 2017; BMWi calculations

The share of energy expenditure in net consumption expenditure averaged around 9.2% in 2018 and around 9.3% in 2019. For households with a low net income of less than €1,300 per month, the share was larger at 11 and 11.2% respectively. If a distinction is made between expenditure on fuel on the one hand, and expenditure on energy sources for heating, cooking and electricity on the other, the differences are even more pronounced. While fuel accounted for an average of 3.6% of household consumption expenditure in 2019 (2018: 3.8%), the share for low-income households was only around 2.2% (2018: 2.3%). By comparison, energy expenditure for heating, cooking and electricity accounted for around 9% of consumption expenditure for these households (2018: 8.7%). This is significantly more than the average for all households, where the share was 5.7% (2018: 5.4%). Especially in such an essential area, the affordability of energy for low-income households continues to be a challenge.

Electricity prices hardly increased at all in 2018 and slightly more in 2019 compared with the respective values of the previous year. Household customers paid an average of 29.88 ct/kWh in 2018 as of the April cut-off date, and 30.85 ct/kWh in 2019. This is an increase of less than 0.1% in 2018 and 3.2% in 2019, with price components for procurement and sales rising again since 2017. In contrast, the EEG surcharge fell from 6.88 to 6.79 ct/kWh in 2018 and further to 6.41 ct/kWh in 2019. Grid fees were down initially, from 7.31 to 7.19 ct/kWh in 2018 – on an average basis. They increased slightly to 7.21 ct/kWh in 2019 (see Diagram 10.5). By the April 2020 cut-off date, however, electricity prices had increased quite significantly, up 3.9% to 32.06 ct/kWh. This development was due to market-driven costs for energy procurement and sales, in addition to higher grid fees and the EEG surcharge.

Overall, the cost dynamics of electricity prices have been kept relatively low in recent years (since 2013) – this is also the result of efforts to make the energy transition as cost-efficient as possible. The Federal Government has consistently pursued this policy, which is now beginning to show effects in terms of the price components, such as the EEG surcharge and grid fees, which have fallen compared with 2017. The amended EEG, which entered into force at the beginning of 2017, switched the award of funding of renewable energy sources and combined heat and power to competitive auctions. This has already resulted in very significant reductions in the costs for funding the further expansion of renewables. The results of auctions for photovoltaics and wind energy to date demonstrate this quite clearly (see Chapter 4), although the low intensity of competition for onshore wind has recently led to bids being close to the legally prescribed maximum. The Act on the Modernisation of the Grid Fee Structure, which entered into force in July 2017, also aims to slow down the cost development in the medium term, among other things, by reducing the so-called avoided grid fees. Due to the very high level of competition on the retail market for suppliers of electricity to final customers, customers can also save costs by changing to a different electricity supplier.

Diagram 10.5: Average electricity price for private households



Source: Federal Network Agency 12/2020. The data was obtained on 1 April of each year. Until 2015, a household with an annual consumption of 3,500 kWh was assumed. Since 2016, an annual consumption of 2,500 to 5,000 kWh has been taken as the basis.

The increase in consumer prices for heating oil in 2018 is primarily due to higher crude oil prices on the international commodity markets. Import prices for crude oil rose by a good 26%. In 2019, however, they fell again noticeably (by a good 5%), so that heating oil prices also fell. Consumer prices for natural gas have declined since 2013, most recently by more than 3% in 2019 to 5.89 ct/kWh. This is well below the EU average of 6.70 ct/kWh. This development occurred even though the cross-border price for natural gas increased noticeably in 2017 and 2018.

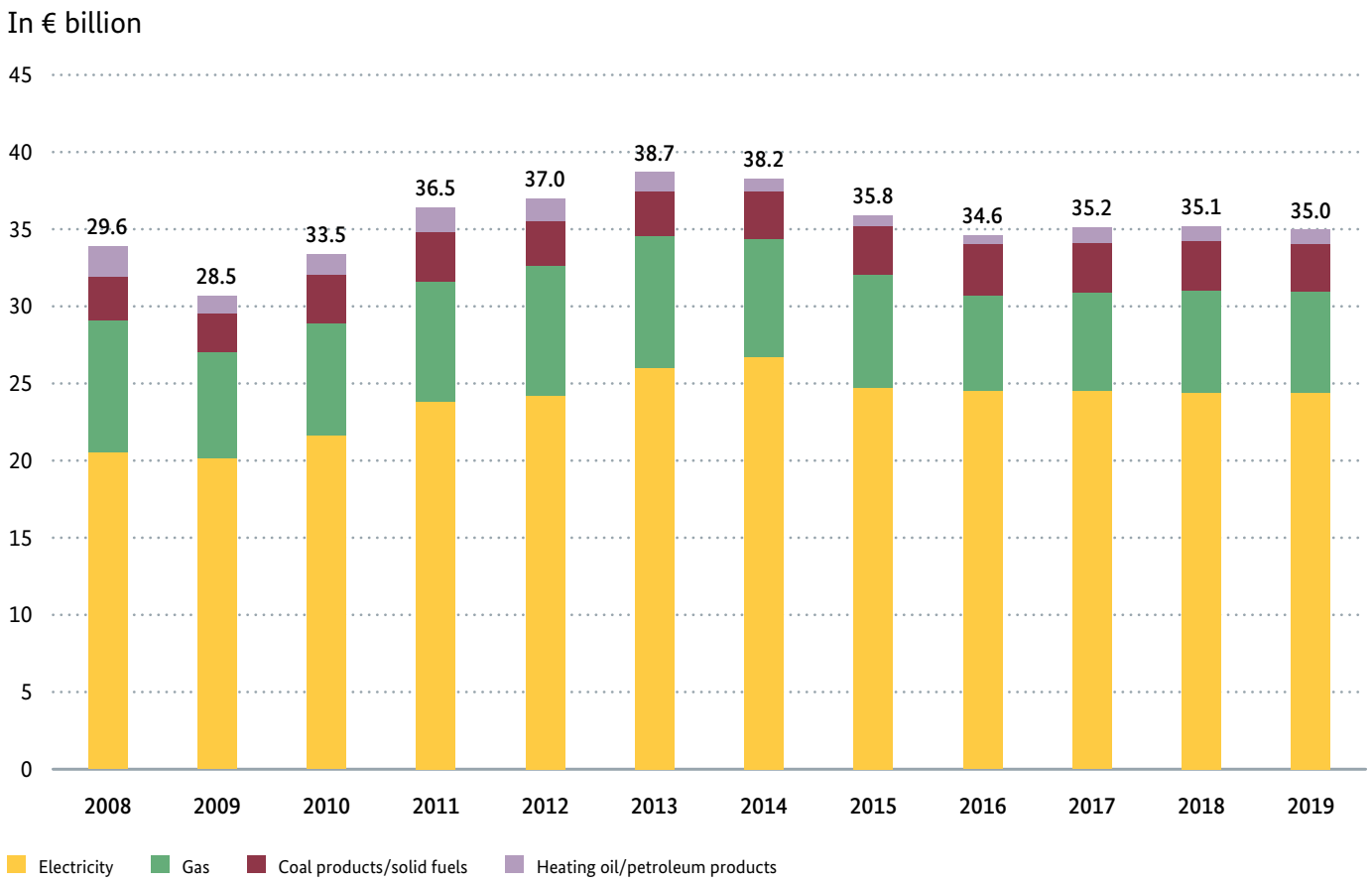
10.3 Affordable energy for industry

The total expenditure of German industry on energy decreased slightly in 2018 and 2019 by 0.3% in each case compared with the respective previous years. Energy is an important cost factor

for industry and as such has an influence on competitiveness compared with other companies that have production facilities in other countries. Overall, industry paid around €35.1 billion for energy in 2018 and €35.0 billion in 2019 (see Diagram 10.5). The reason for the decline in expenditure was primarily lower energy consumption.

The largest cost item for industry in terms of energy costs is electricity. Although electricity prices for industry (with an annual electricity consumption of 24 GWh) increased in both 2018 and 2019. At the same time, however, electricity consumption has decreased. As a result, expenditure was slightly lower in both years than in 2017. Other important cost items for industry are expenditure on gases, coal products and solid fuels. There was a slight increase in expenditure for gases in 2018 than in 2017, but this was down again slightly in 2019. This again reflects the development of both prices and consumption: in 2018, for example, it would seem that the increased gas prices more than compensated for the lower consumption compared with the previous year. In 2019, both gas prices and consumption were down. Costs for coal products and solid fuels in 2018 and 2019 remained roughly at the same level as the previous year.

Diagram 10.6: Energy costs in industry



Source: In-house data from the BMWi based on AGEB and StBA 06/2020 (values for 2019 are estimated)

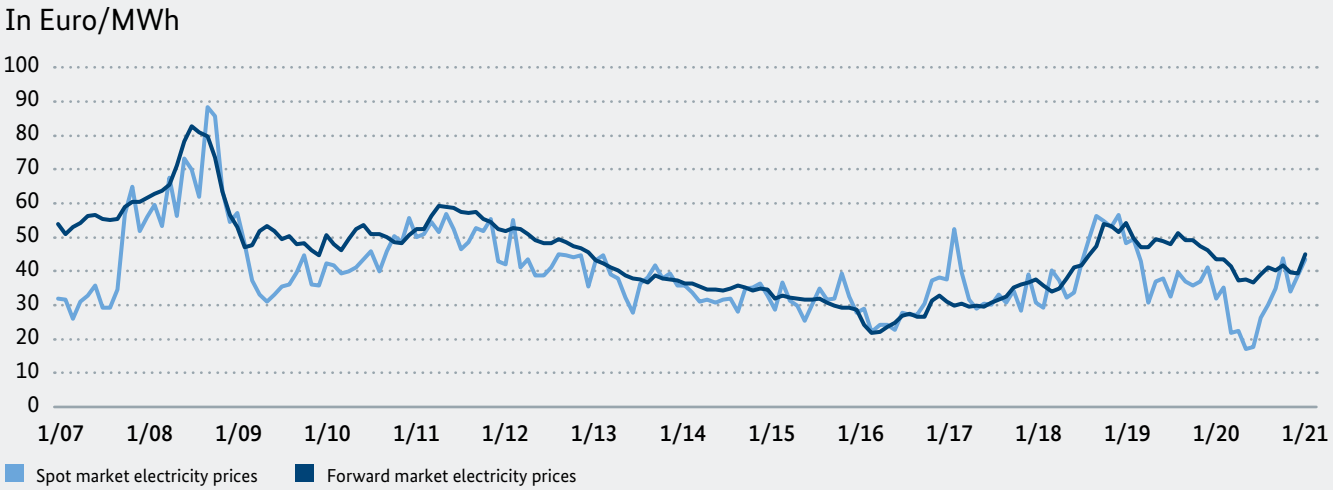
Exchange electricity prices

The upward trend in prices in electricity exchange trading that had begun in 2016 continued initially in 2018. On the European Energy Exchange (EEX), the price for deliveries in the following year (baseload, year future) increased by an annual average of some 32% in 2018 compared with 2017 to €44.20/MWh (see Diagram 10.6). In 2019, the price essentially remained at a high level, averaging €48.06/MWh for the year. Since late summer 2019, however, prices on the futures markets have fallen continuously. The exchange price did not reach its first interim peak since November 2011 until December 2018 at €54.06/MWh. The low spot market prices in spring 2020 are surprisingly high. They are partly due to the effects of the Covid-19 pandemic, but also, for example, to a record feed-in of onshore wind in February 2020. The prices on the spot market, which have a higher volatility by nature, recorded an overall trend comparable with the futures market. Even the price level – with the exception of a significant drop in prices on the spot market in the first months of 2020, which was not so clearly reflected on the futures market – was usually similar. Prices on the futures market indicate that market participants can expect to see a trend towards a further decline in wholesale electricity prices in the near future.

If a supply of large quantities of low-cost electricity is available when demand is low, negative exchange prices can occur. This results in electricity buyers being paid to take delivery of electricity. Such a situation can occur, for example, when low demand coincides with high feed-in from wind and photovoltaics on public holidays or weekends. In 2018, there were a total of 134 hours with negative prices on the spot market, and in 2019 there were no less than 2,011. This corresponds to a share of 2.4%.

Exchange trading accounts for the majority of electricity trading. Another part is traded via over-the-counter bilateral contracts, which are, however, also influenced by the price signals from the power exchange. Such contracts often have a term of several years.

Diagram 10.7: Exchange electricity prices on the spot market and in futures trading

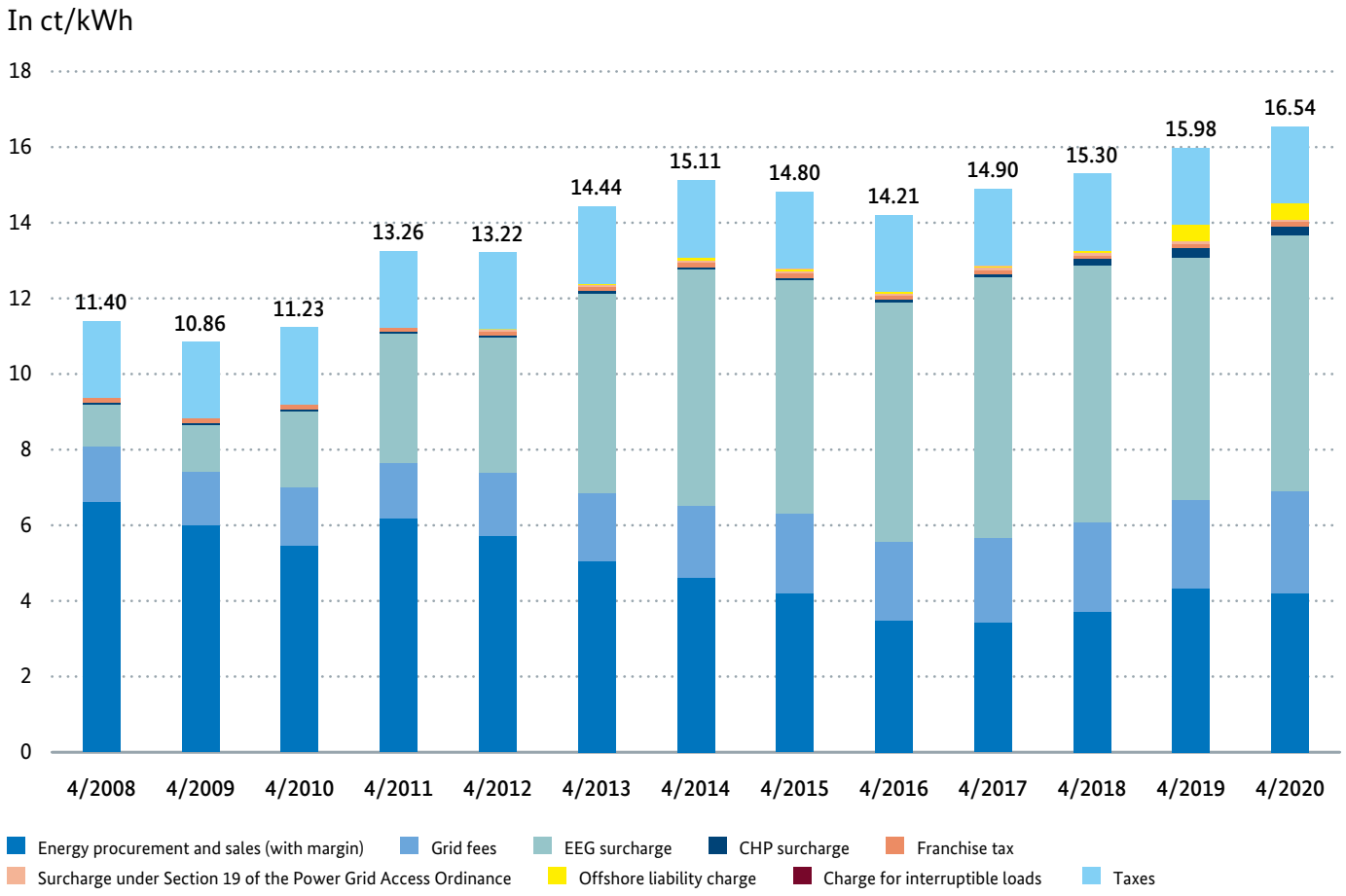


Source: EEX 06/2020, monthly averages for Day Base (hourly contracts) and Phelix Futures (baseload, year future) products

Electricity costs account for a good two-thirds of total energy costs in industry. They are particularly important therefore for energy costs. However, the share of electricity in final energy consumption varies considerably between industries. Furthermore, prices can also differ significantly from company to company. For example, individual offtake quantities and profiles are a factor when determining prices. There are also regional differences in grid fees, for example. Various relief schemes mean that electro-intensive companies that face strong international competition under certain conditions have to spend less on electricity.

Electricity prices for industrial companies not covered by relief schemes increased in 2018 and 2019. According to surveys conducted by the

Diagram 10.8: Average electricity price for industrial companies not covered by relief schemes



Source: BKartA 12/2020. The data was obtained on 1 April of each year. An annual consumption of 24 GWh (annual maximum load 4,000 kW and annual utilisation period of 6,000 hours) medium voltage was assumed. Data relating to taxes until 2013 include VAT.

Federal Network Agency, electricity prices for industrial companies (annual purchase volume 24 GWh) that do not fall under the statutory exemption regulations by and large ranged from 14.11 to 17.65 ct/kWh (excluding VAT) as of the cut-off date of 1 April 2019. Average prices increased from 15.30 to 15.98 ct/kWh in 2019 as of the April cut-off date compared with the previous year. This represents a rate of increase of 4.4%, up from 2.7% in 2018 (see Diagram 10.7). This resulted primarily from the increased costs for procurement and sales as well as a sharp increase in the offshore liability surcharge in 2019. The EEG surcharge, on the other hand, decreased in 2018 in contrast to previous years. As of the reporting date of 1 April 2020, electricity prices for these industrial customers had increased further by 3.5% to 16.54 ct/kWh. This was mainly due to higher grid fees and a renewed increase in the EEG surcharge.

10.4 Affordable energy for a competitive economy

Growth and employment in Germany require powerful, internationally competitive industries. The energy-intensive industries in particular are the prerequisite for maintaining closed value chains and for locating downstream production sites in Germany. They thus make a major contribution, both directly and indirectly, to the creation and preservation of qualified jobs. However, the competitiveness of German companies and industry in particular ultimately depends on domestic energy prices compared with other countries.

Fuel prices in Germany were at a similar level to the EU average, for example, in 2018 and 2019, while diesel fuel prices were 0.8% below the EU average in 2018 and 3.2% below in 2019. Natural gas prices for industrial customers in Germany were 4.2% above the European average in 2018. However, they fell to a 2.5% lower level in 2019.

Electricity prices for German industrial and commercial enterprises in many cases were also significantly higher than the EU average in 2018 and 2019. According to Eurostat figures for the second half of 2018, prices for small commercial and industrial customers with an annual consumption of less than 20 MWh were around 18% higher than the EU average, and 12.7% higher in the second half of 2019. For medium-sized industrial customers with an annual consumption of 70 to 150 GWh, the electricity price was still 16.7% above the EU average in 2018. It fell in 2019, however, to a 1.3% lower level (all figures excluding VAT and refundable taxes and duties).

Unit energy costs

The energy costs of a company are determined not by energy prices alone, but also by energy consumption, while energy consumption itself depends not only on how much is produced, but also on how efficiently energy is used. This means that higher energy prices compared with the prices offered by a competitor at another location can be partially offset by investing in a higher efficiency level in terms of energy usage with a subsequent reduction in energy intensity

in manufacturing. Both factors – energy prices and energy efficiency – can be considered together in unit energy costs. In order to calculate the unit energy costs, the summarised energy costs are generally considered in relation to the gross value added or the gross production value (gross value added plus the value of any preliminary work). However, a variety of scientifically based approaches to come up with the final calculation are discussed by experts. Ultimately, the significance of using unit energy costs to determine the overall costs borne by a company and its competitiveness is disputed.

Calculations based on official statistics show, for example, that the average unit energy costs of German industry rose slightly in 2018 to €16.75 per €1,000 of gross production value. In 2017, the figure was €16.22.

To ensure that the competitiveness of companies that are energy-intensive and also face intense international competition does not suffer from high energy costs, the various relief schemes that are available are particularly important. They are an indispensable for the viability of Germany's commercial and industrial sectors and benefit the entire economy. For the Federal Government, it is clear that the migration of companies to countries with lower environmental standards or lower taxes on energy (carbon leakage) must be avoided and that every effort must be made to keep closed value chains intact and to preserve and create industrial jobs in Germany in the long term. On the other hand, exemptions for energy-intensive companies under the Renewable Energy Sources Act (EEG) and the Combined Heat and Power Act (KWKG) will automatically lead to higher electricity prices for private households and companies not entitled to such benefits. According to the current annual accounts, the relief provided by the Special Equalisation Scheme was financed at 1.68 ct/kWh in 2018 and 1.57 ct/kWh in 2019. This is just under 25% of the EEG surcharge. According to figures published by the German Association of Energy and Water Industries (2019), around 4% of industrial companies benefit from the Special Equalisation Scheme, while 96% pay the full surcharge. Despite the Special Equalisation Scheme, industry as a whole bears a substantial part of the costs of the EEG surcharge. If we look at the amount of the surcharge in 2019, just under 33% of the total costs of the EEG surcharge borne by consumers is accounted for by industry. On the other hand, industry regularly accounts for over 40% of total electricity consumption in Germany.

Regulations designed to prevent carbon leakage contribute to achieving consistency between the competitiveness of German industry and climate protection requirements. The situation today is that the German economy produces more, and yet in spite of that still emits fewer greenhouse gases (for details of greenhouse gas emissions per euro of gross domestic product, see Chapter 8). For energy-intensive companies marketing products that have to deal with tough international competition, the cost burden of CO_2 avoidance is to be limited in such a way that carbon leakage is avoided. This will ensure that Germany's economy remains strong. At the same time, appropriate regulations are also needed on global climate protection, because this will reduce the spread of greenhouse gas emissions and ensure they are not transferred to countries where quite possibly lower climate protection standards prevail.

Key measures implemented to date in the field of affordable energy for private households and industry

Legislation

- The EEG 2017, which entered into force at the beginning of 2017, strengthens the principle of an economic, cost-efficient and environmentally compatible implementation of the energy transition as it marked, among other things, the transition to competitive auctions. The auctions have led to a sustained and significant reduction in subsidy costs, particularly for photovoltaics (see Chapter 4).
- In July 2017, the Act on the Modernisation of the Grid Fee Structure entered into force, an act that also regulates a gradual elimination of avoided grid fees. From 2017 to 2018, the costs for avoided grid fees in the electricity distribution systems were down by a total of more than 1 billion euros, resulting in corresponding cost savings for electricity consumers. Both of these measures, therefore, can make a noticeable contribution to bringing down the costs incurred by final consumers as a result of the operation, modernisation and expansion of the electricity grid (see Chapter 12).
- The Renewable Energy Ordinance (EEV) was amended by the Federal Cabinet in mid-July 2020 with the approval of the Bundestag. It creates the possibility of the Federal Government providing subsidies for the EEG surcharge. The legislature decides on the specific use of the subsidies and the level of funding granted under budget legislation. Revenues from national carbon pricing and subsidies from the Economic Stimulus and Future Technologies Package will reduce the EEG surcharge to 6.5 ct/kWh in 2021 and to 6.0 ct/kWh in 2022 (see Chapter 4).

Other measures

The efficient use of energy and energy savings will provide the basis for a reduction in energy expenditure in the future and will also strengthen the competitiveness of German companies. To this end, the Federal Government has launched the following measures in particular:

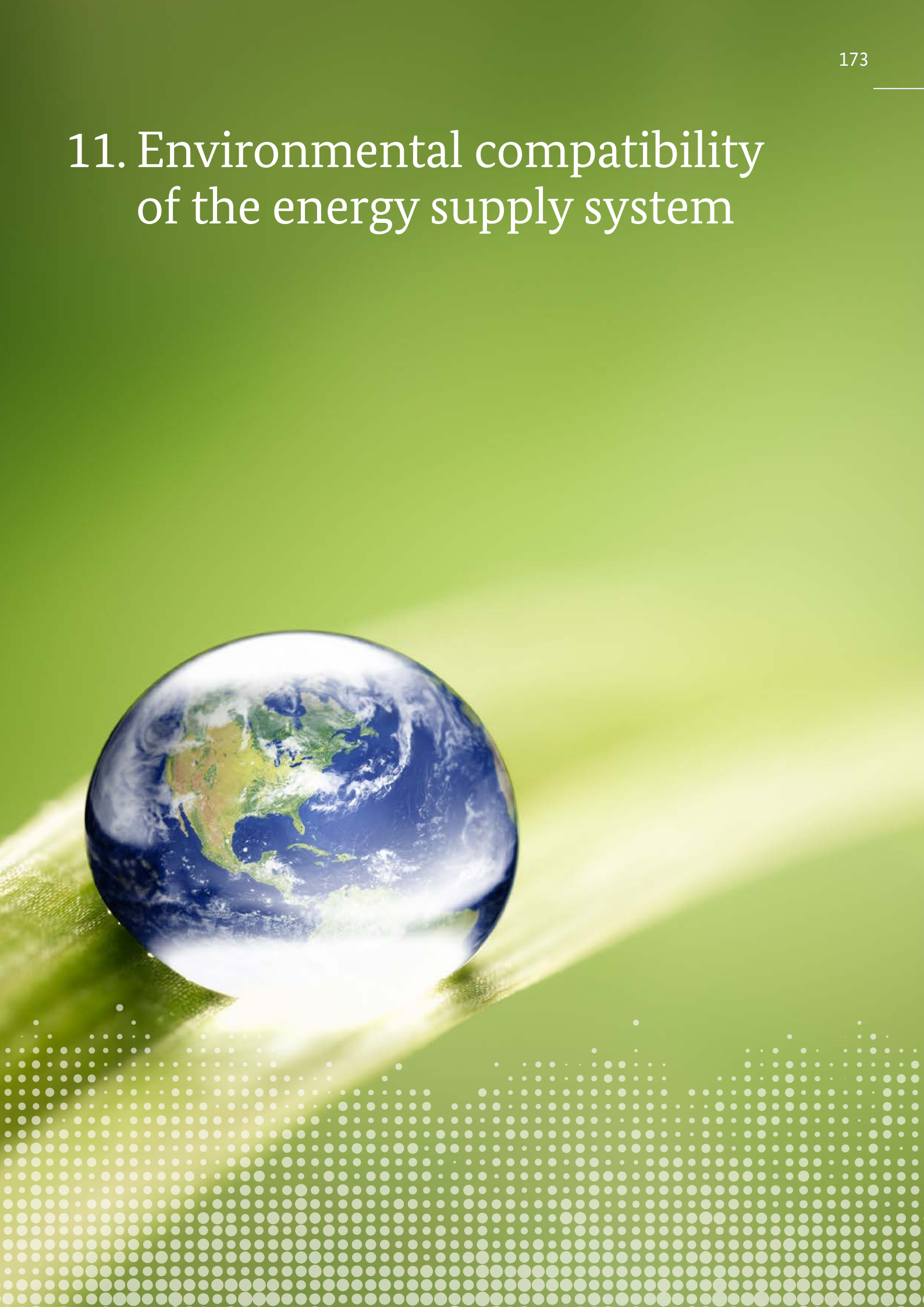
- Energy Efficiency Strategy 2050 (EffSTRA, see Chapter 5)
- National Action Plan on Energy Efficiency (NAPE 2.0, see Chapter 5)
- Federal Funding for Efficient Buildings (BEG, see Chapter 6)
- Long-Term Renovation Strategy (LTRS, see Chapter 6)
- Energy Efficiency Strategy for Buildings (ESG, see Chapter 6).

Since Germany will continue to be dependent on imports for fossil fuels, at least in the medium term, despite the progress made in the energy transition, energy costs will also depend heavily on import prices. Germany's international energy policy will continue to aim at achieving the greatest possible diversification of energy suppliers and transport routes (see Chapter 3).

Key measures implemented to date in the field of fair competition

- Special Equalisation Scheme and relief schemes for private domestic use under the EEG
- Reductions in the CHP surcharge
- Relief provided in the energy and electricity tax laws, e.g. energy tax cap
- Free allocation in the EU emissions trading system and electricity price compensation for indirect carbon costs
- Relief from grid fees

11. Environmental compatibility of the energy supply system



Where do we stand?

The energy transition not only gives rise to beneficial effects for the environment and synergies for a sustainable energy sector, but also opens up new possibilities for the environment and health, along with positive impacts on nature and the landscape.

Efforts are now focused on using a continuous, scientifically backed monitoring concept to identify impacts of the energy system on the environment, nature and human health at an early stage.

The Federal Environmental Agency is working on the development of a suitable set of indicators to enable technically substantiated mapping of the changes in the condition of the environment and nature that can be attributed to the energy transition.

What is new?

Extensive research is currently underway to assess the ecological impact of the existing energy system, as well as the expansion of renewables and modernisation of the infrastructure. Some of the research findings have been used as a basis for this report.

ENVIRONMENTAL COMPATIBILITY	To make the energy supply compatible with the environment, the climate and the nature throughout the entire life cycle.

11.1 Present situation

Starting with the triad of energy-policy goals as the main focus and the policy objective of the state on environmental protection set out in Article 20a of the Basic Law for the Federal Republic of Germany, this Monitoring Report also devotes a separate chapter to the environmental impacts of the energy transition. Although no quantitative goals have been formulated regarding the environmental impact of the energy transition in the energy transition process itself, they are already anchored in international, European and national agreements and laws. The implementation of the energy transition and the achievement of environmental goals are closely meshed with one another and must therefore be regarded collectively. Generally speaking, energy conversion of any description and the provision of the required infrastructure (supply, use and disposal/recycling) go hand in hand with impacts on the environment, nature and the landscape,

humans and natural resources. It is therefore even more important to provide the necessary protection for natural resources and to safeguard the means of livelihood for future generations. The purpose of environmental energy transition monitoring is to highlight the effects that the energy transition has already been able to unfold in recent years in order to improve the environmental performance of our energy supply and indicate what further developments can be anticipated. After all, in terms of the economical and considerate use of resources and landscapes, environmental compatibility is a central aspect in further structuring the energy transition.

In this sense, it is not only essential to provide evidence of the reduction in greenhouse gas emissions, but also to ensure that possible environmental impacts that can be attributed to the energy supply system are identified and evaluated at an early stage. If, for, example, fewer fossil fuels are burned and Germany phases out the commercial use of nuclear energy by the end of 2022, we can assume that this will lead to a reduction in ecological and health risks for humans, animals and the natural environment. At the same time, it is important to ensure that the continued expansion of renewable energy (see Chapter 4) and other technological developments (see Chapter 14) eliminate the possibility of negative – and particularly serious – repercussions for the environment, nature and human health to the greatest extent possible.

The first step in monitoring the environmental and health impacts of the energy transition is to establish a qualified evaluation standard for the impacts and changes in the state of the environment associated with energy conversion. Comparable time series, like those already applied to the development of greenhouse gases (see Chapter 8) and air pollutant emissions, are not yet available for a comprehensive assessment of the environmental compatibility of the energy system. The results of ongoing research conducted on behalf of the Federal Environmental Agency and the Federal Agency for Nature Conservation should help to close these data gaps. Some of the research findings have been used as a basis for this report. In the years to come, bioeconomy monitoring, which according to the National Bioeconomy Strategy has been devised to track the development of a sustainable bioeconomy and is currently being set up, will also be able to contribute towards further developing the monitoring of the energy transition's impacts on the environment and on human health.

The results of these studies will be used as the basis for the step-by-step development of environmental energy transition monitoring in the future. It is to focus on the effects of the energy transition, i.e. of the energy supply system and its transformation, in the areas of

- soil, air and water (Chapter 11.2)
- natural resources and land use (Chapter 11.3)
- nature and the landscape (Chapter 11.4)
- and human health (Chapter 11.5).

Apart from the impacts of the energy conversion processes and the energy infrastructure, the production, extraction and processing of energy sources should be taken into account, as well as the transport and transmission of energy to the final consumer with the necessary infrastructure, throughout the entire life cycle, wherever possible. Indirect environmental impacts, which can be attributed to such imports as energy, energy sources or natural resources, cannot be taken into account at this time, as it is not usually possible to map such impacts methodically or in the form of data. The same applies to indirect positive effects, particularly those achieved by preventing loss of

biodiversity and important biotopes by mitigating climate change. The following sections provide an overview of these individual aspects of environmental energy transition monitoring.

11.2 Soil, air and water

The energy conversion processes of certain energy sources are responsible for a large proportion of the air pollution in Germany today. Apart from greenhouse gases, air pollutants are also released into the environment, particularly in sectors where fossil and biogenic fuels are burned. The sectors, which must be completely or partially ascribed to the energy system (energy industry, transport, fugitive emissions from fuel treatment processes, households, industrial furnaces to some extent and the commercial, trade and services sectors), for example, accounted for a significant share of total nitrogen oxide emissions (almost 77%), sulphur dioxide emissions (around 73%), particulate matter emissions (PM2.5, around 41%) and mercury emissions (almost 76%) in 2018. Fossil fuels account for 71% of nitrogen oxide emissions, 64% of sulphur dioxide emissions, around 20% of particulate matter emissions and 72% of mercury emissions (UBA (2020a)). The emissions of these air pollutants declined continuously between 2000 and 2018. This can be attributed to investments in more efficient flue gas treatment systems, the reduced use of fossil fuels and other measures (reduction of the sulphur content in heating oil, replacement of old stoves and boilers within the framework of the Amendment to the First Ordinance on the Implementation of the 1st Federal Immission Control Ordinance – 1. BImSchV). These pollutants are not only harmful to human health, but also to the natural environment. As far as the influence of pollutants is concerned, the emissions into the air also have adverse effects on soil and surface water.

Coal-fired power plants, in particular, continue to contribute to total emissions, albeit to a declining extent. Accounting for 39 (50)% of sulphur dioxide emissions, they made a relevant contribution to total emissions in 2019 (2017). They also accounted for 59 (over 75)% of total mercury emissions, and for 13 (16)% of overall nitrogen oxide emissions. Their contribution towards particulate matter emissions was comparatively low at 3 (9)% (UBA (2020a)). Even though energy-related emissions have gone down overall since 1990, this shows that the share of “classic” air pollutants is still significant. It must be borne in mind, however, that all emissions from coal-fired power plants will be gradually reduced to a considerable extent as a consequence of the political process of phasing out coal by the end of 2038 at the latest.

The use of biomass can also result in additional air pollutant emissions and contamination of soil and water. Biomass is used as a renewable energy source in transport and for the generation of electricity and heat. However, when burned in relatively small, decentralised plants, it not only produces nitrogen oxides, but also particulate matter, which is produced in much greater quantities when solid biomass is burned than when gaseous or liquid fuels are used. An increase in ammonia emissions has also been observed since biogas has been produced from energy crops. The ammonia emissions from the German energy system (attributable to energy conversion processes, flue gas cleaning and the storage and spreading of digestate from energy crop cultivation) almost doubled between 2000 (40 kt) and 2018 (72.4 kt), for example. They now account for around 11%

of total ammonia emissions, which contribute towards acidification, eutrophication and the formation of secondary particulate matter. As a result, they have an overall negative impact on the quality of air, water and soil. Furthermore, the cultivation of silo maize (especially on slopes) can lead to increased soil erosion. Emissions produced in the course of using vehicles and machines for cultivation, harvesting, transport and the further processing of biomass must also be taken into account.

The area under cultivation for energy crops remains at a high level. In recent years, the area under cultivation with energy crops has been maintained at a constant level by means of adjustments in the EEG. Energy crops also need to be fertilised. As a rule, however, land that has not previously been used for agriculture is not usually developed for the cultivation of energy crops. So even without energy crops, agricultural crops would have been regularly cultivated in these areas and fertiliser applied to cover the plants' nutrient needs. This may give rise to greater nitrate inputs into groundwater and surface water, as well as increasing inputs of ammonia, nitrogen oxides and nitrous oxide into the air according to the intensity of fertilisation and agricultural use. These can be reduced to a bare minimum by complying with the guidelines for good fertilisation practice.

Generally speaking, all pollutants released into the ambient air are also carried into the environmental media soil and water with the passage of time. The potential input of nitrogen compounds from the energy system declined by around 38% between 2000 (503 kt N total ha^{-1} a^{-1}) and 2018 (343 kt N total ha^{-1} a^{-1}). The deposition potential of acidifying substances from the energy system decreased by about 48% between 2000 (69.3 billion eq. ha^{-1} a^{-1}) and 2018 (36.5 billion eq. ha^{-1} a^{-1}).

Although data on regional emissions from energy production affecting soil and water are available at regular intervals, they offer a more suitable means of characterising local or regional pollution situations (see the national Pollutant Release and Transfer Register – PRTR).

Apart from material contamination attributable to emissions, the non-solid repercussions of the energy sector on bodies of water or soil, for example, must be taken into account as well. These include direct intrusions of a technical nature, where hydropower plants are used to generate electricity, for example. Such plants interrupt the passability of rivers, which cannot be compensated for completely, and compensation efforts in the form of upstream/downstream fish ladders, minimum water flow regulations and precautions for sediment passage are still too rare. The number of hydropower plants in Germany has been constant for a long time now. The ecological characteristics of existing power plants, particularly with respect to the passability of watercourses, are gradually being improved by means of retrofit packages. Another factor is the adverse impact of cooling thermal power plants on the material and thermal structure of the river ecosystem. In this respect, the situation in Germany has improved in recent years as a result of conventional power generation being superseded by renewable energy sources. The volume of cooling water was reduced by around 8.6 billion cubic metres between 2001 and 2016, the most recent reporting year, for example (StBA (2018b)), whereby this reduction in cooling water volume is unevenly distributed among Germany's river basins. While reductions in the volume of cooling water have

been observed in some river catchments, e.g. the Weser, an increase has been registered in others, e.g. the Elbe. The energy supply accounts for the largest share of water withdrawals in Germany. In 2016, the amount of water withdrawn for the energy supply accounted for around 52% of the total water withdrawal volume of 24 billion cubic metres (StBa (2018a)). This share is expected to lessen further as a result of the decline in the use of thermal power plants and the expansion of renewable energy sources. Apart from its impact on surface waters, the energy industry also exerts an influence on the groundwater, with its pollutant inputs from open-pit mining or geothermal plants, for example, as well as affecting the groundwater level, volume and temperature.

In the transport sector, positive effects of the use of renewable energy sources, which can be attributed to electric mobility, must also be taken into account: While some of the pollutant and climate gas emissions produced during the combustion of fuels are being avoided as a result of the switchover to electric and other alternative drive concepts, others are being shifted from the traffic sector to the electricity sector, where – as far as conventional electricity production is concerned – more focused measures can be taken to reduce pollutants if necessary (see Chapter 7 and Chapter 13).

11.3 Natural resources and land use

Natural resource requirements and plant locations generally play a decisive role in any type of energy conversion – not only with respect to climate change mitigation and environmental compatibility, but also economic efficiency. With efficient use of natural resources and sustainable land use, the energy transition can make an important contribution towards climate change mitigation and significantly reduce Germany's consumption of primary resources between 2010 and 2050 (Purr et al. (2019)). Efficient use of resources presupposes resource-efficient planning, production and operation of plants, in addition to resource cycles that are closed to the greatest extent possible. Furthermore, if imported natural resources are used, efforts must be focused on organising the extraction and procurement of natural resources responsibly, applying the sustainability criteria for RED II imports (from the domestic market and third countries) where relevant (see Climate Action Programme 2030) and increasing the transparency of resource supply chains. An increasing number of voluntary initiatives in the mining-derived resources sector are contributing towards this (Kickler et al. (2018)). There is also a growing number of efficient recycling concepts for materials used in utilising renewable energy, for instance. Accompanying technologies are continually being developed and made more efficient. In future it will be essential to place greater emphasis on recyclability during the R&D phase, especially for composite materials and lightweight construction components. Progressive use of electricity from renewable energy sources as early as the raw material extraction stage and in the plant component production process, will reduce the impact of renewably produced electricity on the climate and the environment (Maennling, Toledano (2019)).

The following issues must be taken into consideration in an effort to minimise land use for extracting, processing and transporting energy sources and energy facilities, including indirect land use through upstream chains, and to avoid permanent degradation of soils and the loss of agricultural land: While the land used for con-

ventional power plants and the mining of such fossil energy sources as lignite must be taken into account, consideration must also be given to the fact that renewable energy sources also occupy land, or at least change the way in which land is used, which could as a result intensify competition for the way in which land is used – particularly with such a scarce resource as land.

In terms of conventional generation, future changes in land use, such as the recultivation of lignite excavation sites, must be taken into account if the land is to be used later – even if the condition is degraded by comparison with the situation prior to its use by the energy industry.

Renewable technologies use land in many different ways and have a very heterogeneous impact on the environment, nature and the landscape. According to the Agency for Renewable Resources, an area of some 2.4 million hectares was used in 2018 and 2019 for cultivating plants for energy purposes, such as rapeseed and maize (Agency for Renewable Resources (2020)), which means that approximately 20% of arable land has been used for the cultivation of energy crops over the last two years. Apart from shifting the proportion of land used for agricultural products for the production of food and animal feed, this has also affected biodiversity, soil erosion and the risk of soil compaction.

Using bioenergy produced from residual and waste materials is an important step towards avoiding competition for utilisation and land between food producers and nature conservationists, as well as rolling back the share of bioenergy produced from renewable raw materials to make room for more space-efficient energy sources, such as wind energy or photovoltaics. It is important to prioritise waste avoidance in the process, however, and to develop efficient strategies for the material use (e.g. cascading use) of biogenic resources based on upstream closed-loop recycling systems. Another factor to be taken into account is that the use of biogenic residues can also have negative ecological impacts, e.g. through excessive use of forest residues (Ewald et al. (2017)).

Efficient generation of electricity, heating and fuels, low-loss distribution of renewable energy sources and reduced and flexible energy requirements can make a decisive contribution to reducing competition for land and the impact on the countryside. As a basic principle, it is imperative that technologies used to reduce land take further also include in particular those that are already being used on sealed surfaces, such as systems for generating solar energy mounted on rooftops and façades, heat pumps and geothermal energy systems, and concepts that use the same area of land for more than one purpose, such as agrophotovoltaics. An increase in biodiversity can also be achieved by means of open-space photovoltaic systems on tracts of land formerly used for agriculture, for example.

11.4 Nature and landscape

Whenever efforts are made to protect biodiversity and basic resources for flora, fauna and humans, the energy transition will become much more acceptable. Although reductions in the use of conventional energy sources will significantly reduce the overall impact on the environment, structural change in the energy sector will also result in changes in the way nature is affected. They will alter the appearance of the countryside and possibly affect the ecosystem and biodiversity.

The effects of building and operating different types of conventional and renewable energy plants and the associated network infrastructure on nature and the countryside are very diverse. They include in particular the amount of land occupied, the loss of habitats, the impairment of soil and water and the adverse effects on the appearance of the countryside, as well as possible adverse effects on flora, fauna and biodiversity. Possible conflicts arising from disruption or loss are regularly reflected in planning and the award of approvals with regard to the protection of endangered species and territories. Apart from national regulations, binding framework conditions prescribed by EU law, such as the regulations of the Birds and Habitats Directives, must also be observed. One positive aspect in this case is that the Amendment to the Grid Expansion Acceleration Act (NABEG) of April 2019 makes it possible to plan ahead in certain cases by laying empty pipes. This can lead to a reduction in the impact on certain environmental assets.

As far as onshore wind energy plants are concerned, optimum site planning is a prerequisite for avoiding and minimising conflicts. Sites with low conflict potential are selected as part of a forward-looking land use planning process at regional and municipal planning level. In most cases, areas excluded from the planning of wind energy projects not only include conservation areas but also the habitats of protected species. When a specific project is being planned, calculations will include any negative impacts, particularly on bird and bat species that are potentially endangered by wind energy installations, which are to be avoided or minimised to the greatest extent possible by selecting an appropriate site and implementing suitable measures. Examples of possible avoidance measures include specified shutdown procedures, which may be established as standard practice for the protection of certain bat species. If negative impacts cannot be avoided to an adequate extent in an individual case, the granting of a special permit may be considered.

As far as the appearance of the countryside is concerned, it is assumed that in some cases it will not be possible to compensate for the adverse effects and for this reason compensation payments can be determined in accordance with the Federal Nature Conservation Act. This is to be explained and examined during the approval procedures, which are carried out in conjunction with environmental impact assessments as and when necessary. The majority of wind turbines are located on farmland. Some Länder are erecting increasing numbers of wind turbines in forests. Of the turbines commissioned in 2019, 18% were erected in forests, for example; this corresponds to 7% of the total number of turbines and 10% of the installed capacity (Agency for Onshore Wind Energy (2019)).

Marine life must be protected from offshore wind turbines. The construction, operation and dismantling of wind turbines can have various impacts on the marine environment. There may be an increase in the risk of collision and barrier effects for migratory birds, while resting birds and seabirds may respond to offshore wind farms with species-specific avoidance behaviour. These aspects are already taken into account in the course of designating suitable areas in the regional planning process and more specifically in the sectoral planning of the area development plan and in the approval procedure for offshore wind farms. The monitoring of migratory birds prescribed at regular intervals for the offshore wind farm approval process has already contributed to

a better understanding of flight paths as just one example. These findings are taken into account in the planning processes. Insights into species-specific avoidance behaviour acquired while monitoring wind farms are also taken into account in regional and sectoral planning, as well as individual projects (e.g. loons). Apart from this, percussive underwater noise is generated during the construction phase, when the percussive pile driving method is used to install the foundation piles. Over long distances, such noise events have the potential to drive marine life such as harbour porpoises, seals and fish away from important habitats temporarily. The animals are also at risk of sustaining serious injuries, including irreparable loss of hearing, in the immediate vicinity of the pile driving site. In 2013, the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety developed a noise abatement programme for the Exclusive Economic Zone in the North Sea in an effort to minimise these impacts (BMU 2013). This provides for appropriate sound mitigation measures (including bubble curtains, pipe-in-pipe systems and hydro silencers) and compliance with strict noise limits to protect species and habitats. The noise protection concept also ensures that sufficiently large habitats are available in the German North Sea Exclusive Economic Zone (EEZ) to serve as feeding and breeding areas or as resting and refuge areas for the harbour porpoise population. In an international comparison, Germany is playing a pioneering role in the development and application of technical noise reduction systems, as well as in the development of low-noise installation techniques (see Case Study on Pile-driving Noise, Bellmann et al. (2020) for details of current state-of-the-art in terms of noise reduction science and technology). The seabed is also being impacted by the installation and operation of the submarine cables required for the connection. The so-called 2K criterion was established as a precautionary value in an effort to avoid possible adverse effects of cable operation on benthic communities, for example. This criterion imposes a limit on the permissible temperature rise of the sediment. The introduction of hard substrate, e.g. foundation piles, can also have positive effects on the marine environment by creating new habitats. What is more, trawling and gillnetting fishing methods are now banned in the offshore wind turbine safety zone for safety reasons, to ensure that the associated impacts on habitats and species in this area are eliminated.

All of these possible impacts are being taken into account in the expansion of offshore wind energy in accordance with Section 1 of the Offshore Wind Energy Act (WindSeeG). Large regions of the exclusive economic zone and the coastal waters are already being kept completely clear of wind energy installations at regional planning level by exclusively designating priority and reserved areas for wind energy outside nature conservation areas. Apart from this, priority is being given to areas where as few conflicts as possible are to be anticipated for wind energy zones.

Timber is primarily used for energy purposes in decentralised household heating installations. Around 30% of the timber used in Germany (including timber that cannot be used as an industrial material) is currently being used to produce energy. Compared with 2010, the share has declined from 37% to 30% (Thünen Institute (2020)). So far, there is no evidence of a threat to sustainable forest use as a result. The largest proportion of the available wood fuel comes from residual materials, such as sawmill by-products or waste wood. The Federal Government is supporting the cascading use of wood (giving use of wood

as a raw material priority over its use as an energy source) where possible and expedient in order to use the biomass as efficiently as possible.

The cultivation of biomass for energy generation is also affecting the pressure on the use of farmland. The possibility of more intensified utilisation and the loss of such agricultural microstructures as hedgerows, uncultivated field perimeters and other boundary areas pose risks for biodiversity, water resources and the quality of water and soil, as well as terrestrial ecosystems. Agroforestry systems can make a contribution towards the conservation of biodiversity and soil quality. Furthermore, the negative ecological consequences of importing bioenergy sources, such as palm oil-based biodiesel, into other countries must be taken into account, as well as the impacts attributable to crowding-out effects on domestically produced bioenergy sources in other regions of the world. In most cases, it is impossible or at least extremely difficult to reproduce indirect effects methodically or in data terms, particularly with respect to biodiversity. The GHG emissions from such indirect changes in land use cannot be reproduced due to the lack of display options available with common assessment methods. The greenhouse gases emitted during agricultural production and treatment processes must also be taken into consideration. Bioenergy can only make a limited contribution towards reducing GHG emissions by comparison with fossil energy sources.

Hydroelectric power plants can adversely affect the ecological function of river courses: on the other hand, hardly any new hydropower plants have been built for years. The EEG focuses primarily on providing incentives for the modernisation of existing installations. Funding is provided for new plants only if they are built on an existing dam structure. The Water Framework Directive creates a legal framework for achieving a good ecological status for bodies of water. To this end, overall concepts must be drawn up for the watercourses concerned. Precautions must be taken to protect animals, plants and meadows (e.g. upstream/downstream fish ladders, minimum water flow stipulations) in an effort to limit the encroachments on nature arising from the operation of such installations. Among other provisions, the Water Resources Act stipulates that the use of hydropower may only be permitted if measures are taken to protect fish populations. A sufficient minimum water flow rate must also be maintained and the passability of the watercourse must be preserved or restored.

11.5 Impacts on human health

The energy sector emissions described in Chapter 11.1 also affect human health. Of airborne pollutants, particulate matter, nitrogen dioxide and ozone pose a particular threat to human health. As far as the energy system is concerned, road traffic, coal-fired power plants and domestic heating systems are primarily accountable for a relevant proportion of the emissions of these pollutants or their precursor gases. Significant primary sources of particulate matter include motor vehicles, heating plants, waste incineration plants, industrial furnaces, heating installations and various industrial processes, with road traffic also playing an important role in built-up areas. Sulphur dioxide, nitrogen oxides, ammonia and hydrocarbons are the main contributors to the formation of secondary particulate matter. Coal-fired power plants play a significant role in the production of secondary particulate matter pollution, for example, because of the high level of sulphur dioxide

emissions. People who are exposed to alarming concentrations of particulate matter over a long period of time may develop cardiovascular diseases, chronic obstructive pulmonary disease (COPD) or even lung cancer. Recent studies also indicate that there may be a connection between exposure to particulate matter and the occurrence of diabetes mellitus (type 2), neurodegenerative diseases in old age and low birth weight. Other potentially harmful pollutants discharged through the stacks of coal-fired power plants include heavy metals (including arsenic, cadmium, lead and mercury). In the majority of cases, heavy metals find their way into the human organism by being ingested in contaminated food, contributing towards human exposure via the food path.

Apart from the emission of pollutants, light and noise emissions can also have an impact on human and animal health. Energy conversion facilities (e.g. power plants or wind turbines) may emit noise that can affect human health. However, there has been no evidence to date indicating that the noise immissions from wind turbines have a negative effect on hearing. The immission benchmarks laid down in Technical Instructions on Noise Abatement (TA Lärm), must be observed when operating energy plants in order to eliminate the possibility of considerable annoyance and adverse effects, which can be attributed to low sound levels. Wind turbines are therefore planned with precautionary distances to residential areas for the protection of local residents, for example. Furthermore, it has also been possible to reduce noise emissions in recent years due to the development of technical modifications to the rotor blades and noise-reduced operating modes. Adherence to the immission benchmarks is verified within the framework of the approval procedure. According to the current state of research, exposure to infrasound can be assumed to be at a very low level compared with other sources, and without any negative effects on human health. Other decentralised energy plants (e.g. heat pumps, combined heat and power plants) can give rise to noise problems attributable to low-frequency noise and infrasound, particularly if they have not been installed properly.

Under certain meteorological conditions, wind turbines have been known to cause periodic shadow flicker. Local residents may find this effect disturbing. A solution to this problem was found back in the early 2000s by drafting guidelines for the approval procedure, development and implementation of technical avoidance measures (shutting down when limit values are exceeded), which means that shadow flicker is no longer a relevant factor.

Wind turbines with an overall height in excess of 100 m must be equipped with daytime and night-time markers identifying them as obstacles to air traffic in accordance with the General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation (AVV). Local residents find night-time lighting and flashing red lights on the nacelle particularly disturbing, as well as the permanent obstruction lights on the towers of turbines measuring 150 metres or more in height (Hübner, Pohl (2010)). The greatest potential for reducing emissions is in the use of an on-demand night-time marking (BNK). In this case, the lighting system is only activated when an aircraft is in the action radius of the wind turbine, and remains deactivated for the rest of the time. On-demand night-time marking (BNK) was introduced as a mandatory requirement with the amendment to the AVV. Retrofitting of existing installations is scheduled for completion by

31 December 2022 for onshore wind turbines and by 31 December 2023 for offshore turbines, which will bring about a considerable reduction in this perceived disturbance.

Traffic, a major component of the energy system, is one of the major producers of noise. Every five years the impact of ambient noise in metropolitan areas is mapped, along the main traffic arteries and at large airports. The noise maps from 2017 show that more than 4.8 million people are exposed to nightly noise levels in excess of 55 dB(A) and almost 3.5 million people are exposed to sound levels exceeding 65 dB(A) all day long. More recent studies show that prolonged exposure to traffic noise can lead to chronic stress reactions and can also increase the risk of cardiovascular diseases. Further expansion of electric mobility (see Chapter 13) can help to reduce this noise pollution in cities, thereby improving the noise situation and alleviating the impact on human health.

Electricity-conducting components may be a source of electromagnetic fields. High electric field strength may be a risk to human health. For this reason, the installation and operation of power lines in transmission and medium voltage grids are subject to the provisions of the 26th Ordinance Implementing the Federal Immission Control Act (EMF Ordinance – 26th BImSchV), which defines immission limits and a minimum requirement. Charging stations and drivetrains in electric vehicles are subject to the requirements set out in the Product Safety Act. In the case of inductive charging stations, the EMF Ordinance – 26th BImSchV would be applicable.

In addition to the environmental and health impacts of installations during normal operation, the potential impacts of incidents or damage must also be taken into consideration. Although serious incidents are rare, they can have far-reaching consequences. The phase-out of nuclear power for the production of electricity is reducing the risks posed by the release of radioactive substances. Safe final disposal of radioactive waste is intended to contribute to minimising the radioactive after-effects of using nuclear energy over long periods of time. Generally speaking, the negative effects of renewable energy resources in the event of an incident can be regarded as being relatively minor as a result of their decentralised nature and also by comparison with large, centralised installations with high energy density. We can therefore generally assume that, in this respect, the energy transition will reduce the risk of damage as a whole.

11.6 Key measures implemented to date

German Resource Efficiency Programme III (ProgRess III): Updating the German Resource Efficiency Programme means that the previous process supported by the Federal Government is to be continued and expanded. This includes a joint study of material efficiency and energy efficiency and material efficiency improvement measures along the entire value-added chain, e.g. by means of resource-efficient production and manufacturing processes. The programme highlights the way in which efficient use of resources contributes towards achieving climate protection goals. It also supports the strengthening of ecological, social and transparency standards in the international natural resources sector and the creation of more sustainable supply chains. In this way, the German Resource Efficiency Programme is also supporting the continuation of the Federal Government's Raw Materials Strategy, which aims to place the

focus of industrial policy action on a raw materials sourcing concept that is not only safe and competitive, but also responsible. The German Resource Efficiency Programme III was adopted by the Federal Cabinet on 17 June 2020.

In its first Nitrogen Report published in May 2017, the Federal Government emphasised the need for a cross-sector approach to reducing nitrogen pollution to a level that is compatible with the environment and human health. Relevant nitrogen emissions, the level of which is also influenced by the technologies used to bring about the energy transition (e.g. processing of fermentation residues), include ammonia, nitrous oxide and nitrate emissions (agriculture), as well as nitric oxide emissions (energy generation and transport). In Germany, agriculture contributes 67% of the total annual nitrogen emissions amounting to 1.6 million tonnes of nitrogen. The energy sector and industry contribute 11% each, transport 16% and the remaining 6% come from wastewater and surface runoff (UBA (2020d)). The amended Fertilisation Ordinance came into force on 1 May 2020 in an effort to reduce nitrate contamination of groundwater. It focuses primarily on replacing the nutrient comparison with documentation of the actual fertilisation measures, defining uniform nationwide measures in nitrate-polluted areas and issuing a mandate to the Länder to designate polluted areas in accordance with uniform criteria by the end of the year. The measures defined for nitrate-polluted areas will become legally binding as of 1 January 2021.

Federally owned companies for intermediate and final storage: The Act Reorganising Responsibility for Nuclear Waste Management came into force in 2017. It stipulates that the energy supply companies operating nuclear power plants will remain responsible for decommissioning and dismantling the power plants, and for ensuring that radioactive waste is packaged properly, whereby the Federal Government is responsible for the interim storage and delivery of waste for final storage. The Federal Government set up the Company for Interim Storage (BGZ) to perform this work, with a key focus on interim storage, and the Federal Company for Radioactive Waste Disposal (BGE) to search for possible repository sites for highly radioactive waste, and to set up, operate and decommission the repositories for which it was already responsible. See Chapter 9.3 for details of financing through the German Nuclear Waste Management Fund (KENFO).

In 2017, statutory rules on fracking entered into force. They provide for extensive bans and restrictions on the use of fracking technology in Germany. There is a general ban on what is referred to as unconventional fracking. The Länder may authorise a maximum of four nationwide research projects for scientific purposes to provide answers to unresolved issues.

Mandatory on-demand night-time marking (BNK) was introduced for all onshore wind turbines and offshore coastal turbines with the Omnibus Energy Act (EnSaG) at the end of 2018. This laid the foundation for a policy that no longer requires having red lights on wind turbines flash permanently at night in an effort to improve acceptance. To enable another technology based on transponder signals to be used as a supplement to a previously approved radar solution, the Air Navigation Equipment Ordinance (FSAV) was amended with effect from 1 August 2019, as was the General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation (AVV, in force since 1 May 2020). The Fed-

eral Network Agency has extended the Omnibus Energy Act (EnSaG) implementation deadline for onshore wind turbines to 31 December 2022 and to 31 December 2023 for offshore wind turbines, as the required equipment was not available on the market in sufficient quantities when it was needed.

Apart from this, the Efficiency First guiding principle also contributed towards reducing consumption, avoiding emissions and reducing environmental damage in 2018 and 2019 by means of efficiency improvements in the energy sector and the other sectors. See Chapters 5 and 6 for details of the respective energy efficiency measures in general and those implemented in the building sector (e.g. the Energy Efficient Construction and Refurbishment funding programme).

The Competence Centre for Nature Conservation and Energy Transition (KNE) that began its work in July 2016 is making a contribution towards avoiding conflicts during the expansion of renewable energy sources. The KNE centre of expertise is helping to bring greater objectivity into the debate and assists in avoiding local conflicts.

Funded by the BMWi since 2015, the initiative for a public dialogue on grids is present locally in regions particularly affected by the expansion of the grid, organising events and discussions, and providing online information about its services. The topics dealt with relating to the energy transition and grid expansion also include electromagnetic fields and residential environmental protection, as well as nature conservation and environmental protection/agriculture.

Key measures implemented to date in the field of environmental compatibility

- German Resource Efficiency Programme II
- The First Nitrogen Report issued by the Federal Government
- Ban on unconventional fracking for the exploration and production of natural gas and crude oil
- Efficiency First measures
- Founding of the Competence Centre for Nature Conservation and Energy Transition (KNE)

12. Grid infrastructure

Where do we stand?

Around 800 kilometres (46%) of the projects under the Power Grid Expansion Act (EnLAG) with a total length of around 1,700 kilometres had been implemented by the end of the last quarter of 2019. Almost three quarters of the projects have already been approved.

Of the projects under the Federal Requirement Plan Act (BBPlG), with a total of around 5,900 kilometres of transmission lines, 183 kilometres were in operation at the end of the 4th quarter of 2019. Around 600 kilometres were under construction.

As far as the important HVDC electricity highways (high-voltage direct current transmission) are concerned, the approximate routes have already been determined for 650 kilometres (of a total of 2,400 kilometres).

While grid fees for household customers went down in 2018 and were up again in 2019, the grid fees for industrial customers went up in 2018 and down again in 2019.

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

What is new?

At the end of 2019, the Federal Network Agency confirmed the 2019–2030 Grid Development Plan, which identifies the expansion of the transmission system required to realise the 65% share of renewable energy in gross electricity consumption by 2030.

The Federal Network Agency has approved pilot plants for testing reactive system management for the first time with the grid boosters confirmed in the 2019–2030 Grid Development Plan. This is an innovative system management concept that aims to increase grid utilisation.

The Amendment to the Grid Expansion Acceleration Act (NABEG) passed by the Bundestag and Bundesrat in April 2019 constitutes an important milestone for faster grid expansion. This act has had a direct impact on several grid expansion projects and shortened the administrative proceedings by several years.

The BMWi has introduced a forward-looking controlling concept for grid expansion for all line projects under the Power Grid Expansion Act (EnLAG) and the Federal Requirement Plan Act (BBPlG). The aim of the controlling concept is to leverage acceleration potential and implement measures in good time, in order to avoid further delays in grid expansion.

The Amendment to the Grid Expansion Acceleration Act (NABEG) of April 2019 also restructured congestion management and made it more efficient. From October 2021, all electricity generation plants and storage facilities with an installed capacity of 100 kW or more will participate in the so-called Redispatch 2.0 process.

The law governing the market-based procurement of ancillary services of November 2020 paves the way for transparent, non-discriminatory, market-based procedures for the provision of ancillary services. The law facilitates participation by all potential market players, stimulates competition and offers a means of unlocking previously unused potential for the economic provision of ancillary services.

The BMWi initiated a sector dialogue to assess the further development of incentive regulation in May 2019, which was concluded in the summer of 2020. Further expert discussions were subsequently held on possible options for adjustments to the Incentive Regulation Ordinance (ARegV). An amendment to the Incentive Regulation Ordinance (ARegV) is currently being drafted on this basis.

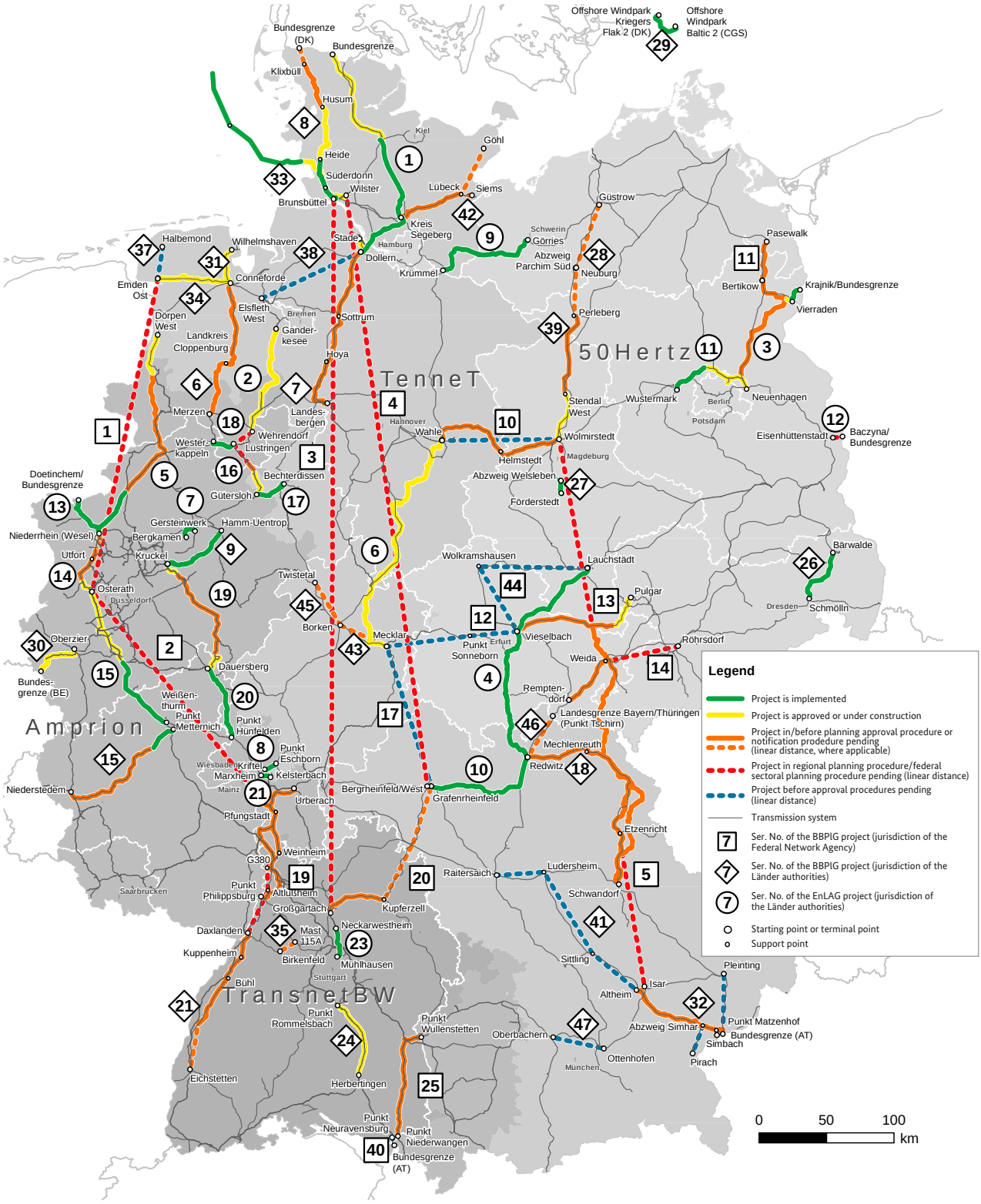
GRID EXPANSION	To expand and modernise grids to meet demand.

12.1 Expansion of the transmission systems

Around 46% of the projects under the Power Grid Expansion Act (EnLAG) had already been completed and had gone into operation by the end of the fourth quarter of 2019. This corresponds to around 800 kilometres of transmission lines. A total of around 1,250 kilometres had been approved, which meant that almost three quarters of the projects had been completed. Significant progress had been made in 2019 with the completion of the Elbe Crossing as part of Project Number 1 under the Power Grid Expansion Act (EnLAG) from Kassø (Denmark) via Hamburg to Dollern (see Diagram 12.1). The uprated Elbe Crossing 2 went into operation in October 2019. With a length of 45 kilometres, this line is regarded as the main artery between the windswept Länder of Lower Saxony and Schleswig-Holstein. Uprating this line resulted in a fourfold increase in transmission capacity to 9,600 MW, which is equivalent to the capacity of ten large conventional power plants or around 3,000 wind turbines.

At the end of the fourth quarter of 2019, a total of 183 kilometres had gone into operation on the basis of projects approved under the Federal Requirement Plan Act (BBPlG). Some 1,747 kilometres of transmission line were in the approval stage. A further 600 kilometres were under construction. This meant that more than 40% of the projects were going through the approval process or had progressed even further. The four HVDC electricity highways (high-voltage direct current transmission) are to become the backbone of Germany's modern electricity supply system. The authorities have made important interim decisions in the course of the last few months: the approximate route for 650 kilometres (of a total of 2,400 kilometres) has now been defined in accordance with the federal sectoral planning procedure. Approval has already been granted for the construction of the southern converter stations of the SuedLink and Ultranet projects in Baden-Württemberg. Further decisions are expected in 2020.

Diagram 12.1: Projects under the Power Grid Expansion Act (EnLAG) and the Federal Requirement Plan Act (BBPlG)



Source: BNetzA Q1/2020

Note: Graphical representation of the expansion status of line projects under the Power Grid Expansion Act (EnLAG) and the Federal Requirement Plan Act (BBPlG) as of 31 December 2019. The lines on the map merely represent the direct connections between the legally defined grid connection points (straight lines) and should not be interpreted as the visualisation of the power line routes.

12.2 Expansion of the power distribution grids

Power distribution grids are facing an increasing number of new challenges. Traditionally, the role of power distribution grids is to distribute electricity locally within a limited region. Increasingly, these grids are now having to contend with new challenges. Feed-in to the distribution grid is now increasing, for example. This is because more than 90% of the installed capacity in renewable energy installations is connected to the distribution grid and a growing number of energy consumers are also producing electricity. Since the distribution grids are not currently designed to handle such a feed-in of electricity, however, it means that additional investments are needed in this area, as well as in maintenance and modernisation.

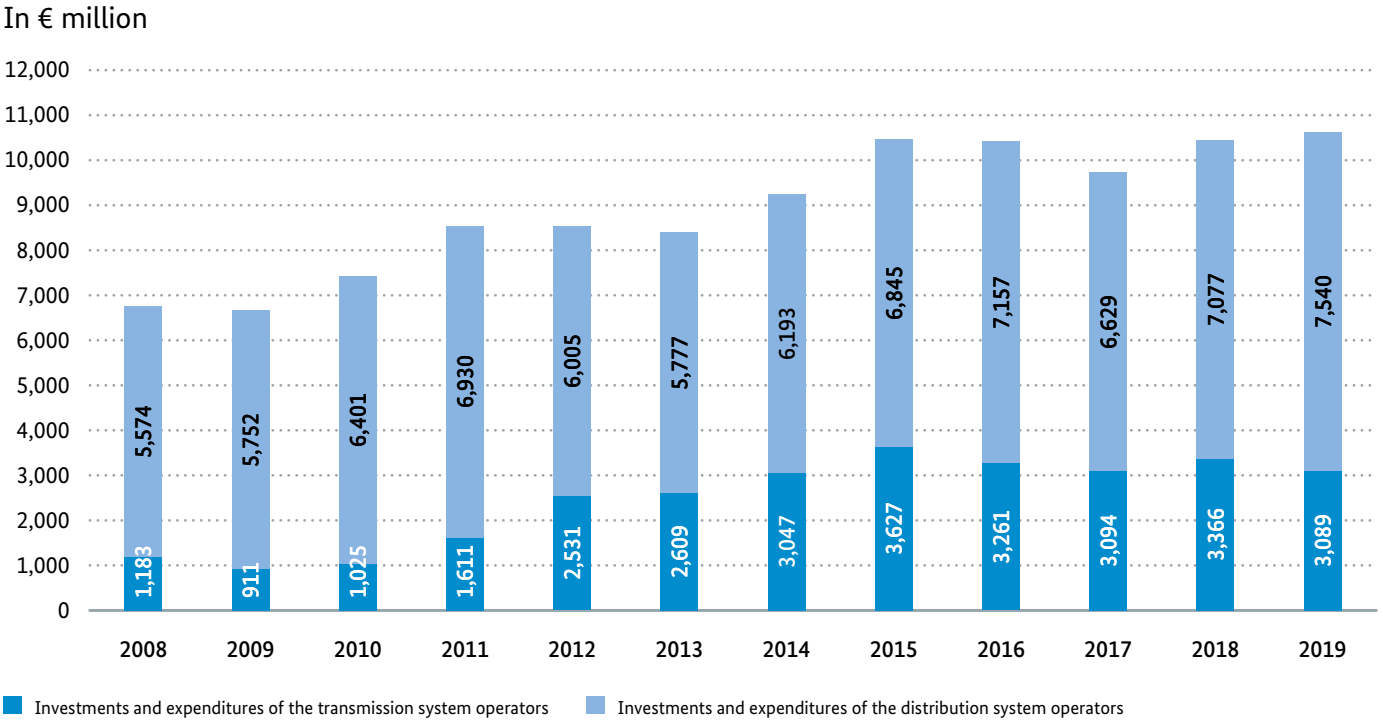
New consumer devices such as electric vehicles and electric heat pumps also represent new challenges for the distribution grids. The ambitious goals that have been set for the development of a nationwide charging infrastructure create a need to adapt to the new circumstances in terms of grid expansion and operation, especially in the distribution grids. Additional power distribution requirements will also increase with the use of electric heat pumps. Intelligent instrumentation and control technology is needed to integrate these new consumer devices into the grid efficiently and to provide optimised grid operation.

The use of digital technologies is playing an important role in the modernisation of the distribution grids. Distribution grids must be upgraded to smart grids if they are to be capable of meeting the new challenges described above. Conventional electricity grids evolve into smart grids when they are equipped with communication technology, instrumentation and control technology and IT components. In this way, the grids can be intelligently linked with one another and with electricity generation and consumer systems. The Act on the Digitisation of the Energy Transition (GDEW) is also intended to help in this respect. Apart from this, innovative processes, technologies and business models for a power infrastructure operating on a large share of renewables are being tested for consumers, storage and grid operators in five extensive showcase regions as part of the Smart Energy Showcases – Digital Agenda for the Energy Transition (SINTEG) funding programme initiated by the Federal Ministry for Economic Affairs and Energy. This living lab for the digitisation of the energy landscape is developing blueprints for future operation of grids and systems in the electricity sector and making recommendations for further development of the legal framework (see Chapter 13).

12.3 Grid investment and grid fees

The expansion of the power grids requires greater investment. Grid operators' investments in German electricity grids (see Diagram 12.2), together with expenditure on maintenance and repair, increased to a total of €10,443 million in 2018 and to a total of €10,629 million in 2019 (an increase of 1.8% compared with the previous year). In 2018 and 2019, €2,954 million and €2,727 million respectively were invested in new construction and grid uprating projects within the transmission grid. Furthermore, an additional €413 million and €362 million were spent on grid maintenance and repair respectively. At the distribution grid level in 2018 and 2019, grid operators invested €3,933 million and €4,337 million respectively in expansion and €3,144 million and €3,203 million respectively in infrastructure maintenance and repair.

Diagram 12.2: Transmission and distribution system operators' investments and expenditure for the grid infrastructure



Source: BNetzA 12/2020

The costs of operating, maintaining and expanding the power grids are financed by grid fees, which are borne by the grid users. Grid fees averaging 7.19 ct/kWh and 7.22 ct/kWh were levied in 2018 and 2019 respectively to supply domestic customers drawing between 2,500 and 5,000 kWh annually. When considered in relation to the average electricity price of 29.88 ct/kWh (2018) and 30.85 ct/kWh (2019) this is equivalent to a share of 24.1% and 23.4% respectively. Grid fees in 2018 decreased on the previous year by 1.6% and increased by 0.4% in 2019. For industrial customers with an annual purchase volume of 24 GWh who are not covered by special compensation arrangements, the grid fees increased by 4.4% to 2.36 ct/kWh in 2018 and decreased by 1.3% to 2.33 ct/kWh in 2019, with the result that the share of grid fees in the electricity price amounted to 15.4% (2018) and 14.6% (2019).

Grid operator revenues are subject to the incentive regulation. The power grid is a natural monopoly. Prudential regulation implemented by the Federal Network Agency and Land regulation authorities protects electricity users from any monopolistic abuse. According to the regulatory framework, grid operators can only use the grid fee to refinance costs that would be incurred under efficient management conditions, whereby an individual revenue cap is set for each grid operator for every year of the regulation period. The purpose of this is to enable grid operators to generate sufficient revenue to cover their actual costs while allowing for efficiency requirements. The revenue cap is a determining factor for the grid fee amount.

Transparency, participation and acceptance of grid expansion

Regular, comprehensive monitoring of the expansion projects creates transparency for all stakeholders on the progress of the infrastructure projects. To this end, the Federal Network Agency publishes a report on the www.netzausbau.de website every three months. The monitoring system documents the status of projects implemented in accordance with the Federal Requirement Plan Act (BBPlG) and projects under the Offshore Grid Development Plan, i.e. the connection lines for offshore wind farms. The projects are also identified as grid expansion or grid reinforcement projects in the reports. As of mid-2018, the monitoring system was extended to include measures to optimise existing grids (e.g. use of overhead line monitoring or high-temperature conductor cables). Directive 2007/2/EC can also be applied in an effort to create geographic information bases relating to power line routes, thereby increasing transparency with respect to grid expansion and network optimisation.

This monitoring concept is being supplemented by a BMWi controlling system, which lists the six most important milestones in the expansion of the transmission line projects: the commencement and completion of the federal sectoral planning and regional planning procedures, the planning approval procedure and commencement of construction and commissioning. This offers the public a means of accessing information regarding the progress of grid expansion at any time.

The public is closely involved in the grid expansion planning process. This applies to the determination of requirements, federal sectoral planning and the planning approval procedures. Transmission system operators (TSOs) and the Federal Network Agency make draft grid development plans available for public consultation, for instance. In each case the public has an opportunity to submit written opinions concerning these plans. Apart from participating in these formal procedures, the public can also get involved in informal dialogue processes at an early stage. Among other things, the TSOs and the Federal Network Agency organise numerous local events.

Furthermore, the BMWi has been funding an initiative for a public dialogue on grids since 2015. The initiative is active locally in regions particularly affected by grid expansion, organising various event and discussions for citizens and stakeholders, in addition to a mobile citizens' office, known as the dialogue mobile. Information about the initiative can be found on the www.buergerdialog-stromnetz.de website.

12.4 Stability and quality of the power grids

The grid operators are responsible for the stability of the power grids. The grid operators rely on certain measures, known as ancillary services, to keep the grids stable in the event of frequency or voltage fluctuations or grid congestion, using balancing capacity to correct frequency deviations, for example. Grid congestion is overcome by redispatching conventional power stations and managing the feed-in from renewable energy plants. These will be combined in Redispatch 2.0 from October 2021 onwards. Grid operators and the parties responsible for power generation plants are currently developing the necessary cooperation processes, which will ensure that they collab-

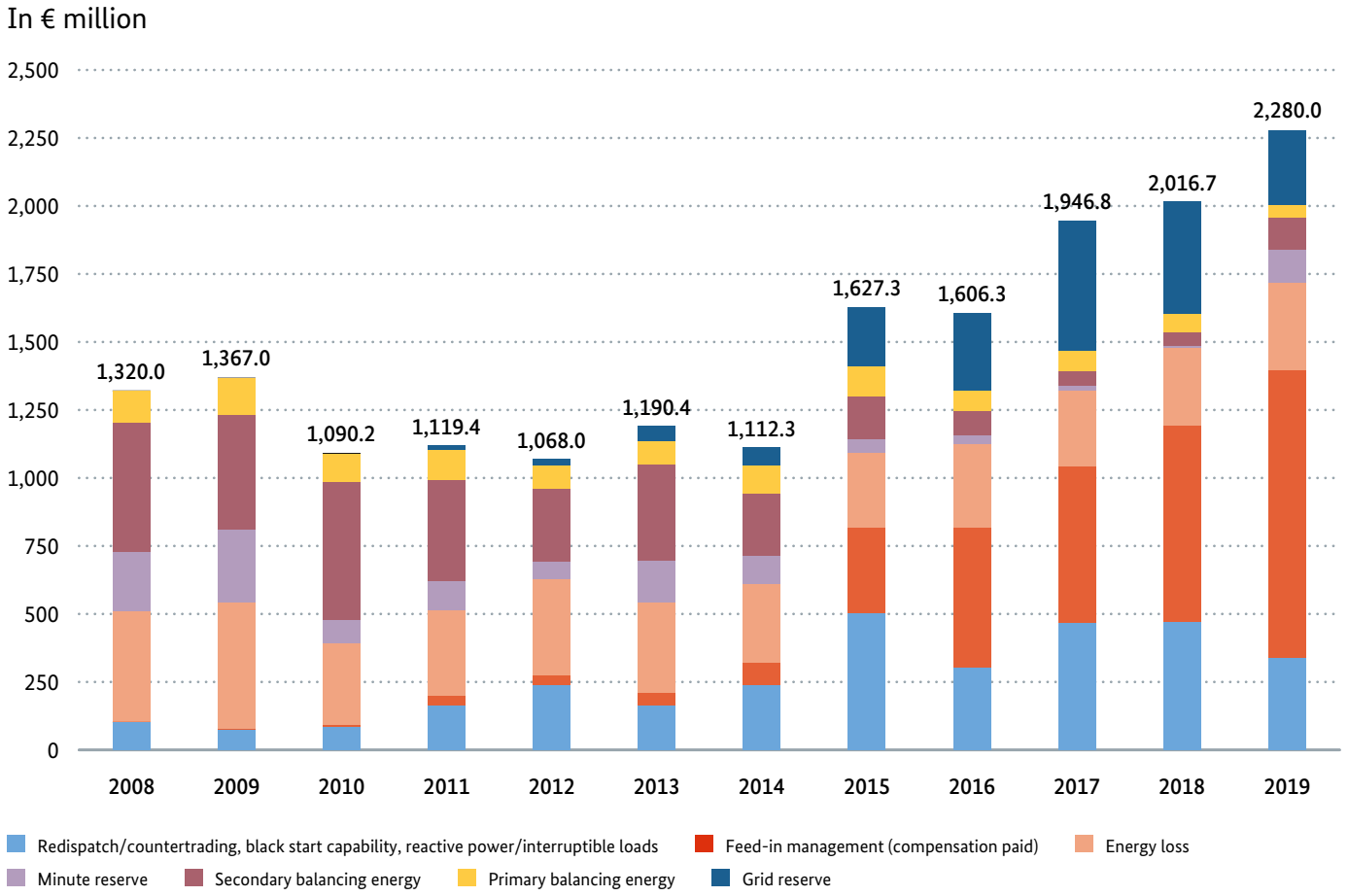
orate to an even greater extent when it comes to optimising the power grids. Generally speaking, producers of renewable electricity, storage systems and flexible loads will also need to contribute more to system stability in the future. Grid operators are already able to use interruptible loads today, for example. Apart from this, modern renewable energy plants provide ancillary services by making important contributions towards voltage stability and balancing capacity. Procurement of ancillary services will in future be market-based as a matter of principle. This will enable the participation of all market players, including power generation plants, storage facilities and consumer devices. Competition and innovation will be stimulated as a result of this and it will be possible to unlock previously unused potential for the provision of ancillary services.

Leveraging potential by optimising the existing grid

Apart from accelerating grid expansion, optimisation of the existing grid can contribute towards increasing available transmission capacity. The increase in utilisation is intended to prevent grid congestion, thereby reducing the need for congestion management (redispatching) in the short to medium term. The German TSOs have taken various optimisation measures into account in their joint Grid Development Plan. By confirming the 2017 Grid Development Plan, the Federal Network Agency approved phase-shifting transformers (PSTs) for the first time as an ad hoc measure for active load flow control. Three additional plants with scheduled commissioning dates in 2025 have been added in the 2019 Grid Development Plan. So-called grid boosters have also been confirmed as pilot installations for testing reactive system management with the confirmation of the 2019 Grid Development Plan. In doing so, the TSOs are entering unknown technological territory and it is therefore necessary to adopt a step-by-step approach to the introduction of pilot systems.

Ancillary service costs increased in 2018 and 2019 compared with the respective previous year. They amounted to €2,016.7 million in 2018 (up 3.6% compared with the previous year) and €2,280.0 million in 2019 (up 13.1% compared with the previous year) (see Diagram 12.3). Most of the costs for ancillary services are borne by electricity customers through the grid fees (see Chapter 10). The proportion of ancillary service costs attributable to congestion in the power grid (redispatch, countertrading, feed-in management, grid reserve) increased by 5.7% in 2018 compared with 2017, from €1,474.4 million to €1,559 million, and by 4.4% to €1,627.9 million in 2019 compared with 2018, thus remaining at a high level. This being said, the fact that the costs incurred in 2019 also included compensation payments relating to feed-in management for claims arising from previous years (2017 and 2018) must be taken into account. Compared with the previous year, the costs incurred for the classical types of balancing energy required to stabilise frequency and voltage fell by 15.3% in 2018, from €145.5 to €123.2 million, which was also attributable to the fact that less balancing energy is needed in a functioning electricity market. In 2019, on the other hand, the costs for these types of balancing energy rose by 131.8% to €285.6 million compared with the previous year. The increase is due to the mixed price method applied to the allocation of secondary balancing energy and minute reserve during the period between October 2018 and July 2019, which resulted in higher capacity prices for both types of balancing energy compared with the previously

Diagram 12.3: Costs of ancillary services



Source: BNetzA 12/2020

applied allocation procedure (price effect). It can also be attributed to the fact that the TSOs put significantly higher quantities of minute reserve out to tender from July 2019 onwards than in the same period of the previous year (quantity effect).

12.5 Key measures implemented to date

The Power Grid Expansion Act (EnLAG) defined the requirements for the construction of new power lines and the uprating of existing power lines as early as 2009. A total of 22 projects act the baseline for calculations in the grid development plan. The overall line length amounted to around 1,700 kilometres during the fourth quarter of 2019. As the actual line routing is not finalised until the approval procedure takes place, there are considerable variations in the kilometre length data. The status of implementation of projects under the Power Grid Expansion Act (EnLAG) is documented in Chapter 12.1.

The Federal Requirements Plan in the Federal Requirement Plan Act (BBPlG) of 2015 is based on the projects of the 2024 Grid Development Plan

that have been approved by the Federal Network Agency. The rapid expansion of renewable energy sources necessitates further expansion of the grid beyond the projects under the Power Grid Expansion Act (EnLAG). The Federal Requirements Plan currently comprises a total of 43 projects, 16 of which are categorised as interstate or cross-border projects. The total length of the lines implemented under the Federal Requirement Plan Act (BBPlG) was around 5,900 kilometres in the 4th quarter of 2019. The Grid Development categorises around 3,050 kilometres of these lines as grid reinforcements and about 2,850 as new constructions. The status of implementation of projects under the Federal Requirement Plan Act (BBPlG) is documented in Chapter 12.1.

On 20 December 2019, the Federal Network Agency approved the revised version of the 2019–2030 Grid Development Plan dated 15 April 2019 and submitted it to the Federal Government as a draft Federal Requirements Plan in accordance with Section 12e (1) sentence 1 of the Energy Industry Act (EnWG). The plan incorporates the more ambitious target for expansion of renewable energy sources to a share of 65% of gross electricity consumption in 2030 for the first time. This gives rise to an increase in grid expansion requirements. The current Federal Requirements Plan is to be updated by means of an amendment to the Federal Requirement Plan Act (BBPlG).

Priority given to underground cables for specific HVDC transmission projects. The Act to Change Provisions of the Law on Energy Cable Construction gives priority to the planning principle of underground cabling for new HVDC transmission projects. 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 expansion of the grid.

The grid expansion areas for onshore wind energy were introduced with the Renewable Energy Sources Act (EEG) 2017. A central government area designation, preliminary investigation and tendering system for offshore wind energy was introduced in tandem with the necessary offshore grid connections. These were the first steps taken in an effort to better dovetail grid expansion and the expansion of renewables. The expansion of wind energy will be temporarily adapted at local level in areas with high grid congestion. In these areas, the volume put out for auction for onshore wind-powered installations will be temporarily limited to 58% of the average capacity added between 2013 and 2015 until the end of 2019. The purpose of this is to relieve the strain on the transmission system and avoid further increases in grid congestion. The remaining expansion amounts will be distributed across the other regions in Germany. As far as offshore wind is concerned, the purpose of the central system is to establish a reliable expansion course and, at the same time, ensure that the necessary connection lines are available to transport the electricity away when new offshore wind turbines are commissioned. Collectively, these measures relieve the strain on the grids.

The Amendment to the Grid Expansion Acceleration Act (NABEG) adopted in April 2019 by the Bundestag and the Bundesrat is an important milestone for more rapid expansion of the grid. The simplification and acceleration of planning and approval procedures are the key here,

achieved by partially waiving federal sectoral planning, strengthening the notification procedure and creating the potential for forward-looking planning by laying empty pipes. Taken together, all of these measures will bring about expansion, especially of the transmission network. At the same time, substantive standards in environmental law, and health protection in particular, will not be degraded. Furthermore, planning at Federal, Länder and local authority levels will be better coordinated. Measures under the Grid Expansion Acceleration Act (NABEG) will be supplemented with the Federal Government's authorisation to decree a federal compensation ordinance in order to create uniform federal standards for expenses incurred under nature conservation legislation relating to power lines for which the Federal Network Agency is responsible.

Congestion management will also be restructured and made more efficient as of October 2021 as a result of the Amendment to the Grid Expansion Acceleration Act (NABEG) of April 2019. As of October 2021, all electricity generation plants (including renewable power stations, CHP plants and storage facilities) with an installed capacity of 100 kW or more will participate in the so-called Redispatch 2.0 process. This will also unlock redispatch potential in the lower grid levels and give rise to new congestion management tasks for the grid operators. From now on, they must organise congestion management in continuous coordination with the upstream and downstream network operators as well as the parties responsible for deployment of the generation plants connected in their respective network areas. The cooperation and data exchange processes between the players have been developed since the adoption of the Amendment to the Grid Expansion Acceleration Act (NABEG).

The figures quoted are based on the forward-looking controlling concept for grid expansion introduced by the Federal Ministry for Economic Affairs and Energy in 2019 for all line projects under the Power Grid Expansion Act (EnLAG) and the Federal Requirement Plan Act (BBPlG). To this end, time schedules and milestones for all projects were agreed with the Länder, approval authorities and transmission system operators in May 2019. The purpose of this is to ensure that delays in specific projects are identified in good time and countermeasures can be taken if necessary. As soon as a project is jeopardised by delays, the key players meet to agree on countermeasures. The timetables are published on the BMWi website.

Competition and innovation are strengthened by market-based procurement of ancillary services. The law governing the market-based procurement of ancillary services of 22 November 2020 paved the way for transparent, non-discriminatory, market-based procedures for the provision of ancillary services as an important building block for security of supply. The law facilitates participation by all potential market participants: producers, storage facilities and consumers. It stimulates competition and innovation and offers a means of unlocking previously unused potential for the economic provision of ancillary services. The regulation applies to the following ancillary services: voltage control, inertia of local grid stability, short-circuit current, dynamic reactive current support, island operation capability and black start capability. The embodiment of the concrete procurement systems will be defined by the Federal Network Agency. The Federal Network Agency will make provision for exceptions in the event that market-based procurement of an ancillary service is not economically efficient.

The Grid Charge Modernisation Act (NEMoG), which came into force in July 2017, gradually reduces regional differences in grid fees, thereby establishing more equitable distribution. Implementation was planned in greater detail in 2018 with the Ordinance on the Incremental Alignment of Grid Fees across Germany. The second of five steps towards the nationwide standardisation of fees charged for the use of transmission grids was implemented in January 2020. The standardisation process will be concluded in January 2023.

The BMWi initiated a sector dialogue to assess the further development of incentive regulation in May 2019 and this was concluded in the summer of 2020. This established the basis for subsequent further expert discussions on possible options for adjustments to the Incentive Regulation Ordinance (ARegV), including the future handling of congestion management costs and the standardisation of the regulatory framework for the handling of capital expenditure, for example. An amendment to the Incentive Regulation Ordinance (ARegV) is currently being drafted on the basis of the outcome from the sector dialogue and the subsequent expert discussions.

Key measures implemented to date in the field of grid infrastructure

- Amendment to the Grid Expansion Acceleration Act (NABEG)
- Ad-hoc grid measures in the Grid Development Plan (NEP)
- Forward-looking controlling concept for grid expansion
- Optimisation of network congestion management (Redispatch 2.0)
- Law governing the market-based procurement of ancillary services
- Act on the Digitisation of the Energy Transition (GDEW) (see Chapter 13)
- Grid Charge Modernisation Act (NEMoG)
- Incentive Regulation Ordinance (ARegV)

13. Sector coupling and digitisation of the energy transition

Where do we stand?

Integrated development of the energy system is essential for the energy transition. The economically efficient integration of the electricity, heating and transport sectors is contributing towards decarbonisation, greater efficiency and a more flexible energy system to an ever-increasing extent. The importance of heat pumps has increased significantly, as just one example.

Digitisation is transforming the structure of the energy sector substantially, turning it into a decisive driver force for the energy transition. Implemented in accordance with the Act on the Digitisation of the Energy Transition (GDEW), smart metering systems will serve as future communication platforms for exchanging data across various utilities and sectors. Although the Barometer for the Digitisation of the Energy Transition presented on behalf of the BMWi reported that progress has been made in specific areas, it also sees a need to catch up in terms of implementing the system and the platform idea behind the GDEW.

What is new?

In the digitisation sector, a total of three certified smart meter gateways (SMGWs) and 39 certified SMGW administrators from independent manufacturers were available at the end of 2019 so that the technical feasibility of installing smart metering systems was formally established by the Federal Office for Information Security (BSI) (market declaration) with the BSI market analysis, which was updated at the beginning of 2020. This paved the way for the rollout of smart metering systems, which is mandatory for certain installations, and attainment of an important milestone in the digitisation of the energy transition.

SECTOR COUPLING DIGITISATION	To unlock the potential of efficient sector coupling and digitisation for a successful energy transition.

13.1 Sector coupling – integration of the electricity, heat and transport sectors

Renewable electricity is becoming the most important source of energy. Efficient use of renewable electricity is making an increasingly important contribution towards the decarbonisation process. The demand for energy that remains after unlocking existing efficiency potential and using renewable energy directly in the heating and transport sector will be covered increasingly by the efficient use of renewable electricity (sector coupling). In the transport sector, this will be

accomplished primarily through the introduction and dissemination of direct-electric drive technologies based on a power supply increasingly derived from renewables. In the buildings sector, electricity from renewables is playing an increasingly important role in supplying heat by means of heat pumps, for example, alongside other renewable energy sources. Allowing for the limited sustainable potential available, sustainably produced renewable fuels are being deployed where electricity cannot be used expediently for technical or economic reasons. This may apply to the aviation or shipping sectors, in particular, and to some sectors of industry. However, fossil fuels are still cheaper than electricity for transport and heating, because electricity prices are burdened with various government-induced price components.

High-efficiency heat pumps and electric vehicles require comparatively little electricity and can make a major contribution towards decarbonisation and improving efficiency in the heating and transport sectors. As shown in Table 13.1, both technologies need less electricity to generate the same quantity of heat or motive power than conventional fossil fuels or technologies involving several conversion steps. They are therefore particularly important for the energy transition and are the current focus of attention.

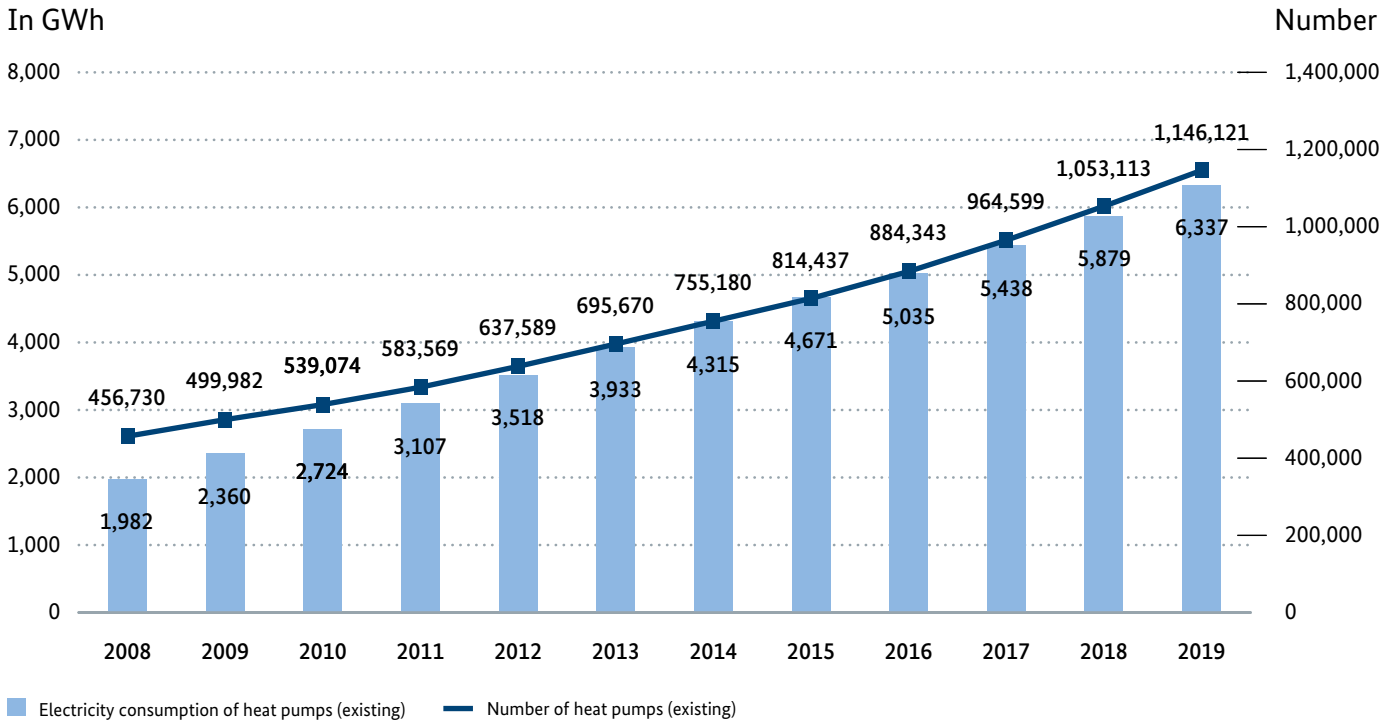
Table 13.1: Different quantities of fossil fuels replaced by different sector-coupling technologies with one kilowatt hour of electricity (in the heat supply and transport sectors)

Regenerative supply			Fossil fuel savings			Substitution ratio energy	Avoided GHG emissions (in g CO_2-eq.)
Input	Technology	Provided energy/use		Technology	Input		
1 kWh regenerative electricity	Power-to-heat heat pump	3.3 kWh Heat	3.3 kWh Heat	Condensing boiler (105%)	3.14 kWh Natural gas	3.14	≈ 640
1 kWh regenerative electricity	Electric car (80%)	4,6 km	4.6 km	Internal combustion engine (28%)	2.6 kWh liquid fuel	2.6	≈ 690
1 kWh regenerative electricity	Power-to-heat direct electric	0.95 kWh Heat	0.95 kWh Heat	Condensing boiler (105%)	0.91 kWh Natural gas	0.91	≈ 185
1 kWh regenerative electricity	Power-to-gas (hydrogen) residue	0.74 kWh hydrogen	0.74 kWh hydrogen	Steam reforming (85.2%)	0.87 kWh Natural gas	0.87	≈ 180
1 kWh regenerative electricity	Power-to-gas (methane)	0.58 kWh methane	0.58 kWh methane		0.58 kWh Natural gas	0.58	≈ 120
1 kWh regenerative electricity	Power-to-liquid	0.5 kWh liquid fuel	0.5 kWh liquid fuel		0.5 kWh liquid fuel	0.5	≈ 135

Source: Purr et al. (2019). Note: The calculations are based on flat-rate assumptions (relating to the efficiency of plant and application technologies, etc.).

The importance of heat pumps for heat generation has increased dramatically in recent years. Since 2008, the number of installed electric heat pump systems rose from just under 457,000 to around 1,146,000 in 2019. This can be attributed to both the continuous reduction in the cost of the systems and to minimum regulatory requirements with regard to renewable energy and energy efficiency (e.g. Energy Conservation Ordinance, Renewable Energies Heat Act), as well as funding programmes (e.g. CO_2 Building Modernisation Programme, Market Incentive Programme). The installed thermal capacity increased almost threefold, from 3,651 MW to 10,872 MW, over the same period. This is because more pumps are being installed and the pumps themselves are now larger 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 around 6.3 TWh in 2019. According to the German Association of Energy and Water Industries (BDEW), the proportion of heat pumps in heating systems in new residential buildings amounted to around 30% in 2019, but only 2.4% of the existing housing stock (BDEW (2020a) and BDEW (2020b)) (heating structure: see Chapter 6). More R&D is needed to further optimise the installation and use of heat pumps. See Chapter 6 for information on the decarbonisation of the heat supplied to buildings, industry and the commerce, trade and services (CTS) sector (heat transition).

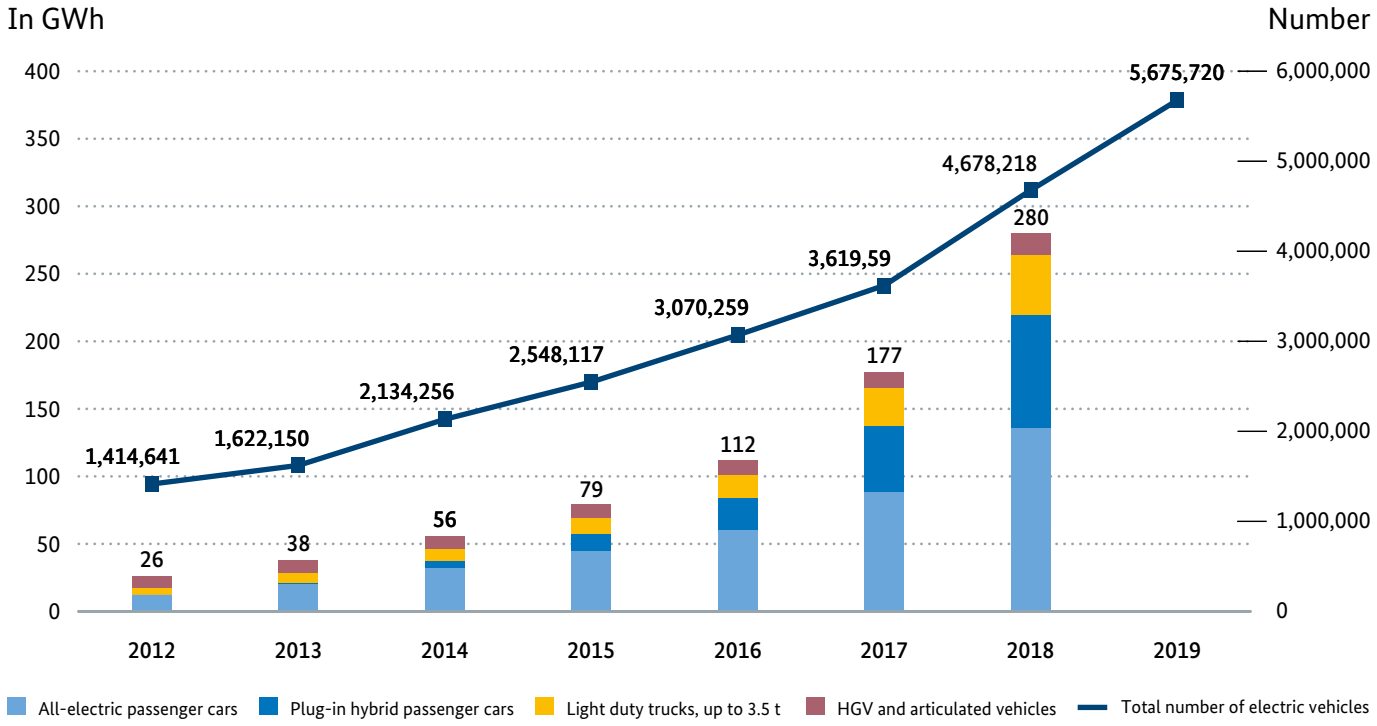
Diagram 13.1: Number and electricity consumption of heat pumps



Source: UBA, AGEE-Stat based on ZSW and GZB 03/2020

The number of electric and plug-in hybrid vehicles on German roads continued to rise in 2018 and 2019. Having said that, with the exception of the rail sector, the electrification of vehicle drives in Germany is still in its infancy (see Chapter 7). Nevertheless, electricity consumption resulting from electric mobility based on the number of vehicles with two or more wheels increased in 2018 by around 14% to about 367 GWh compared with the previous year (see Diagram 13.2). Transport-related final consumption of energy from renewables also increased as a result of the increasing proportion of renewable energy sources in the electricity sector. However, calculations made using the Federal Environment Agency's TREMOD model show that electricity consumption for the rail sector declined by around 3% between 2008 and 2018. The Federal Government is committed to ensuring that further progress is made in the field of alternative drive technologies (see Chapter 7).

Diagram 13.2: Number and electricity consumption of electric vehicles with two or more wheels



Source: UBA TREMOD 6.03 01/2020. The study included purely electric drives and plug-in hybrid drives.

The share of electricity in final energy consumption in industry rose by 0.5 percentage points in 2018 compared with the previous year and declined by 0.4 percentage points in 2019 compared with the previous year. At 814 PJ (2018) and 785 PJ (2019), the share amounted to 31.3% and 30.9% of total consumption respectively. In the years under consideration in this case, no major changes have taken place in the structure of energy consumption according to area of application or energy source.

In its capacity as an important option for achieving the energy and climate targets, sector coupling is the subject of a wide range of funding measures. The Federal Government is supporting innovative technologies, for example, with various programmes that enable sector coupling, such as the Market Incentives Programme for heating with renewable energy sources, the CO_2 Building Modernisation Programme and the Heating Networks 4.0 funding programme. Among other things, a regulation with experimental options was created for the SINTEG Programme that enables participants to experiment with sector coupling in practice with no economic disadvantages (SINTEG Regulation).

The Gas 2030 dialogue process is closely linked with sector coupling. This also addresses the question as to whether and to what extent renewable electricity can be integrated in the long term (see Chapter 9).

The National Hydrogen Strategy

Hydrogen is playing a key role in the further development and completion of the energy transition. This is because it offers a means of reducing CO_2 emissions, especially in industry and the transport sector. In the future, precedence will be given to the use of green hydrogen for this purpose.

With the National Hydrogen Strategy, which was adopted by the Federal Cabinet in June 2020, the Federal Government is creating a coherent operational framework for the future generation, transport, use and further use of hydrogen, and for the associated innovations and investments. It defines the steps that are necessary to help achieve the climate targets, to create new value-added chains for the German economy and to further develop collaboration on international energy policies.

A flexible governance structure was set up to implement and further develop the strategy:

A committee of state secretaries for hydrogen from the ministries concerned monitors the activities relating to the National Hydrogen Strategy. It implements corrective action in the event of impending delays or missed targets.

A National Hydrogen Council was appointed, made up of high-ranking experts from industry, science and civil society. The National Hydrogen Council advises and supports the Committee of State Secretaries with proposals and recommendations for action with respect to the implementation and further development of the hydrogen strategy.

The BMBF Innovation Commissioner for Green Hydrogen is a permanent guest at meetings of the Committee of State Secretaries and the National Hydrogen Council. He is not only responsible for the orientation of the BMBF's research and development activities, but also for R&D networking and transfer.

The Hydrogen Coordination Office supports the ministries in implementing the National Hydrogen Strategy and supports the Hydrogen Council in coordinating and formulating recommendations for action. The Coordination Office is also responsible for monitoring the National Hydrogen Strategy.

13.2 Digitisation of the energy transition

The energy transition is bringing about a fundamental change in the German energy system, which in future will be shaped by a large number of players. Apart from numerous central large-scale consumers and electricity producers, a growing number of decentralised, volatile generation plants, particularly including wind turbines and photovoltaic installations, will be involved in the system, in addition to millions of consumers. The networking of all parties concerned, i.e. the final consumers, the producers and suppliers, as well as the grid operators, is of vital importance if such a heterogeneous and complex energy system is to work properly. One particular way of achieving this is to digitise the energy transition. Digitisation affects all levels of the value creation chain in the energy industry – generation, grids, trade, sales and consumption. Implemented successfully, it makes a considerable contribution towards the security, affordability and environmental compatibility of the energy supply. Consumers are able to decide when, where and how they consume the amount of energy they require and – if they are generating energy themselves – the amount of energy they produce. As the measurement and documentation of energy consumption become easier, more accurate and more comprehensive, new possibilities are unfolding to increase energy efficiency and cut costs. New business models are emerging for business enterprises. Suppliers and grid operators are able to integrate decentralised and volatile generation plants into the system more flexibly, intelligently and therefore more cost-effectively. Smart networking and management of energy generation and consumption on the basis of innovative digital technologies are key prerequisites for launching the digital transformation of the energy sector and the energy transition.

The Act on the Digitisation of the Energy Transition (GDEW) constitutes the legal basis for digitisation of the energy transition. The key element of the GDEW is the Act on Metering Point Operation and Data Communication in Smart Energy Grids (Metering Point Operation Act, MsbG), which regulates the introduction and operation of a smart metering system as the core of a modern infrastructure. A smart metering system comprises a modern measuring device (digital electricity meter) and a central communication unit (smart meter gateway, SMGW). Smart Meter Gateways can be used to integrate electricity meters and technical installations into an intelligent electricity grid (smart grid) and to exchange data with other sectors as well (electricity, heat, gas and water) on the basis of sector coupling (including electric mobility and heat). This will make better use of the existing infrastructure, diminish the need for expansion and improve grid stability.

The Metering Point Operation Act (MsbG) is establishing the regulatory framework for technical requirements imposed on the equipment and with respect to the installation, operation and maintenance of the modern measuring equipment, on data communications (reading out and transmitting the data) and on financing, in order to support advances in economic and technological terms. For electricity customers with an annual consumption of between 6,000 and 100,000 kWh – primarily commercial and industrial customers – and electricity generators with an installed capacity of at least 7 kW, the installation of smart metering systems is required by law to be carried out by the designated metering point operator (MPO). Private households with lower annual consumption and electricity generators with less installed capacity should be equipped with modern metering devices by 2032. Furthermore, the designated metering point operator (MPO) is at liberty to decide whether smart metering systems are to be installed in private households with lower annual consumption. Price caps ensure that the costs for the installation and operation of digital electricity meters or smart meters do not exceed certain limits.

Apart from this, the legal regulations must also ensure that safety, security, interoperability between the IT systems and innovative solutions are assured. Stringent requirements for data protection and data security are formulated in addition to standards. The Federal Office for Information Security (BSI) draws up so-called BSI protection profiles and technical guidelines for this purpose and continues to develop the requirements in an ongoing process. These binding standards provide the basis for testing the SMGWs by the BSI, who certify them if the requirements are met. The security requirements to be met by an SMGW are similar to the security requirements in modern online banking. A total of three certified SMGWs and 39 certified SMGW administrators from independent manufacturers were available at the end of 2019 so that the technical feasibility of installing smart metering systems was formally established by the BSI (market declaration) with the BSI market analysis, which was updated at the beginning of 2020. This paved the way for the rollout of smart metering systems, which is mandatory for certain installations, and attainment of an important milestone in the digitisation of the energy transition. In the future, it will be possible to use smart metering systems as secure platforms for diverse innovative applications and value-added services, such as smart home and smart service.

The smart metering systems must be integrated into the communications between the energy industry players in the various markets. Once the rules for electronic market communication (Market Communication 2020) had been defined by the Federal Network Agency at the end of 2018, the requirements were implemented within the industry and came into force in December 2019. This means that fundamental principles of the Metering Point Operation Act (MsbG), such as the collection, processing and distribution of meter data by the metering point operator (MPO), point-to-point distribution of meter data and aggregation of individual values into balancing group totals at the premises of the transmission system operator (TSO), are being implemented in the market.

The BMWi initiated monitoring of the energy transition digitisation process with the Digi-

talisation of the Energy Transition: Barometer and Top Topics project, which was launched in October 2017. An annual barometer provides an overview of the progress made in implementing the GDEW. Expert reports are also drawn up on key issues (top topics): How can digitisation turn consumers into players in the energy transition? What business models will a digitised energy world offer? How can grid regulation based on the Metering Point Operation Act (MsbG) provide additional impetus to make a grid-based energy supply and coupling of the heating and transport sectors more flexible? Are the infrastructure and regulatory framework ready for the smart grid? The barometer is supported by an advisory board with experts from various sectors. The Smart Grids and Meters working group of the Energy Networks Platform is also becoming closely involved in the overall project. The Digitisation Barometer of the Energy Transition for reporting year 2019 was presented at the beginning of 2020 (Ernst & Young (2020)). This annual publication is available on the BMWi homepage.

The BMWi put forward a plan of action in the form of the Roadmap for the Further Digitisation of the Energy Transition of January 2020. It defines binding targets for the next steps on the road to digitisation of the energy transition and specifies timeframes (BMWi (2020e)).

Apart from establishing a digital communications structure, the Federal Government is providing a testing ground for digitally networked solutions for the energy system of the future. Living labs for the smart energy supply of the future were created with the Smart Energy Showcases – Digital Agenda for the Energy Transition funding programme (SINTEG) in 2017. Intelligent networking of generation and consumption, and the market and grid is being developed and demonstrated in five large-scale pilot regions. The solutions that are tested in real-life situations are to be implemented on a broad scale at a later date and the knowledge gathered in the process is to be used to refine the regulatory framework (see box).

The operational phase of SINTEG will run until the end of March 2021. Practical experience will be acquired in a number of various test applications during the remaining project period. The scientific evaluation of the programme results – the synthesis of deliverables – had already begun at the beginning of 2020. The purpose of the synthesis of deliverables is to make the results of the SINTEG project available as blueprints and model solutions for those involved in the energy system.

The SINTEG programme: Smart Energy Showcases – Digital Agenda for the Energy Transition

In five large showcase regions involving over 300 companies and other participants, the SINTEG programme is developing and demonstrating solutions for technology, economic and regulatory issues posed by the smart energy system of the future. Particular focus is on safe and efficient processes that can be used on a wide scale, innovative technologies and market-based mechanisms for flexible smart grids and markets. The main emphasis is on digitisation of the energy sector.

The programme also seeks to gather practical experience for the future development of the

regulatory framework. To this end, the Federal Government adopted the SINTEG Ordinance, which entered into force on 21 June 2017, with time-limited experimentation options. The Ordinance gives SINTEG participants an opportunity to test new technologies, processes and business models with no economic disadvantages, e.g. for digitisation, sector coupling and ways of making electricity consumption more flexible, in order to synchronise fluctuating electricity generation and consumption. SINTEG is therefore becoming a living lab for the intelligent energy supply of the future. Another focus of SINTEG is to develop and test innovative approaches for acceptance of the energy transition and citizen involvement.

The BMWi is sponsoring the five SINTEG showcases with more than €200 million. Combined with additional investments from the participating companies, a total of over €500 million is being invested in digitisation of the energy sector.

The projects were launched on 1 December 2016 and 1 January 2017 respectively and will run for four years. Each of the five showcases has its own thematic focus:

- **C/sells: The energy system of the future in the solar arch in southern Germany**
  C/sells showcases model solutions that are suitable for use on a large scale in Länder such as Baden-Württemberg, Bavaria and Hesse, with lots of sunshine. The C in C/sells stands for autonomous regional cells that interact in a supra-regional network. This cellular approach allows the energy system to become flexible, by linking numerous smart properties, districts, towns and cities with a digital infrastructure without endangering the overall stability of the system.
- **DESIGNETZ: Blueprint for the energy transition**
  The DESIGNETZ showcase in North Rhine-Westphalia, Rhineland-Palatinate and Saarland seeks to use decentralised energy (a mix of solar and wind power) to supply energy to urban and industrial consumers. DESIGNETZ aims to develop the appropriate framework and workable solutions for the future energy supply with millions of small generating systems that feed fluctuating amounts of electricity from renewables into the distribution system.
- **enera: Intelligent energy networking**
  The enera showcase in Lower Saxony aims to demonstrate the transformation of the energy system from a static, centralised system to a dynamic system. A systemic approach is being adopted to test the consistent digitisation and technical flexibility of the energy system using the interaction of innovative solutions in the grid, market and data sectors. With a renewable electricity share of 235%, the pilot region had already generated significantly more renewable energy than it consumed as early as 2016.
- **NEW 4.0: The energy transition in the north of Germany**
  This project aims to show on a large scale how the pilot region with 4.8 million inhabitants (Schleswig-Holstein and Hamburg) can be supplied with 100% renewable energy sources as early as 2035 in a secure, cost-effective, environmentally compatible and socially acceptable manner. It also seeks to supply renewables to large areas of the

heating and mobility sectors in an effort to reduce the CO_2 emission by 50 to 70%.

- **WindNODE: Showcase for smart energy from the north-east of Germany**
  Spanning five eastern German Länder and Berlin, the WindNODE showcase seeks to demonstrate how large renewable generation capacities can be made economically efficient in a digitally networked supply system at the right time and in the right place across all sectors. To this end, innovative products and services are to be developed that which will supersede the traditional volume-based energy sales business.

Digitisation also offers a means of improving energy efficiency through innovative business models and better information for consumers and planners. New possibilities are unfolding in terms of analysis and user information, and for the development of energy efficiency services based on this information that were previously impossible or too expensive in this form. The Energy Savings Meter pilot programme, for example, which was launched in May 2016 to promote innovative and IT-based pilot projects to reduce energy consumption using energy services that are based on the digital acquisition and processing of energy consumption data.

Two years after the launch, a lively start-up scene has been established on the basis of this programme. This currently includes around four dozen digital platforms and energy saving services. What they all have in common is that they develop energy saving measures in the form of business models, thereby closing the gap between research and application. Energy savings meters are to be issued to customers from the private household, commercial, service, manufacturing, building and industrial sectors, for example, as well as to public services, associations and churches. These systems use a digital platform to make all of a building's energy consumption transparent and enable uniform control. In 2018, funding for the Energy Savings Meter pilot programme was increased to a total of €69 million. March 2019 saw an amendment to the programme and a further increase in funding in an effort to provide greater incentives for developing new business models and energy efficiency services (see Chapter 5).

Energy Savings Meter pilot programmes: Promoting the development and application of digital energy saving assistants

The Energy Savings Meter programme provides funding for pilot projects and digital platforms for the energy transition. Participants seek and develop digital solutions for technical and economic digital energy savings platforms that can be scaled as business models. The BMWi is providing a total of €170 million for the funding period 2016 to 2022. The projects have a life span of five years and each one has its own focus according to the respective applicant, the selected target group and the digital platform under development. Potential savings of up to 10% can be achieved for certain target groups under certain circumstances and significantly greater savings potential can be realised in individual cases. Various innovation categories and approaches for digital energy services are being pursued in the pilot projects:

- One group of projects focuses on sector-specific energy saving services and developing custom-made solutions for its customers from the hospital, hotel and restaurant sectors, for example. Analysis and consulting services, as well as maintenance and financing services in some cases, are being developed and offered for the needs of these customer groups.
- A second group is endeavouring to create integrated digital systems. This involves bundling renewable electricity production and delivery with efficiency measures and automatic consumption control to produce a combined energy service.
- A third group is working on ways of integrating multiple systems and energy sources into a joint digital platform and using digital sector coupling to adapt energy consumption to volatile generation of renewable electricity.

The Federal Office for Economic Affairs and Export Control has approved more than 50 pilot projects on energy savings for the BMWi since 2016. Projects for the development of real time, digitally assisted and individualised energy consulting are being funded, for example, as well as automatically operating energy saving assistants or an innovative individualised building and heating technology that depends on the weather forecast and is supported by artificial intelligence. The funded projects enable energy-optimised operation of offices and retail spaces, hospitals, indoor swimming pools, hotels and restaurants or industrial production processes.

The amended funding opportunity announcement for the Energy Savings Meter pilot programme is providing funding for digital platforms and smart services in the fields of energy efficiency and the energy transition. A typical innovation project basically consists of the development of new software and hardware, along with the development and application of digitally assisted services to save energy at the customer's premises. The key changes introduced by the new funding opportunity announcement include raising the maximum funding amount from €1 million to €2 million, increasing the proportion of funding made contingent upon evidence of energy saved (from 50% to 75%) and special funding for lighthouse projects to strengthen the market for financing energy efficiency.

In the buildings sector it is important to investigate the potential for digitisation as early as the planning process, wherever possible. Building Information Modelling (BIM) provides a means of promoting energy-related optimisation and facilitating transparent, comprehensible solutions for all plant processes related to energy efficiency.

In the building operation field, smart building automation and energy management systems can increase energy efficiency and enhance living comfort (smart home) at the same time. Apart from continually updated information on energy consumption and savings achieved, selective control of heating or air conditioning systems on the basis of presence sensing or user profiles offers considerable efficiency potential. The KfW CO_2 Building Modernisation Programme financed by the BMWi therefore offers a wide range of funding opportunities for the use of digital measurement and control technology as well

as other building automation measures. The KfW Efficiency House 40 Plus, a user interface for the visualisation of electricity generation and consumption in each living unit, is a prerequisite for funding.

At European level, additional measures are being implementes to enhance proficiency in smart metering and energy consumption management in the buildings sector. Based on the amended Buildings Directive, which came into force in July 2018, the European Commission is currently joining forces with the Member States in preparing to introduce an optional smart readiness indicator. A background study on the basic concept and evaluation matrix (evaluation criteria, evaluation areas, etc.) was completed in the summer of 2018. An in-depth technical study is currently underway.

The digital transformation of the economy, and the digitisation of industrial production processes along the entire value-added chain – known as Industry 4.0 – in particular, unlock enormous potential for improving the energy efficiency and climate friendliness of production processes, thereby making a major contribution to the energy efficiency goal of the energy transition. The Federal Government is supporting these efforts with funding programmes for investments in modern sensor technology, software and hardware, as well as smart efficiency solutions. Specific examples include the Autonomics for Industry 4.0, E-Energy, Energy Efficiency in Industry and SINTEG programmes and the Copernicus projects for long-term research issues (see Chapter 14).

Digitisation can also provide solutions for better management and optimisation of energy consumption in the transport sector. One example of this is the "Strategy for Automated and Connected Driving (AVF)", which is redefining mobility in motorised private transport, freight transport and public passenger transport. Automated and Connected Driving is an innovative technology at the interface between mobility and digital advances, which can contribute towards increasing traffic safety and efficiency, as well as reducing mobility-related emissions, while giving rise to new business opportunities in the service and mobility sectors (see Chapter 7). Germany is currently seeing dynamic growth in car sharing and ride hailing in particular. These car-sharing services are smartphone apps that have established a completely new transport segment in urban areas.

Digitisation is firmly anchored in the 7th Energy Research Programme as a cross-cutting issue with far-reaching effects. The research funding is intended for the purpose of investigating the diverse opportunities of digitisation, as well as its challenges. This can address interdisciplinary needs for research and development in such areas as artificial intelligence, ICT security, simulation methods or robotics. As a cross-cutting issue, digitisation is addressed in all energy research networks. Where innovative ideas on digitisation of the energy transition cannot be implemented easily under the current regulatory framework, Living Labs of the Energy Transition can in some cases provide a testing ground for new technologies and concepts. An ideas competition on Living Labs of the Energy Transition was published in February 2019. Specific funding formats for start-ups are under development, including application procedures tailored to this target group (see Chapter 14).

The digitisation of the energy transition has begun. With the GDEW and other activities, the Federal Government has taken important steps towards defining the framework for digitisation in the electricity sector and must continue to pursue this path towards smart meters, smart grids, smart homes and other applications consistently.

Key measures implemented to date in the field of sector coupling

- Funding of heat pumps
- Electric mobility environmental bonus (see Chapter 7)
- SINTEG Ordinance

Key measures implemented to date in the digitisation of the energy transition

- Act on the Digitisation of the Energy Transition (GDEW)
- Digitalisation of the Energy Transition: Barometer and top topics
- Standardisation strategy for cross-sector digitisation in accordance with the Act on the Digitisation of the Energy Transition (GDEW) roadmap.
- Smart Energy Showcase – Digital Agenda for the Energy Transition (SINTEG) (see box)
- Energy Savings Meter pilot programme
- Strategy for Automated and Connected Driving (see Chapter 7)
- Digitisation as a cross-cutting issue in the 7th Energy Research Programme (see Chapter 14)

14. Energy research and innovations

Where do we stand?

Energy research plays a key role in a successful energy transition. In 2018 and 2019, the Federal Government budgeted over €1 billion (2018: €1.05 billion, 2019: €1.15 billion) to sponsor research and development within the framework of the Energy Research Programme.

Adopted in September 2018, the 7th Energy Research Programme entitled Innovations for the Energy transition addresses current and emerging challenges with a holistic approach to funding policy. There is a new focus on technology and innovation transfer facilitated with Living Labs of the Energy Transition. These serve as new funding pillars for the preparation of innovative solutions for the market. The dynamic transfer of practical experience will be accompanied by the improved integration of start-ups. Apart from the main fields of research – energy efficiency and renewable energy sources – the programme sets new points of focus on cross-sectoral and cross-system issues relating to the energy transition, such as digitisation, sector coupling and society-related energy transition research. In the period from 2018 to 2022, the Federal Government is making a total of around €6.4 billion available within the framework of the 7th Energy Research Programme. This means that support for energy research has increased by around 45% compared with the previous funding period (2013–2017).

In view of the challenges associated with the progressive integration of renewable energy sources into the energy system and coupling of the electricity, heating and transport sectors, research funding is becoming increasingly systemic. Apart from the Living Labs of the Energy Transition, the focus is also on such overarching initiatives as Solar Construction/Energy Efficient City, Energy Transition in Transport and the promotion of hydrogen technologies.

What is new?

In 2019, the BMWi selected 20 projects in the hydrogen, energy-efficient neighbourhoods and electricity storage sectors as winners of the Living Labs of the Energy Transition ideas competition. The four SmartQuart, IW3, TransUrbanNRW and WESTKÜSTE 100 living labs were able to start up as early as 2020, to be followed by other living labs in 2021. A funding guideline was discussed and agreed with the European Commission in order to provide funding of the operating costs for living lab projects in particular, whereby the Commission is to be notified in good time.

The Federal Government has bundled the research measures on key hydrogen technologies strategically in a new inter-ministerial research effort entitled Hydrogen Technologies 2030. Initial measures to implement the National Hydrogen Strategy in the R&D sector include the BMBF's Hydrogen Republic of Germany ideas competition (industry-led lead projects and basic research projects) and the BMWi's Hydrogen Technology Initiative, which were both launched in 2020.

The Hydrogen Research Network, founded and funded by the BMWi, commenced work at the end of September 2020. The Network brings stakeholders from industry, research and politics together, who want to

exchange views on issues relating to generation, storage, distribution and cross-sectoral use of hydrogen. The purpose of the Network is to accelerate the transfer of innovative hydrogen technologies to the market.

The Energy Transition and Society funding priority to study society in the context of the energy transition was anchored in application-oriented energy research for the first time in the 7th Energy Research Programme. Among other things, it addresses acceptance of and participation in the transformation process. After the first call for funding applications in mid-2019 was oversubscribed by a wide margin, the BMWi published a second call for funding in September 2020.

Research communication is an important element of technology and innovation transfer. Information that has been tailored to the various target groups is being made available on various platforms, including the central web portal www.energieforschung.de and other subject-specific portals.

RESEARCH INNOVATION	To foster forward-looking innovations for the transformation of the energy supply.

14.1 Research and development

The research, development and demonstration of innovative energy technologies are first and foremost the tasks 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.

The Federal Government adopted the 7th Energy Research Programme entitled Innovations for the Energy Transition in September 2018. This programme addresses current and expected challenges with a holistic approach to funding policy. Four fundamental principles define the framework of the energy research policy in the years to come:

- a new focus on technology and innovation transfer through Living Labs of the Energy Transition as a new pillar of funding for market readiness of innovative solutions. The dynamic transfer of practical experience is being supplemented by the stronger involvement of start-ups and the energy research networks and research communication are also being expanded in the process;
- the shift in focus towards cross-sectoral and cross-system issues of the energy transition such as digitisation, sector coupling and society-related energy transition research;
- better coordination of funding instruments used for project funding and institutional funding;
- stronger European and international cooperation.

Apart from the main fields of research – energy efficiency and renewable energy sources – the programme sets new points of focus on sector coupling, digitisation and the energy transition in the heating, industrial and transport sectors, as well as on social issues. The responsibilities at ministry level are being determined for the first time on the basis of the Technology Readiness Level, which is the desired degree of maturity of a specific technology. The new Energy Research Programme thus covers the entire innovation cycle from basic research to market launch across all ministries. In the period from 2018 to 2022, the Federal Government is making a total of around €6.4 billion available within the framework of the 7th Energy Research Programme. This means that support for energy research has increased by around 45% compared with the previous funding period (2013–2017).

Apart from research funding, support in the form of suitable policy frameworks is also essential to make innovative technologies more cost-effective and marketable. This involves regular changes to regulatory law, as well as specific measures to support the transfer of research and market preparation.

Business companies' expenditure on research and development in the area of innovative energy technologies under government research programs remained at a high level in 2019. Compared with around €186 million in 2018, business companies spent around €184 million on the development of innovative energy technologies within the publicly funded energy research projects in the 7th Energy Research Programme alone in 2019. Other expenditure includes 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 significantly higher. According to the the Donors' Association for the Promotion of Sciences and Humanities in Germany, the energy sector's internal expenditure on research and development in the field of energy research and energy technologies amounted to €3.3 billion in 2017 (Stifterverband (2019)).

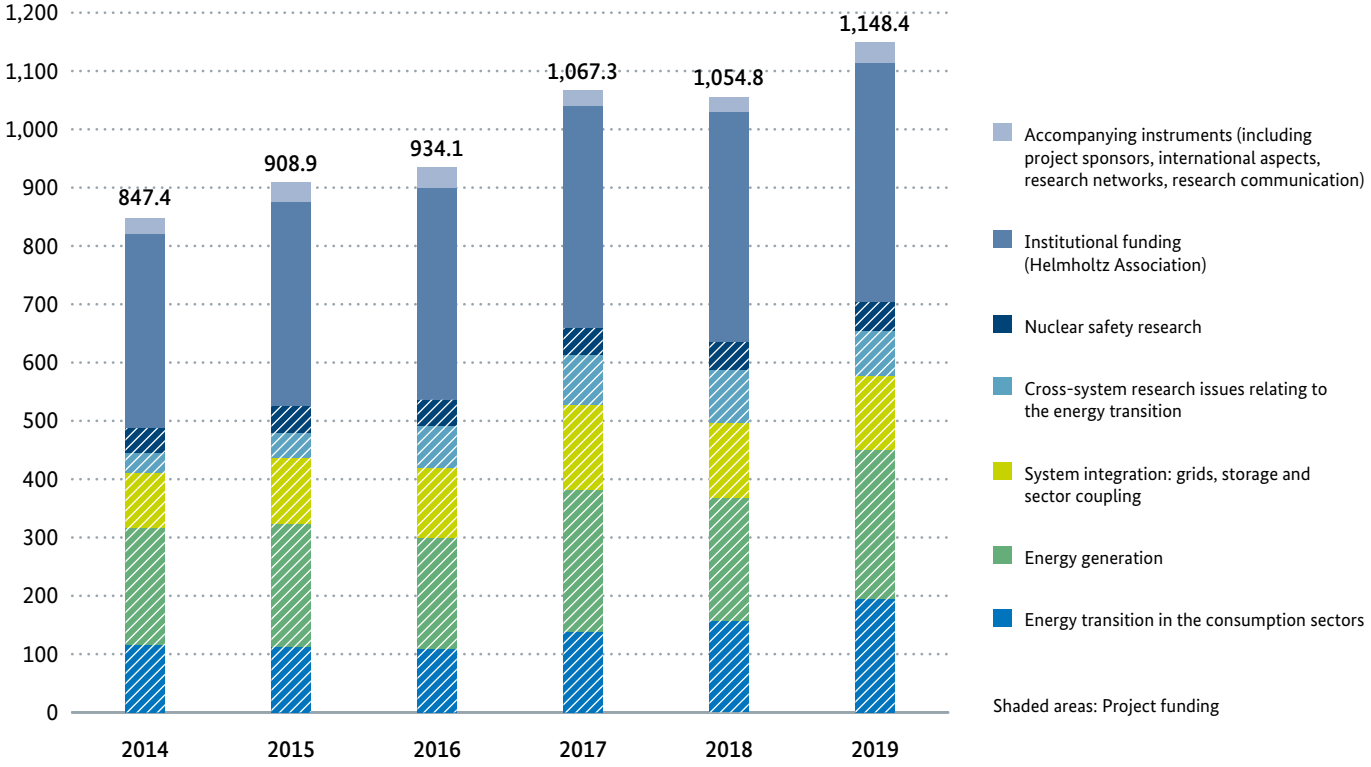
Industry-oriented energy research safeguards the competitiveness of German industry. In applied research and technological development, the focus is on industry-led projects. These are usually conducted in close cooperation with research institutions and universities. All in all, industry participated in around 45% of all ongoing research projects in the 7th Energy Research Programme in 2019. In terms of newly approved research projects, industry commitments within the 7th Energy Research Programme amounted to around €255 million in 2019, compared with €218 million the year before. The fluctuations are primarily due to the fact that the funding opportunity announcements by the Federal Ministry of Education and Research in the area of basic research appeal to different target groups over time.

The Federal Government increased the budget for energy research again in 2019. In 2018 and 2019, the Federal Government budgeted over €1 billion (2018: €1.05 billion, 2019: €1.15 billion) within the framework of the 7th Energy Research Programme. This corresponds to an increase of around 8.9% in 2019 compared with the previous year and an increase of around 35.5% compared with 2014 (see Diagram 14.1). The funding made available for energy research is in high demand. The annual Federal Report on Energy Research presents a comprehensive overview of all major

developments in this respect (BMWi (2020f)). In this way, the Federal Government creates transparency on funding policies for energy research and provides information about the promoted energy technologies. The Federal Energy Research Report is based on EnArgus, the portal set up by the Federal Ministry of Economics and Energy to provide access to information related to energy research funding. This system provides a detailed insight into the Federal Government's energy research activities, which also extends far into the past, at www.enargus.de.

Diagram 14.1: Federal Government research expenditure in the Energy Research Programme

Disbursement in € million



Source: BMWi (2020f)

The Living Labs of the Energy Transition are putting the climate-friendly society of tomorrow to the test. The Living Labs of the Energy Transition ideas competition held in February 2019 was the starting signal for a new energy research format, which was introduced in autumn 2018 with the cabinet decision on the 7th Energy Research Programme. The Living Labs of the Energy Transition accelerate the transfer of technology and innovation by demonstrating new technologies in key areas of the energy transition on an industrial scale. Of the 20 projects focusing on the subjects of sector coupling and hydrogen technologies, energy-optimised neighbourhoods and large-scale energy storage in the electricity supply sector, which were selected by the BMWi as winners of the Living Labs of the Energy Transition ideas competition in July 2019, four had already been launched in 2020 (SmartQuart, IW3, TransUrban-NRW and WESTKÜSTE 100). WESTKÜSTE 100 in Schleswig-Holstein is the first project to focus on hydrogen. A new funding guideline was developed for the living labs in order to provide the necessary investment incentives beyond the previous R&D funding. It is currently being finalised with the European Commission. The primary purpose of the funding guideline is to provide support for operational expenditures (OPEX funding), which is particularly crucial for hydrogen projects, and to enable funding periods of up to 10 years. The Living Labs of the Energy Transition are making an important contribution towards the implementation of the National Hydrogen Strategy.

Research funding for green hydrogen is pursuing the objectives of making green hydrogen tradeable and enabling its production, transportation and use on an industrial scale. The Federal Government has bundled the research measures on key hydrogen technologies strategically in a new inter-ministerial research effort entitled Hydrogen Technologies 2030. Research is a strategic element of energy and industrial policies. German companies and research institutions are playing a pioneering role in hydrogen and other PtX technologies. The Federal Government's reliable, long-term research funding has made a decisive contribution in this respect. The Federal Government is focusing on funding research on key technologies and new approaches along the entire hydrogen chain: from production and storage, transport and distribution, through to utilisation. The meshing of forward-looking basic research and targeted, application-oriented research paves the way for key technologies. Initial measures to implement the National Hydrogen Strategy in the R&D sector include the BMBF's Hydrogen Republic of Germany ideas competition (industry-led lead projects and basic research projects) and the BMWi's Hydrogen Technology Initiative, which were both launched in 2020.

In its capacity as an element of the National Hydrogen Strategy, the Hydrogen Research Network is a key driving force for research and innovation policy in the hydrogen sector, with a particular focus on application orientation and practical implementation. Attended by more than 1,000 people, a digital kick-off event was held in September 2020 to launch the Hydrogen Research Network, which was founded and funded by the BMWi. This underlines the importance of networking stakeholders from industry, research and politics on issues relating to the production, storage, distribution and cross-sectoral use of hydrogen. At the same time, this kind of networking accelerates the transfer of innovative hydrogen technologies to the market. Hydrogen's importance to many sectors of industry and several ministries is such that the BMVI and the BMBF are also involved in the research network. The launch of the Hydrogen Research Network also heralded the start of the consultation process on research strategies for hydrogen technologies in the 7th

Energy Research Programme among the members of the research network.

Application-oriented basic research is advancing green hydrogen innovations along the entire value creation chain. The sustainable generation of hydrogen (green hydrogen) is playing a crucial role as part of the BMBF's package of measures for implementation of the Climate Protection Plan 2050. The purpose of the projects is to support research into hydrogen generation technologies with industrial-scale production volumes at marketable prices. The large-scale recycling of steel mill gases from the steel production process is to be further developed within the framework of the Carbon2Chem project from 2020 onwards. Complementary approaches to replacing coal with hydrogen as the reducing agent in steel production are also being funded. Other funding priorities will be initiated with a view to producing electricity-based fuels and chemicals.

Energy research investigates ways in which people's concerns can be better addressed in the transformation process for the energy transition. The energy system must undergo a radical restructuring process in the decades to come. However, the transformation of the energy system and the energy transition will only be successful if the restructuring process is borne jointly by all of the stakeholders – by the public, by members of civil society and multipliers, by local authorities and other public institutions, by businesses and industries, by energy suppliers, and ultimately by society as a whole. For this reason, the Energy Transition and Society funding focal point is being anchored in application-driven energy research for the first time with the Federal Government's 7th Energy Research Programme. The budget available for the first call for funding applications in mid-2019 was oversubscribed several times over, with almost 60 project outlines received. This reflects the high relevance of this aspect to the energy transition. The BMWi therefore published a second call for funding applications in September 2020.

Germany is strongly committed to the EU Horizon 2020 Framework Programme for Research and Technological Development. Some 13.5% of all EU funding recipients are based in Germany and account for around 16.5% of the programme funds (Germany Horizon 2020 country profile[2]). Of the total Horizon 2020 budget of approximately €80 billion, around €5.9 billion are earmarked for non-nuclear energy research projects over the duration of the programme (2014–2020) (see 2019 Federal Report on Energy Research, BMWi (2019f)). Funds amounting to around €3.2 billion were allocated to approved funding projects for Secure, Clean and Efficient Energy.

International cooperation agreements are facilitating the transformation of the energy systems and achievement of European and global energy and climate protection targets. Germany is committed to international collaboration in energy research in a variety of ways. One example of this is Germany's active participation in 22 of the 38 current IEA Technology Collaboration Programmes (TCPs). The Mission Innovation initiative was launched at the 21st session of the Conference of the Parties to the Framework Convention on Climate Change in Paris (COP21) in December 2015. 24 countries and the European Union are currently participating in the initiative. These countries, including Germany, have agreed to double their public investment in research and development of clean energy within five years.

2 https://www.webgate.ec.europa.eu/dashboard/extensions/CountryProfile/CountryProfile.html?Country =Germany

International research partnerships are an important element **for** the implementation of the National Hydrogen Strategy**.** Cooperation agreements with potential green hydrogen producing countries in Africa and Australia were launched in 2020. The prospects and problems associated with a global green hydrogen economy are being investigated with the partners in these countries, beginning with the production of green hydrogen as the basis and moving on to downstream products, such as methanol or ammonia in sunny and/or windy regions, and continuing through to transportation at regional, national and global level.

Cross-sectoral and cross-system energy research is an important contribution towards the energy transition. The 7th Energy Research Programme supplements technology and innovation funding in the energy sector by adding a dimension for systemic approaches that are oriented to society as a whole. In this way, the major, overarching trends in the energy sector are being brought into sharper focus: the integration of the electricity, heating and transport sectors (sector coupling) and system integration of innovative energy technologies are crucial to meeting the energy transition targets. Digitisation is also playing a key role in modernising the energy system. Inter-ministerial and cross-programme research initiatives in the building and neighbourhood sectors, for example, and for the use of electricity-based fuels for smart sector coupling, will be continued and supplemented by new activities in the area of hydrogen technologies.

The fact that there is a consistently high outflow of funds from an annually growing budget underlines the key importance of energy research for implementation of the energy transition. Energy research creates the technology basis for restructuring the energy supply system and is a strategic element of Germany's energy policy.

Transparency and participation in energy research

Energy research networks

The BMWi has successively set up nine research networks on key focal points of energy research policy in order to transfer the results of energy research directly to those involved in the energy transition and to promote dialogue between the scientific community, industry and those involved in government funding policy:

Energy Transition Construction

Industry and commerce

Renewable energy

Use of biomass energy

Flexible energy conversion

Power grids

Systems analysis

Start-ups

The new Hydrogen Research Network brings participants from industry, research and politics together to exchange views on issues relating to the production, storage, distribution and cross-sectoral use of hydrogen. The purpose of this is to accelerate the transfer of innovative hydrogen technologies to the market.

In their capacity as interfaces between research, practice and policy-making, the networks contribute towards discussions on subject-specific funding strategies with a practical orientation, and suggestions of new measures, bringing transparency and efficiency into the focus 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.

www.forschungsnetzwerke-energie.de

Research communications

Apart from research funding, research communications is another key task of federal energy research policy, particularly when it comes to reporting on future developments and research content and transferring research findings into practical applications. Research communications should also create transparency in the use of funding. To this end, the Federal Government has set up a central web portal with extensive information for the various target groups:

www.energieforschung.de

In-depth information on all aspects of energy research can be found here, as well as research portals relating to various key energy research topics:

www.energiewendebauen.de

www.industrie-energieforschung.de

www.strom-forschung.de

www.energiesystem-forschung.de

EnArgus, the central information system for energy research, provides access to an extensive database on the projects funded in the Energy Research Programme:

www.enargus.de

Key measures implemented to date in the field of energy research

- 7th Energy Research Programme
- Live Labs of the Energy Transition
- Hydrogen Technology Initiative
- Hydrogen Republic of Germany ideas competition
- Founding of the Hydrogen Research Network
- Energy Transition in the Transport Sector funding initiative
- Solar Construction/Energy-efficient Cities funding initiative
- Energy Transition Copernicus Projects funding initiative
- Energy Transition Research and Innovation Platform (R&I platform)
- 2020 Federal Report on Energy Research
- Expansion of research communication with new web portals
- Launch of the Energy Research Newsletter

14.2 Innovative energy technologies

Promising research results are the jumping-off point for new, cost-effective and marketable energy technologies. As described 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 field of renewable energy are testament to the high level of innovation in this field. No less than 983 and 1,077 patents were filed in the field of renewable energy sources in 2018 and 2019 respectively (DPMA (2020b)). This corresponds to a year-on-year increase of 9.6%. The previous decline in patent applications in Germany and abroad virtually ended as a result. The rise in domestic patent applications for wind power plant technology (243 in 2019 compared with 235 in 2018) is particularly reassuring. Most of the applications, 65.2% (2018) and 69.3% (2019) in total, were filed by applicants from abroad. Patents, however, are just one of many facets of innovation and therefore are not an indicator in their own right. More important is the extent to which new products are actually put into practice and bring economic benefit. This information cannot be derived from the number of patents. Apart from this, there is considerable variation in the number of patent applications in different technological disciplines.

German patents filed in the field of automotive engineering are a reflection of innovative transformation processes. Applications for hybrid and electric drives more than doubled between 2010 and 2019 (DPMA (2020a)). Overall, the number of patents filed for combustion engines is still higher than the number of patents for alternative drives. However, a continued decline is evident in the applications relating to internal combustion engines (-10.1% between 2018 and 2019). In contrast, the 22.7% increase in the number of patents filed for all-electric vehicles from 2018 to 2019 is remarkable. Compared with 2010, applications have risen up by as much as 240.2%. Germany leads the field with 313 applications, ahead of Japan (112) and the USA (90). Growth is particularly evident in the number of patent applications filed by companies registered in Germany, whereas a stagnating or declining trend can be observed among companies based abroad. The Federal Government is committed to ensuring that further progress is made in the field of alternative drive technology (see Chapter 7).

Technological advancements and innovations for RES technology in the field of power generation are driving costs down. This is the case when combined with a strongly growing market volume, as well as economies of scale and learning effects, especially for PV and wind power plants (onshore and offshore). The electricity production costs of wind power plants dropped by 50% between 2010 and 2018. This was due in some part to the reductions in investment costs and operating and logistics costs. The energy yield grew as the turbines became larger, while the investment costs only increased to a moderate extent. Innovations have also been implemented in virtually all turbine components (rotor blades, drive train, generator, etc.), augmented by improvements in turbine construction, positioning, control and maintenance (e.g. knowledge of incoming wind and parking effects, predictive damage detection). The electricity production costs of PV systems is determined by the investment costs to a great extent, which have fallen by 75% since 2006. An energy conversion efficiency of more than 22% can be achieved using increasingly efficient types of solar cells (e.g. silicon PERC cells).

Energy storage facilities for electricity and heat are becoming increasingly important with the growing share of renewable energy in the energy supply. If electricity is converted into hydrogen or another chemical energy source before it is stored, for example, the energy can be used in other sectors (sector coupling) – or converted back to electricity. So far it has only been possible to implement a relatively small number of storage technologies at competitive prices in Germany. The main technology pathways that will be pursued in future for grid-oriented stationary energy storage facilities include mechanical concepts (e.g. pumped storage, flywheel mass storage), chemical concepts (power-to-gas/liquid/chemicals), electrochemical concepts (batteries) and thermal storage concepts. To this end, the Federal Government is developing customised funding activities as part of its 7th Energy Research Programme, and is supporting innovations for a broad spectrum of storage technologies within the framework of project funding. It will continue to address new storage concepts and press ahead with technological developments already begun.

The priorities in R&D are progressively shifting towards making power plant processes more flexible. New requirements are emerging as a result of the growing share of renewable energy sources in the electricity market. Research activities in this area are creating the prerequisites to ensure that the German fleet of power stations will be capable of implementing these requirements to an even better extent in the future.

The trend towards products in the highest energy efficiency classes continues unabated. Energy-efficient technologies and devices saw increasing popularity again in 2019. The EU eco-design and the EU energy labelling system continue to make a major contribution to this development. The new EU Energy Labelling Regulation came into force on 1 August 2017, regulating the (gradual) change from the A+++ labels to the A to G labels and the introduction of a product database. The database offers consumers a means of comparing products in terms of energy efficiency and makes it easier for market surveillance authorities to check for compliance with labelling requirements.

Energy efficiency continues to be the focus of building modernisation measures. Efficiency trends in energy-saving modernisation projects funded through the CO_2 Building Modernisation Programme, the Market Incentive Programme for Renewable Energies in the Heating Market and the Energy Efficiency Incentive Programme are providing further evidence of this. The market share of efficient condensing boilers also expanded significantly in the heating and hot water sector in 2019. The share of electric heat pumps also continues to rise (see Chapter 13). Other heat production concepts, such as biomass and solar thermal power are important as well (see Chapter 6).

Of the new passenger cars registered each year, the number of electric and other alternative vehicle drive systems is increasing. Just under 265,000 battery-powered vehicles with more than two wheels were registered in 2019 and 102,288 of these were hybrids (see Chapter 7). And there is still room for improvement with respect to the efficiency of fossil fuel-based vehicles. To this end, the New Vehicle and System Technologies programme was launched. Vehicles with hydrogen-powered fuel cells and natural gas-powered vehicles are mature technologies and are now available on the market (see Chapter 7).

The power-to-x technology market is still in the demonstration facility commissioning phase. The power-to-x technologies, and the power-to-

gas and power-to-fuel technologies in particular, offer promising prospects for interlinking power generation with the gas and mobility sectors in terms of both technology economy (see Chapter 13). Electricity-based fuels will be needed in the long term, especially in the light of ambitious climate targets. This is particularly true in the aviation and shipping sectors and in certain industrial processes where electrification is hardly feasible for technical reasons. At the moment, electricity-based fuels are still very costly. This being the case, one focus of energy research is on power-to-x technologies, to further develop these technologies and reduce the associated costs. In particular, the Living Labs of the Energy Transition introduced with the 7th Energy Research Programme will contribute to bridging the difficult phase between development and market penetration, by enabling testing of such innovative technologies as power-to-x on a relevant industrial scale. Apart from technical and non-technical innovations, research may also focus on socio-economic aspects and social issues, as well as future market models, business models and regulatory schemes. In their capacity as large-scale innovation projects, living labs can also trigger growing demand for technologies that are still being produced on a small-scale or in a manufacturing process, and allow them to take a step toward more industrial production methods. The Energy Transition in the Transport Sector cross-sectoral funding initiative places the focus on the production and use of alternative, electricity-based fuels and the incorporation of new technologies into the energy sector. By 2022, a roadmap is to be created on the basis of research findings, which will provide recommendations for the development, production and market launch of sustainable fuels as a prerequisite for more climate-friendly mobility.

Digital solutions are making their mark across all industries and sectors. Smart metering systems provided for in the GDEW will serve as communication platforms for exchanging data across various utilities (electricity, heating, gas and water) and in the sense of sector coupling (including electric mobility, heating, smart homes). The Federal Government is also using the SINTEG programme to acquire the knowledge required to define the framework conditions for digitisation in the electricity sector. Efforts must be focused on moving beyond simple metering functions along the pathway to smart grids, smart mobility and smart homes and on leveraging the potential offered by digitisation (see Chapter 13). Automated and Connected Driving is a future technology at the interface of mobility and digital progress. It can contribute towards increasing road safety and efficiency, and to reducing mobility-related greenhouse gas emissions. It also allows new business areas to emerge in the service and mobility sectors (see Chapter 7).

Innovations of small and medium-sized enterprises unfold new market potential

Open to all fields of technology and all sectors, the Central Innovation Programme for SMEs has been set up by the BMWi to foster R&D projects in the field of energy technologies. Under its auspices, SMEs and research institutions that cooperate with these enterprises receive grants for ambitious market-oriented research and development projects. This opens up opportunities to establish new business areas for the innovative SME sector in Germany and advance the digitisation of the energy transition. Examples include smart energy storage and generation systems, the application of Industrie 4.0 methods, and IT-supported resources management that incorporates energy saving aspects.

Innovative and highly efficient energy technologies are key prerequisites for a secure, economical and climate-friendly energy supply. The German economy will only be able to expand its technological lead and competitiveness further by more intensive research and development.

Key measures implemented to date for the funding the market launches of innovative technologies

- Promotion of stationary fuel cell heating systems within the framework of the Energy Efficiency Incentive Programme
- Government Programme for Hydrogen and Fuel Cell Technology for the 2016–2026 funding period

Further examples of innovation funding

- Energy Efficiency Incentive Programme (see Chapter 5)
- Strategy for Automated and Connected Driving (see Chapter 7)
- Electric Mobility Showcase
- Funding programme for PV battery storage systems (see Chapter 9)

15. Investments, growth and employment

Where do we stand?

The energy transition in Germany is a modernisation strategy to open up new market potential and to provide tangible impetus for growth and jobs. Innovative business models offer big opportunities in this process.

A total of €25.4 billion was invested in the energy sector in 2018. The expansion of renewable energy sources continued to be a focus of investment, with €13.8 billion in 2018 and €10.5 billion in 2019.

Investments amounting to €43.2 billion were initiated in the area of energy efficiency improvement measures for buildings in 2018.

Employment figures in 2018 were consistent with the year before, with around 368,000 people directly employed in the German energy industry. However, apart from the direct employment figures, a decline was evident in the number of jobs that are indirectly associated with investments in the energy sector. Furthermore, investments in energy-related building modernisation projects also contributed towards the employment of just under 530,000 people in 2018, most of whom are working in in the construction sector.

With around 304,000 employees, the renewable energy sector remains an important economic factor in spite of a significant decline in employment. These figures not only include jobs arising from investments in generating plants, but also those directly associated with the supply of energy.

Between 2000 and 2018, the proportion of energy technology goods in Germany's export volume grew from about 6.2% to around 8.9%, with German manufacturers holding their own in the growing global market for years with approximately constant market shares of almost 14%.

Legislation creates predictability and establishes a robust framework for investments in the energy system. These include the Renewable Energy Sources Act (EEG) 2017, the Amendment to the Grid Expansion Acceleration Act (NABEG), the Amendment to the Incentive Regulation and the Act on the Digitisation of the Energy Transition (GDEW).

What is new?

Incentives for further investments in renewable energy sources are arising from the Omnibus Energy Act (including the implementation of special auctions for onshore wind energy and photovoltaics), for example, as well as the abolition of the 52 GW PV cap and the introduction of a statutory Länder exemption clause on distance regulations for wind turbines (included in the Buildings Energy Act).

The Fuel Emissions Trading Act (BEHG) of December 2019 and the First Act Amending the Fuel Emissions Trading Act of November 2020 create systematic incentives for investments in low-emission and efficient technologies.

The economy is also experiencing new impetus for growth and innovation initiated by the energy elements of the June 2020 economic stimulus package, such as the National Hydrogen Strategy and the expansion of project-based research.

The Coal Phase-out Act of July 2020 will bring coal-fired power generation in Germany to an end by 2038 at the latest and define a dependable framework for future investments in the energy industry. The coal phase-out is being supported by financial assistance amounting to more than €40 billion for the coal regions concerned within the framework of the Structural Reinforcement Act for Mining Regions.

The Covid-19 pandemic poses challenges for the energy industry, particularly in the light of an initial decline in energy demand and falling sales prices.

INVESTMENTS GROWTH EMPLOYMENT	To retain and create jobs in Germany and to lay the foundations for sustainable prosperity and quality of life.

15.1 Investments

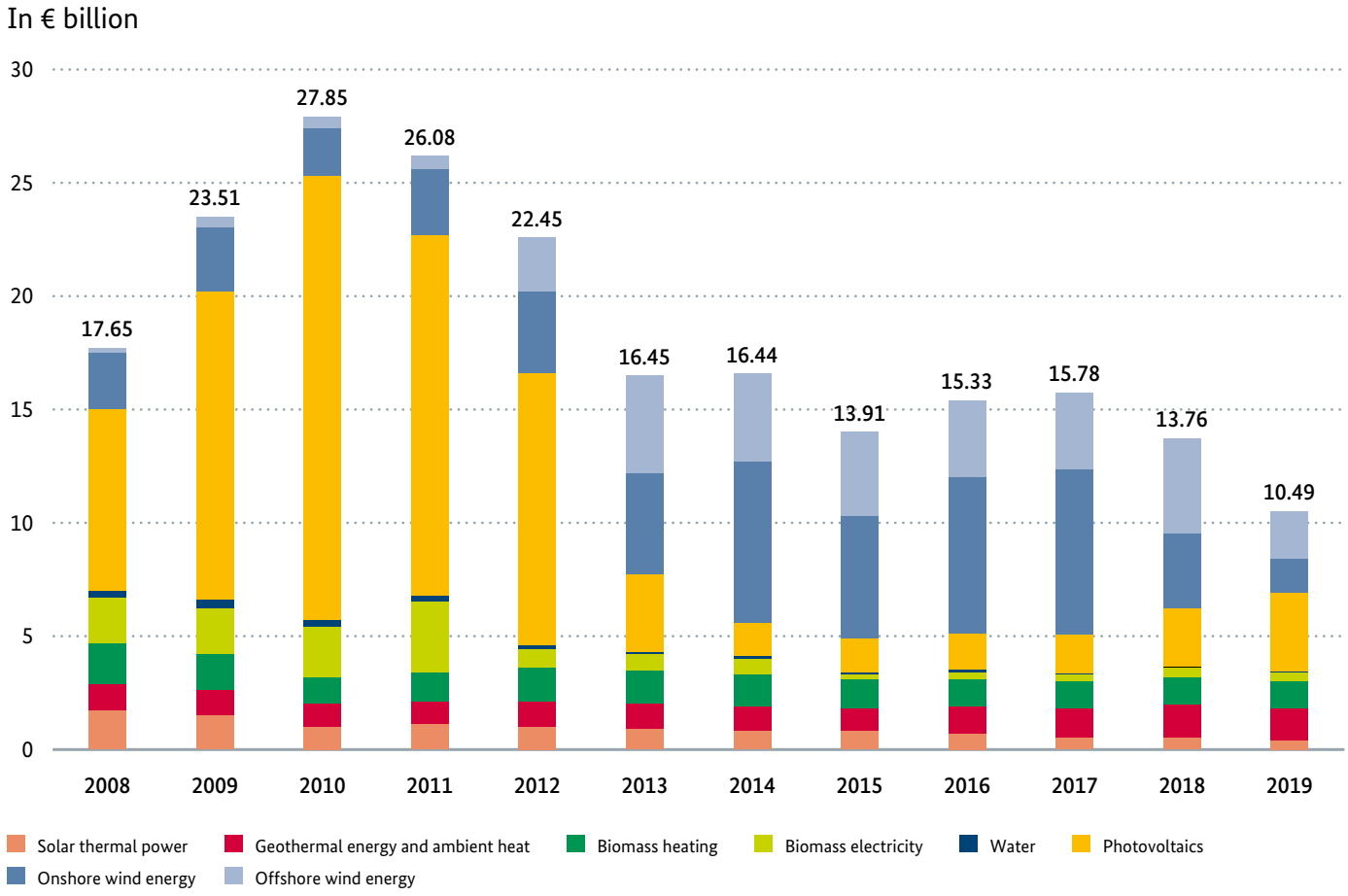
Substantial investments will still be needed in the years to come if the energy transition is to be successful and a modern and efficient infrastructure is to be provided. Clearly defined, consistent framework conditions also increase investment and planning security. This is because they exert a positive influence on companies' investment decisions and the economic viability of innovative business models. This being the case, the Federal Government's Climate Action Programme 2030 and the ensuing decision to introduce a carbon pricing concept for the heating and transport sectors constitute an important step in setting the course ahead. Fuel emissions trading, which will begin in 2021, with an initially predefined price path, will create systematic incentives for investments in low-emission and efficient technologies. Part of the revenue will also be used to relieve the EEG surcharge, thereby encouraging investments in sector coupling technologies. At the same time, there will be a significant increase in existing funding programmes for building modernisation and energy efficiency measures, which will be supplemented by the possibility of tax deductibility for energy-saving modernisation measures. Passed by the Bundestag and Bundesrat in April 2019, the Amendment to the Grid Expansion Acceleration Act (NABEG) is an important milestone for faster grid expansion and the billions of euros in investments that go along with it. In addition, all key measures of the NAPE and the Immediate Action Programme for more private investment in effi-

ciency technology have been carried out by now. In addition to this, the Act on the Digitisation of the Energy Transition (GDEW), which came into force in 2016, is paving the way for innovative business models in the field of digital technologies (see Chapter 13).

The energy industry invested €25.4 billion in 2018, which was a little less than the year before. The term energy industry in this case covers the supply of fuels, operation and maintenance of energy generation facilities, storage and distribution, as well as trading in final energy. The majority of investments went into the supply of electricity and heat, amounting to €13.3 billion. Around €9.9 billion were invested in infrastructures for the distribution of final energy (electricity, gas, heating). The remainder of investments were made in the areas of storage (gas, electricity and heating amounting to €0.7 billion) and facilities for the supply of fuels (coal, petroleum and natural gas, as well as biomass and biofuels amounting to €1.5 billion) (DIW, DLR, GWS (2020)).

Investments in the electricity grids remain at a high level. According to Federal Network Agency figures, transmission and distribution system operators invested around €10.4 billion in grid

Diagram 15.1: Investments in renewable energy



Source: BMWi on the basis of ZSW 09/2020

maintenance and expansion in 2018. This includes investments in cross-border connections and in measurement, control and communication equipment. This is an increase of 7.4% on the previous year (see Chapter 12).

There was a continuing decline in investments in the construction of renewable energy plants in 2018 and 2019, which amounted to around €10.5 billion in 2019 (see Diagram 15.1). A significant reduction in investments was particularly evident in onshore wind energy in 2019. In contrast, there were slight increases in photovoltaics, which accounted for the largest share of all investments in renewable energy plants in 2019, at one third.

Energy transition investments also affect the areas of final energy use, especially in the heating and transport sectors. Expenditure in energy-efficient modernisation of buildings is an important factor in this respect, with investments amounting to €43.2 billion made in 2018. This corresponds to a decline of just under 4% compared with the previous year (BMWi (2020c)). The energy-efficient modernisation of buildings is one of the key measures for increasing energy efficiency. It has unfortunately not been possible to acquire complete data to date on investments in other areas of energy efficiency.

Indirect effects of investments on industrial energy consumers may be attributable to electricity and energy costs or possible cost increases. Energy-intensive industries in Germany are assuming that electricity prices, which have been high for some time by comparison with other countries, are partly responsible for low investment activity, for example. The industries exhibiting a decline in gross fixed capital formation particularly include the paper, glass/ceramics, chemicals, metal production and metalworking sectors. Energy-intensive industries that compete on an international scale continue to benefit from various relief schemes (see Chapter 10).

15.2 Growth

The German economy is currently experiencing a severe recession as a result of the historic slump triggered by the pandemic during the first half of the year and is gradually fighting its way out of the crisis. According to the 2020 autumn projection, the Federal Government is expecting a price-adjusted decline in the gross domestic product of 5.5%. However, the recession already bottomed out in May. After a strong initial revival during May and June, the recovery process continues to be more restrained. The current leading indicators suggest that the process of returning to normal will continue in the coming winter half-year in spite of the renewed increase in the rate of new infections, albeit at a slower pace. The further development of the infection situation will either make or break the country's economic recovery, however. Economic output is expected to grow by 4.4% in 2021. The GDP is not expected to reach the pre-crisis level again until the turn of the year 2021/2022 at the earliest. In its autumn projection, the Federal Government has taken the somewhat friendlier global economic environment in account, as well as the increased dynamics in the national and international infection situation. It has also allowed for the restrictions on social contacts agreed between the Federal Chancellor and the Heads of Government of the Länder on 28 October in an effort to put a stop to the alarming rise in the number of infections. The Covid-19 pandemic is posing challenges for the energy industry, not least due to an initial decline in demand for energy and falling sales prices.

Nevertheless, the energy sectors have an important role to play on the road to recovery after the pandemic. This is because investments made within the context of the energy transition are having extremely positive effects on economic growth. Owing to the interdependencies of intermediate inputs, these investments have a knock-on effect, generating value added in many areas of the national economy. A study was conducted by the Institute of Economic Structures Research (GWS) and Prognos in 2018 to compare the actual situation with a hypothetical situation without the energy transition. The study comes to the conclusion that, as a result of the energy transition, the value added in Germany during 2020 is almost €60 billion (around 2%) higher than it would have been without the energy transition. According to the study, the largest contribution of the energy transition to value added was in the area of equipment investments, meaning investments in power plants as well as in energy-efficient vehicles, equipment and installations. The fact that the study was unable to take the effects of the Covid-19 pandemic into account must be borne in mind. Against this background, the energy-related elements of the June 2020 economic stimulus package, such as the expansion of project-based research at the living labs and SINTEG, the National Hydrogen Strategy and the increase in funds for the CO_2 Building Modernisation Programme (see also Chapters 5, 6,12, 14 and 16), will also provide an important incentive for innovation and economic growth in the post-pandemic recovery process.

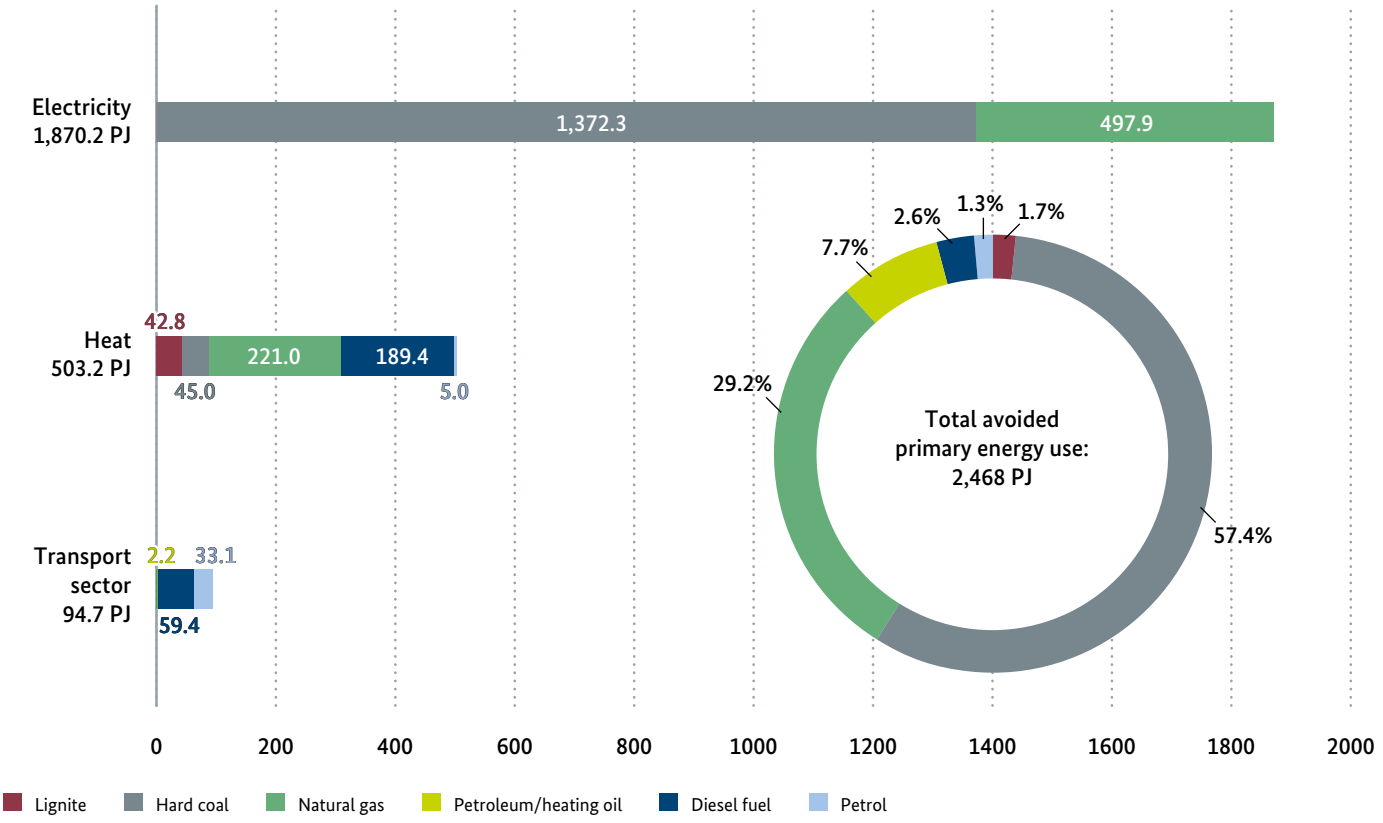
The energy transition has led to a moderate increase in macroeconomic price levels. The Institute of Economic Structures Research and Prognos (2018) are assuming that inflation, i.e. the rise in the cost of living, in Germany will be slightly higher in 2020 than it would have been without the energy transition measures. This development must be regarded in the context of continued low-to-moderate overall inflation in Germany.

Germany is currently covering approximately three quarters of its energy requirements by importing energy sources. The trend in these imports is having an impact on Germany's value added and therefore on economic growth. Imports accounted for virtually all of the quantities of mineral oil, natural gas and hard coal consumed in Germany in 2020. This makes the German economy very vulnerable to the frequently fluctuating prices on the world market. Prices for these fossil fuels rose in 2018, but fell again significantly in 2019 – a development that was intensified to a greater extent at the beginning of the Covid-19 pandemic. Regardless of this, efforts now and in the future must be focused on reducing dependence on individual supply sources on a permanent basis.

More renewable energy sources and concerted endeavours to improve energy efficiency will reduce the need for imported fossil fuels. According to the Federal Environmental Agency, a total of 2,468 billion PJ of energy from fossil fuels were replaced with renewables in the electricity, transport and heating sectors in 2019 (see Diagram 15.2). This meant a further increase in the avoidance of fossil fuels compared with 2018, with an additional 144 PJ avoided. In this way, renewable energy sources can reduce dependency on imports and increase supply security. Increasing energy efficiency also reduces energy requirements (see Chapter 5) and therefore the demand for imports.

Diagram 15.2: Avoided primary energy use of fossil fuels by using renewable energy sources in Germany in 2019

In PJ



Source: UBA based on AGEE-Stat 08/2020

One benefit of the energy transition is the reduction in expenditure for fossil fuel imports. The demand for fossil fuel imports would have been higher in the absence of investments in renewable energy and energy efficiency efforts. According to estimates by the Institute of Economic Structures Research (2020b), renewable energy and energy efficiency dampened fossil fuel imports by about €24.6 billion in 2018. Long-term savings can also be achieved by diversifying energy supply sources and transport routes for natural resources. This therefore remains a priority goal of the Federal Government.

Many capital goods of the energy transition are exported from Germany. Global trading in energy technology goods has almost quadrupled since 2000. Energy technology goods constitute an important category of German exports. Low-emission technologies are produced in branches of industry that are already responsible for substantial shares of German exports and some of these already occupy a prominent position on global markets. These include industries concerned with the production of motor vehicles and motor vehicle parts, mechanical engineering, the production of electronics and electrical equipment, and the

chemical industry. The share of energy technology goods (within the boundaries applied here[3]) in Germany's export volume increased from about 6.2% in 2000 to around 8.9% in 2018. This corresponds to exports worth around €119 billion. An analysis of the various countries' shares in trading shows that German manufacturers of energy technology goods maintain an almost constant share in a growing world market. This share has averaged out at 13.8% since 2000. German industry holds considerable shares in the markets for measurement and control instruments, for instance, and for goods for rational energy supplies. Germany's imports of energy technology amounted to around €82 billion in 2018, which ended with a slight upward trend (GWS (2020a)). However, if we look beyond goods relating to the energy transition to the larger market for environmental and climate protection goods, German companies are maintaining their position as one of the global leaders in exporting these technologies (UBA, BMU (2019) and UBA (2020c)). According to calculations by the German Aerospace Center (DLR) and the German Institute for Economic Research (DIW), equipment and components for the use of renewable energy sources worth around €10.5 billion were exported in 2018, for example.

15.3 Employment

The impact of the energy transition on employment is not only affecting the energy sector in the narrower sense, but also branches of industry that supply commodities to the energy sector. These two areas must be considered together. The energy industry encompasses a broad spectrum of services, from the supply of fuels, operation and maintenance of energy production facilities, storage and distribution, right through to trading in final energy. There is a need for manpower in all of these areas. The expansion of renewables and investments in energy efficiency sharpens the focus on the fact that the growing demand for capital goods in these areas also impacts on production and employment in industries outside the actual energy sector.

Direct employment in the energy sector remained stable to a great extent in 2018. As in the previous year, 368,000 people were employed in this sector. Just under 217,000 people were directly employed in the classical and predominantly conventional energy industry (generating, transmitting, distributing and trading energy, as well as supplying gas and district heating, mining and refining coal, extracting crude oil and natural gas, and processing mineral oil). A good 150,000 people were employed in the operation and maintenance of renewable energy plants and the provision of biomass and biofuels used to produce energy (DIW, DLR, GWS (2020)).

Investment activities in the energy industry continued to induce high employment. In addition to direct employment, the energy industry also creates jobs through investment in the various sectors and value-added steps of providing energy. As far as it has been possible to identify and record these investment activities to an adequate extent, just under 302,000 jobs have been attributed to them for 2018, a figure that is slightly lower than the level for the previous year (DIW, DLR, GWS (2020)).

3 The study is based on official trade statistics, which do not permit a conclusive correlation between individual goods items and energy technology goods or low-emission technologies. They can also be used for other purposes (multiple use problems) and, as a result the results may be overestimated in absolute terms.

Jobs are also created by investments on the energy demand side. These particularly include investments in the energy-saving modernisation of buildings in an effort to improve energy efficiency. Around 530,000 people were employed in this area in 2018, with the main focus on the building and construction industry. Additional employment was created in efficiency services such energy consulting, energy contracting, energy management or IT services. These areas accounted for around 36,500 jobs in 2018 (BMWi (2020c)).

No noticeable impact on employment figures could be ascertained as a result of the transition to electric mobility during the years under review. As far as energy demand in the transport sector is concerned, the growing importance of electric mobility may lead to changes in value added and employment. Changes may affect the automotive industry and its suppliers primarily, as well as related industries. Significant aspects will include the degree to which alternative drive technologies are penetrating the market, the trend in the share of imported upstream manufacturing for the production of electric vehicles, as well as the increase in productivity in the automotive sector and the demand in European and international markets. Attention should also be given to the fact that the structural changes anticipated in this sector of the economy, which is so important to Germany, will not only be shaped by the energy transition, but also by other globally effective developments, such as digitisation, multimodal mobility, networking and automation.

The number of people employed in the field of renewable energy sources totalled a good 304,000 in 2018. Renewable energies not only offer employment in connection with investments in generating plants, but also with the energy supply directly. In parallel with the expansion of renewable energy sources at home (see Chapter 4), exports of German technologies have become a second pillar for securing employment in the renewable energy sectors. However, in 2018, as in 2017, there was a significant decline in gross employment compared with the respective levels of the year before.

The shortage of personnel was most recently perceived as one of the major economic bottlenecks – but what does this mean for the energy transition? After long periods of high unemployment in Germany with the focus on the demand for labour, the focus is gradually shifting to the supply of labour accompanied by the question of sufficient numbers of sufficiently qualified employees. According to an evaluation by the GWS (2018), there are signs of a shortage in qualified personnel in occupational groups associated with the energy transition, such as technical and building professions. The situation in the building trade, in particular, does not present a homogeneous picture: the shortage of personnel varies according to profession, level of expertise and region, with no shortages at all in some Länder and only signs of a shortage in others. It is also very difficult to acquire complete data on the occupational groups associated with the energy transition and the significance of the energy transition for the profession. The implementation of the energy transition also contributes towards employment via upstream service chains, which means there is an additional indirect demand for qualified personnel here as well.

The economic slump in 2020 and the pandemic-related restrictions are having a tremendous impact on the labour market. The level of gainful employment has declined in the wake of the Covid-19 pandemic and unemployment has risen.

So far, it has been possible to prevent an even greater increase in unemployment as a result of the extensive introduction of reduced working hours. The modernisation of buildings is one example of a possible way to strengthen domestic added value again in the energy sector, in some part because of the low level of foreign connections in the building industry. In many cases, unemployed people from other branches of industry can find work in the building sector because of their qualifications. Since July, the labour market has been showing the first signs of recovery and employment is rising, even if it is still well below pre-crisis levels. We can assume that there will be further shortages of skilled personnel in occupational groups with possible associations with the energy transition, such as professions in the building industry, as soon as the economy returns to a pre-Covid-19 level. This could be countered at an early stage with appropriate training and qualifications, which could also be acquired during periods of reduced working hours.

Key measures implemented to date in the fields of investments, growth and employment

Creating planning security and a stable framework for investment in the energy system:

- Renewable Energy Sources Act 2017 (EEG 2017, see Chapter 4)
- Omnibus Energy Act (EnSaG, see Chapter 4)
- Buildings Energy Act (GEG, see Chapter 4)
- Energy Efficiency Strategy 2050 (EffSTRA, see Chapter 5)
- Electricity Market Act (see Chapter 9)
- Act on the Digitisation of the Energy Transition (GDEW, see Chapter 13)
- Amendment to the Incentive Regulation (see Chapter 12).

Providing assistance for the structural transformation caused by the energy transition and opening up new employment opportunities:

- The Structural Reinforcement Act for Mining Regions (StStG) came into force on 14 August 2020 and implements the structural policy recommendations of the Commission on Growth, Structural Change and Employment. Up to €41.09 billion will be made available for the mining regions concerned up to 2038. The disbursement of allocated funds is assured by a new Federal/Länder Coordination Committee.

Supporting German companies in their leading role regarding capital goods for the energy transition and reducing dependency on natural resources:

- Promoting foreign trade with the Energy Export Initiative
- Cooperating within the framework of over 20 energy partnerships and dialogues

Generating new incentives for growth, employment and innovation:

- Energy elements of the economic stimulus package of June 2020

16. Overview of measures

To the extent that measures described in the table below are also measures funded under the Climate Action Programme 2020, detailed information on their implementation status is provided in the annual Climate Action 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.

	Instrument	Implementation status
	Chapter 3: EU and international aspects	
1.	EU Regulation on the Governance of the Energy Union (Governance Regulation)	**Goal:** This Regulation introduces a new planning and monitoring system for implementation of the five dimensions of the Energy Union, particularly including the 2030 Energy and Climate Framework. To this end, the Regulation creates the necessary prerequisites for greater convergence of national energy and climate policies in the various Member States. **Scope/Facts and Figures:** The key elements of the Governance Regulation include the integrated National Energy and Climate Plans (NECP), which every Member State must have submitted to the European Commission by December 2019 (draft by December 2018). The purpose of these is to provide a perspective for the coming 10 years, for the national goals and contributions to the EU 2030 Goals in the five dimensions of the Energy Union (decarbonisation, energy efficiency, energy supply security, the European internal energy market, research, innovation and competitiveness), as well as measures for reaching these goals. To create comparability, the Governance Regulation sets precise specifications for the content and structure of the Plan. These Plans can be updated after five years. Apart from the NECPs, provision is being made for the Member States to submit NECP progress reports every two years from 2023 onwards and the process is to be monitored by the European Commission. This will ensure that the Member States make sufficient contributions with their planned activities toward achieving the 2030 energy and climate goals for the EU and that adjustments can be made, where necessary. In the event that voluntary efforts or progress in achieving the EU goals are not satisfactory, the proposal for the Governance Regulation contains concrete rules for additional measures at EU or Member State level, particularly in the area of renewable energy (gap-filler mechanism), to ensure that the joint EU goals are achieved. **Status:** The Governance Regulation entered into force in December 2018
2.	Integrated National Energy and Climate Plan (NECP)	**Goal/Scope:** The NECP stipulated by the new EU Regulation for the Governance System of the Energy Union is the first European planning and monitoring instrument to provide the framework for achieving the EU's 2030 energy and climate targets by means of national targets and monitoring mechanisms for achieving these targets with a degree of certainty. Each EU Member State has developed and submitted such a plan. The Federal Government adopted its NECP in cabinet on 10 June 2020 and subsequently submitted it to the European Commission. The NECP is an important strategic document on energy and climate policy and is based on the Energy Concept and the Climate Action Programme 2030 in particular. **Status:** The Federal Government's NECP was submitted to the European Commission in June 2020.

	Instrument	Implementation status
3.	Amended Renewable Energy Directive (RED II)	**Goal:** The Directive defines the European framework for funding renewable energy sources for the period between 2020 and 2030. Together with the Governance Regulation, it ensures that the binding EU target for the expansion of renewable energy of at least 32% of gross final energy consumption in 2030 will be implemented with a degree of certainty. **Scope:** The Directive contains regulations for funding energy from renewable sources in the electricity, heating, cooling and transport sectors. It also contains sustainability criteria for gaseous, liquefied and solid biofuels and green fuels. The Directive defines the specific framework for the way in which Member States may set up their funding for renewables in the electricity supply sector. It also contains rules for a voluntary, in some cases cross-border, opening of the support schemes for electricity, as well as for encouraging self-supply using renewables and citizens' energy projects (renewable energy communities). Binding sectoral targets were agreed for the heating and cooling sectors for the first time, according to which the Member States are obliged to aim for an increase in the share of renewables of at least 1.3 percentage points (with a maximum allowance of up to 40% waste heat and cooling) per year by means of suitable measures. Provision is being made for special rules to ensure that the heating and cooling grids also make a reasonable contribution. In the transport sector, marketers of fuels will be obligated to increase the percentage of renewables to at least 14% by 2030. Use of conventional biofuels is to be capped. Certain incentives have been created for new technologies, such as advanced biofuels, electric mobility and power-to-x. **Status:** RED II entered into force in December 2018, and must be transposed into national law by 30 June 2021. The European Commission is planning a further revision of RED II for 2021 with the specific aim of adapting the EU's 2030 target for renewable energy sources.
4.	Concerted Action on the Renewable Energy Sources Directive (CA-RES)	**Goal:** To support the EU Member States in the implementation of the European Renewable Energy Directive. To identify challenges and develop approaches to solutions by means of the exchange taking place within the framework of the format. **Scope/Facts and Figures:** The Concerted Action on the Renewable Energy Sources Directive acts as a communication platform for the European Member States on issues relating to the European Renewable Energy Directive. It focuses on the following five aspects: • Renewable energy in the electricity sector • Renewable energy in the heating sector • Proof of origin • Biomass • Renewable energy in the electricity sector The BMWi represents Germany at the plenary sessions that are held at regular intervals, and devises and organises the workshops conducted on the subject of Renewable Energy in the Electricity Sector. **Status:** Four plenary sessions were held to discuss specific issues relating to the aforementioned subjects at six-monthly intervals during 2018 and 2019.
5.	Amended Energy Efficiency Directive (EED)	**Goal:** The Directive defines the European framework for improving energy efficiency, including concrete energy efficiency targets to be met by 2030, a final energy savings obligation currently extended to 2030 and revised regulations on energy consumption metering. **Scope/Facts and Figures:** Combined with the Governance Regulation, the EED ensures that the EU energy efficiency target of 32.5% will be reached by 2030 (compared with a projection of the European Commission from 2007). This is also the aim of the end-use savings requirement laid down in Article 7 of the EED. The most recent amendment cumulatively extended this requirement to 2030, with a real savings factor of 0.8%. The provisions on energy consumption metering were also revised. **Status:** The amended version of the EED entered into force in December 2018.
6.	Amended Energy Performance of Buildings Directive (EPBD)	**Goal:** To update the EPBD while retaining the basic rules. **Scope:** The benchmarks of the revision are as follows: • The rules are to be integrated into the EPBD on long-term refurbishing strategies previously included in the EED. • An obligation is to be implemented to instigate preparatory measures for creating an electric mobility infrastructure in the buildings sector. • New rules are to be implemented on moving into building automation and a voluntary building assessment instrument, the smart readiness indicator (SMI). **Status:** The EPBD is part of the Clean Energy for All Europeans package, the amended version of which entered into force in July 2018. The requirements of this Directive are being implemented by means of the Building Electromobility Infrastructure Act (GEIG) (currently under debate in parliament) and the Buildings Energy Act (GEG) (which came into force on 1 November 2020).

	Instrument	Implementation status
7.	Accelerating Clean Energy in Buildings Initiative	**Goal:** To help identify potential for sustainable energy in buildings, and remove hurdles to more investment in this area. **Scope:** Many social, financial and technical hurdles must be overcome and administrative challenges dealt with in order to exploit the potential for sustainable energy in buildings. Consumers should be able to decide in favour of energy-efficient solutions when renovating their apartments or houses, for example, whereby financing plays a particularly important role alongside an appropriate regulatory framework. To this end, a new Smart Finance for Smart Buildings initiative is being implemented in close cooperation with the European Investment Bank (EIB) in an effort to mobilise additional public and private funding for energy efficiency and renewables. **Status:** This initiative is part of the Clean Energy for All Europeans package, which was adopted on 6 February 2018. **Facts and Figures:** €10 billion for the Smart Finance for Smart Buildings initiative until 2020.
8.	Amendment to the Directive on the Internal Electricity Market (EU)	**Goal:** To further develop and strengthen the internal electricity market in Europe. **Scope:** The Directive on the Internal Electricity Market contains a number of common rules for the organisation and further development of the European electricity market. These include ground rules for the wholesale electricity and balancing energy markets, which aim to simplify cross-border electricity trading and make the market more easily accessible for various flexibility options. The Directive also stipulates that Members States may make their own decisions on how to solve their grid congestion problems. They can either restructure their bidding zones or solve grid congestion problems by expanding the grid, optimising existing grids and redispatching. To this end, Germany submitted its Bidding Zone Action Plan to the EU Commission at the end of 2019. Apart from this, the Directive contains stipulations regarding the way in which security of supply is to be investigated in the future. It also lays down ground rules for capacity mechanisms, which are to be temporary, market-based and technology neutral, and in future may no longer promote power plants with high levels of CO_2 emissions. Other regulations apply to the organisational structures and tasks of the European associations of transmission and distribution system operators, and to a legal framework for network codes and guidelines. **Status:** The Directive is part of the Clean Energy for All Europeans package and it entered into force on 1 January 2020.
9.	Amendment to the Directive on the Internal Electricity Market (EU)	**Goal:** To expand flexibility, competitiveness and fair pricing in the electricity market with consumers at the focal point of the energy transition. **Scope:** The Internal Electricity Market Directive strengthens the rights of consumers in many different ways. Consumers should now be able to control and monitor their electricity consumption more easily, e.g. by means of dynamic electricity pricing agreements that reflect prices on the electricity exchange, or using smart meters that give consumers a transparent overview of their electricity consumption. A consumer can become what is referred to as an active customer and, in this capacity, can take part in the electricity markets or join forces with other active customers to form an energy company. Aggregators will also help make markets more flexible. The Directive also lays down rules that allow transmission and distribution system operators to own and operate battery-storage system under strict conditions as long as they make investment decisions by 2024. **Status:** In its capacity as part of the Clean Energy for All Europeans package, the Directive had to have been translated into national law by 31 December 2020.
10.	Amended ACER Regulation	**Goal:** To adapt the activities of ACER (Agency for the Cooperation of Energy Regulators) to the new electricity market structure. **Scope:** The Regulation strengthens the position of the Agency for the Cooperation of Energy Regulators (ACER) and provides for an expansion of ACER's competences, e.g. approving a method for European monitoring of supply security. It also formalises the roles of working groups/teams within ACER and strengthens them within the organisation. **Status:** The Regulation is part of the Clean Energy for All Europeans package and is in force.
11.	Risk-preparedness Regulation	**Goal:** To provide a framework for the prevention and management of electricity supply crises and put Member States under obligation to cooperate in a spirit of solidarity. **Scope:** The regulation puts the European Network of Transmission System Operators for Electricity (ENTSO-E) and the competent national agencies under obligation to develop relevant scenarios for electricity supply crises in various regions and/or EU Member States. Furthermore, national authorities must prepare risk preparedness plans containing measures for the prevention and management of electricity supply crises. Cross-border measures must be agreed on between Member States and measures not conforming to market requirements are only permitted under exceptional circumstances. If a Member State is threatened by a supply crisis, the Member State concerned must alert the European Commission and affected Member States beforehand. Member States should join forces in overcoming the crisis and support one another. **Status:** The Risk-preparedness Regulation came into force on 25 June 2019 and has been effective since that date. The relevant regional scenarios for electricity supply crises are currently being determined by ENTSO-E. An initial draft of an overview and description of regional scenarios was published by ENTSO-E on 7 September 2020 and is currently being revised on the basis of comments from the Member States and other parties.

	Instrument	Implementation status
12.	Commission communication on the 15% interconnection target by 2030	**Goal/Scope:** The expansion of cross-border interconnectors is to be strengthened within the EU in order to reduce current congestion and thereby further improve the physical framework for an internal electricity market, facilitate the integration of renewable energy and strengthen security of supply. The European Council therefore underlined the importance of cross-border interconnector capacity for the internal electricity market in October 2014 and confirmed the 15% interconnection target for 2030 proposed by the European Commission. **Status/Facts and Figures:** The electricity interconnection target of 15% for 2030 was specified and operationalised with the adoption of the EU Clean Energy Package. To this end, the following indicators of the urgency of action will be used in the future. (1) The price differential in the wholesale market exceeds an indicative threshold of €2/MWh between Member States, regions or bidding zones. (2) The nominal transmission capacity of interconnectors is below 30% of peak load. (3) The nominal transmission capacity of interconnectors is below 30% of installed renewable generation. New interconnectors will be subject to a socioeconomic and environmental cost-benefit analysis and will only be implemented if the potential benefits outweigh the costs.
13.	Green Deal	**Goal:** The EU Commission's all-embracing strategy for climate protection and growth. **Scope:** Presented on 11 December 2019, the European Green Deal is a multi-pronged set of policy initiatives formulated with the overarching aim of making Europe the world's first climate-neutral continent in 2050. It heralds a wide range of measures, in the areas of energy, the circular economy, finance, mobility, food, biodiversity, air pollution control and chemicals. It also takes the integration of sustainability within the meaning of the 2030 Agenda into account, as well as equitable change processes and a fair, participatory society. **Facts and Figures:** More than 50 individual measures announced.
14.	European Climate Law	**Goal:** To create a regulatory framework for climate policy in order to achieve the EU's emission reduction targets. **Scope:** Enshrinement of the EU's political commitment to be climate neutral by 2050 in legislation. Stipulation of a reduction of at least 55% compared with 1990 as the supply crisis 2030 emission reduction target in accordance with the European Commission's amended proposal of September 2020. Review of progress made by Member States and EU towards achieving the target by the European Commission. **Facts and Figures:** Original proposal for the regulation in March 2020 to be followed by an amended proposal raising the emission reduction target to 55% by 2030, which was submitted in September 2020. The proposed regulation is still in the legislative process.
15.	Climate Target Plan	**Goal:** To set a more ambitious and cost-effective path to achieving climate neutrality by 2050. **Scope:** With the 2030 Climate Target Plan, the Commission proposes to raise the EU's ambition on reducing greenhouse gas emissions to at least 55% below 1990 levels by 2030. Raising the 2030 ambition now helps give certainty to policymakers and investors, so that decisions made in the coming years do not lock in emission levels inconsistent with the EU's goal to be climate-neutral by 2050. **Status:** At the meeting of the European Council held on 10-11 December 2020, EU leaders agreed to raise the EU's 2030 climate target to at least 55% in line with the European Commission's proposal. The European Commission will now start preparing detailed legislative proposals to achieve this target. It will review all relevant policy instruments by June 2021 and, if necessary, propose revisions to enable achievement of the additional emission reductions.
16.	Energy-related aspects of the Recovery Plan	**Goal:** By focusing on specific areas, such as the energy sector, the European Commission wants to ensure that the EU Member States' development and resilience plans drive the Union's green and digital transformation forward. Overall, the plans must include climate-related expenditure amounting to at least 37% (and at least another 20% for digitisation). **Scope:** The European Commission envisages a total of seven key areas for the allocation of funds within the framework of the recovery and resilience plans, which concern the energy sector. Early provision of future-proof, clean technologies and acceleration of the development and use of renewable energy are paramount here, along with efforts to improve the energy efficiency of public and private buildings. Other focal points include the funding of future-proof clean technologies to accelerate the use of sustainable, affordable and smart means of transport, the creation of charging and refuelling stations and the expansion of public transport. **Status:** The Federal Government's Recovery Plan is currently being discussed and agreed and is to be submitted to the European Commission by April 2021.

	Instrument	Implementation status
17.	European Fund for Regional Development (ERDF)	**Goal:** The focus of the new funding period is on an innovative and intelligent economic transition, as well as climate and environmental protection. **Scope:** The European Fund for Regional Development (ERDF) is the most important funding instrument for modernising the economic structure in the European regions. Priority is being given to renewable energy sources, energy efficiency measures and measures to reduce CO_2 emissions in the area of climate protection. **Status/Facts and Figures:** €330 billion have been earmarked for the ERDF across Europe for the funding period 2021–2027.
18.	Just Transition Mechanism (JTM)	**Goal:** To provide support in addressing the social and economic consequences of the structural transition resulting from the 2050 climate neutrality target. **Scope:** The Just Transition Mechanism is founded on three pillars: 1) the Just Transition Fund, which is designed to use the structures of the EU Structural Funds to provide support, mainly through grants, to regions particularly affected by structural change, 2) access to InvestEU for the financing of structural change, and 3) the Public Sector Loan Facility, which is designed to provide investment support to the public sector. **Status:** Negotiations on the legal acts of the pillars of the JTM, and on the appropriations for 2021-27 in particular, all of which have not yet been concluded (while the Public Sector Loan Facility is still open, negotiations on the policies of the Just Transition Facility have been concluded and are expected to enter into force in the second quarter of 2021).
19.	EU Action Plan: Financing Sustainable Growth	**Goal:** To redirect capital flows towards sustainable investments in order to achieve sustainable growth and a more sustainable economic system in general, to manage financial risks arising from climate change, resource depletion, environmental degradation and social issues and to foster transparency and long-termism in financial and economic activity. **Scope:** The Action Plan embodies various measures for reaching the aforementioned goals. Examples of these include the introduction of an EU classification system for sustainable economic activities (the so-called EU taxonomy), the development of standards and labels for sustainable financial products and sustainability benchmarks, as well as the promotion of investments in sustainable projects. **Status:** The Action Plan was announced in March 2018 as a communication from the European Commission and its measures are being implemented successively. A political agreement was reached on the regulation for the central project of the EU taxonomy in December 2019, for instance. It was published in the Official Journal of the EU in June 2020 and has now been specified with technical thresholds. The Commission announced the so-called Renewed Sustainable Finance Strategy, which is to follow the Financing Sustainable Growth action plan, for the first months of 2021.
20.	Energy System Integration Strategy	**Goal:** The strategy sets out a vision of how the transition to a more integrated energy system can be accelerated – to a system that supports a climate-neutral economy at the lowest possible cost for all sectors, while strengthening energy security, protecting health and the environment, as well as fostering growth and innovation and consolidating industrial leadership at global level. **Scope:** Concrete political and, from 2021, legislative measures are proposed at EU level to progressively shape a new integrated energy system. These measures focus on the following areas in particular: • Increased energy efficiency by using waste heat from industrial plants and data processing centres, for example; • Accelerated electrification of final energy consumption with a continuously increasing supply of electricity from renewable sources; • Funding for renewable and low-carbon fuels, including hydrogen, for which a separate hydrogen strategy has been published (see Measure 21); • Strengthening competitive and consumer-driven markets; • Better integration of the infrastructures; • Support for the digitisation of the energy system. **Status:** The Strategy was announced in July 2020 as a communication from the European Commission. The measures included in the Strategy are initially only proposals that must be put forward and negotiated in detail at EU level in order to be implemented.

	Instrument	Implementation status
21.	EU Hydrogen Strategy	**Goal:** To complement the Energy System Integration Strategy and contribute towards the gradual establishment of a European hydrogen market. **Scope:** In this, the European Commission presents a strategic roadmap to show how hydrogen (obtained primarily from renewable sources) can contribute towards achieving a decarbonised European energy and economic system by 2050. It also announces the creation of a system for the pan-European certification of renewable and low-carbon hydrogen, as well as suitable grant schemes (such as Carbon Contracts for Difference). Last but not least, it provides for creation of the necessary infrastructures, advancement of research and innovation and the establishment of international partnerships. The strategy also paves the way for the European Alliance for Clean Hydrogen, which aims to help support and implement the measures and promote investments. The Strategy is closely meshed with other EU initiatives, such as the Energy System Integration Strategy, the InvestEU programme and the Commission's upcoming Sustainable and Smart Mobility Strategy. **Status:** The Strategy was announced at the beginning of July 2020 as a communication from the European Commission. The measures included in the Strategy are initially only proposals that must be put forward and negotiated in detail at EU level in order to be implemented. **Facts and Figures:** Electrolysers with an electrolytic capacity of at least 6 GW are to be installed for the production of renewable hydrogen during the first phase, between 2020 and 2024, producing up to 1 million tonnes of renewable hydrogen. Electrolysers with an electrolytic capacity of at least 40 GW are to be installed throughout the EU during the second phase, between 2025 and 2030, producing up to 10 million tonnes of renewable hydrogen. In the third phase, from 2030 to 2050, renewable hydrogen technologies should be mature and deployed on a large scale.
22.	Strategy on Offshore Renewable Energy	**Goal:** The European Commission's strategy aims to show how the potential of offshore renewables can be harnessed to achieve climate neutrality by 2050 while contributing to post-Covid-19 economic recovery. **Scope/Facts and Figures:** The European Commission estimates that it will be necessary to install 300 GW of offshore wind and 40 GW of other marine renewables in European waters by 2050 in order to achieve climate neutrality by 2050. It is therefore proposing a series of measures at EU level to drive the expansion forward. It envisages better coordination of Member States' national spatial and grid planning, for example, an improvement in the regulatory framework for joint cross-border projects and hybrid projects combining offshore grid connection and interconnector functions, funding for research and development and consolidation of European value-added chains. **Status:** The Strategy was adopted on 18 November 2020 and published on 19 November 2020. It serves as the Commission's first proposal for discussion and forms the basis for further legislative initiatives, guidelines and measures which will be proposed and discussed with the Member States in the years to come.
23.	Renovation Wave	**Goal:** The European Commission's Renovation Wave (RW) announced for October 2020 is part of the EU Green Deal and a core element of the EU recovery after the Covid-19 pandemic. The RW aims to make a significant contribution towards achieving the energy and climate targets by escalating the renovation rate substantially (to at least double) by increasing efficiency and RE, to reduce energy poverty in the EU and provide economic impetus for the EU recovery following the Covid-19 pandemic. **Scope:** The Renovation Wave is part of the EU Green Deal. The Commission is launching the Renovation Wave initiative in an effort to accelerate and intensify the renovation of energy systems in residential and non-residential buildings. To this end, the EU-wide annual renovation rate is to be at least doubled by 2030. 35 million buildings in the EU are to be modernised and an additional 160,000 "green" jobs created in the construction sector by 2030. The focal points of the Renovation Wave particularly include information, legal certainty and incentives (announcing revised versions of EPBD, EED, RED II, etc.), more targeted funding (public and private), skills and technical advice, "green" jobs, sustainable construction, a life cycle approach, digitisation, an integrated, participatory and neighbourly (urban quarter) approach, in addition to the New European Bauhaus approach. **Status:** The European Commission submitted a communication for a Renovation Wave for Europe: Greening Our Buildings, Creating Jobs, Improving Lives initiative on 14 October 2020. With this initiative, the Commission announced non-legislative and legislative measures for the period between 2020 and 2024.

	Instrument	Implementation status
24.	Draft of a Long-term EU Climate Strategy	**Goal:** The strategy puts forward scenarios up to 2050 that are consistent with the Paris Climate Agreement's goal of limiting global warming to well below 2°C, preferably 1.5°C. **Scope:** The Commission wants to rely on renewable energy sources and energy savings to an even greater extent in order to reduce net greenhouse gas emissions to zero by 2050. This being the case, the percentage of renewable energy in electricity generation is to be increased to at least 80% and energy consumption halved. Apart from this, electrification is to be intensified in industry and the transport sector. More low-emission mobility options are to be used and the circular economy is to be promoted. Where emissions are unavoidable, in agriculture for example, these are to be countered by natural carbon sinks on the one hand and carbon capture and storage (CCS) concepts on the other. **Facts and Figures:** Overall, decarbonisation of the European economy will require additional annual investments of €175 to €190 billion, according to the scenario to be implemented. This represents 2.8% of the gross domestic product instead of the 2% invested so far. **Status:** The European Union communicated its Long-term Climate Strategy to the United Nations on 7 March 2020. It formulates the target of net-zero greenhouse gases by 2050. The EU strategy is based on the European Commission's communication entitled A Clean Planet for All, which outlined the vision of a GHG-neutral EU by 2050 for the first time.
25.	Regulation on setting up the LIFE Programme for the Environment and Climate Action	**Goal:** To protect, restore and improve the quality of the environment and to curb and reverse loss of biodiversity and ecosystem degradation, and to support the transition to a sustainable, circular, energy-efficient economic system based on renewables, which is climate-neutral and climate-resilient. **Scope:** The LIFE programme was already included in the budgetary period 2014–2020 and should be continued in the period 2021–2027. Funding will be provided for projects, for example in a new sub-programme for the energy transition that help to create capacities and distribute knowledge and innovation, in order to achieve renewables and efficiency targets at EU level. **Status:** The Regulation on extending the LIFE programme was proposed by the European Commission in June 2018. **Facts and Figures:** The programme is to be endowed with a total of €4.81 billion with a large portion earmarked for the climate policy, which also includes the Clean Energy Transition sub-programme.
26.	EU Ecodesign Directive	**Goal:** The EU Ecodesign Directive establishes a framework for the environmentally compatible design of energy-using and energy-related products. **Scope:** Imposing minimum requirements for energy and resource efficiency, the Ecodesign product regulations ensure that inefficient products are no longer allowed on the market. **Status:** The Federal Government is involved in monitoring the further development of the Ecodesign Directive and the associated product regulations at regular intervals.
27.	Strategy to Reduce Methane Emissions	**Goal:** Reducing methane emissions is one of the priority initiatives of the European Commission's EU Green Deal Initiative. The announced Methane Strategy aims to support the transition to a clean energy system. The strategy focuses on curbing temperature development by 2050, improving air quality and strengthening the EU's global leadership in the battle against climate change. **Scope:** The European Commission would like the Methane Strategy to take the form of an integrated strategy. Apart from energy, it should also include waste and agriculture, as these three sectors account for almost all anthropogenic methane emissions. As far as energy-related methane emissions are concerned, the entire value-added chain in the gas, oil and coal sectors is to be considered, both within and outside the EU. As methane emissions go beyond national boundaries, the European Green Deal also emphasises the need for collaboration with international partners in the form of cooperative ventures with multilateral initiatives, for example. **Status:** The European Commission published a communication on an EU strategy to reduce methane emissions in October 2020 and a legislative proposal is planned for the first half of 2021.
28.	European Climate Pact	**Goal:** The European Climate Pact is an EU-wide initiative that aims to empower stakeholders and communities in climate change mitigation action and more sustainable behaviour. It focuses on raising awareness of climate protection and supporting implemented measures. **Scope:** The European Commission is planning to establish a dedicated secretariat to support the implementation of the Pact. Its purpose will be to provide information and communicate on climate change mitigation, to encourage the involvement of citizens and stakeholders, to establish governance and to implement the Pact. The measures to be taken in an effort to raise public awareness of climate protection will include the appointment of Climate Pact Ambassadors and more intensified integration of climate change mitigation into educational programmes. Within the pact, existing climate protection initiatives are to be supported with a special focus on green spaces, green mobility, green buildings and green skills. **Status:** The European Commission published a communication on the European Climate Pact in December 2020.

	Instrument	Implementation status
29.	Cross-border grid expansion	**Goal:** To push ahead with the expansion of cross-border interconnectors in order to further improve the physical prerequisites for the internal electricity market, facilitate the integration of renewable energy and strengthen security of supply. Additional grid expansion projects must also be implemented and ongoing projects completed to achieve the 10% European interconnection target in 2020 and for further development toward the 2030 target. **Scope:** Legislation has been passed for ten interconnector projects to further expand numerous interconnection points with our neighbours. Four additional interconnector projects are to be included within the framework of the 2020 BBPIG Amendment. **Status:** Seven of the ten interconnector projects established by law are already in service or are to be commissioned by 2023 at the latest. Specific planning and approval of the new projects agreed in the Grid Development Plan are not expected until the projects have been confirmed under the Federal Requirement Plan Act (BBPIG). **Facts and Figures:** By putting all the planned interconnectors into service, more than 1,000 km of lines will be uprated or newly constructed, and the cross-border interconnector capacity will be roughly doubled by 2030.
30.	Regional partnerships	**Goal:** Regional partnerships offer Member States a means of becoming involved in joint projects, contributing towards the implementation of European regulations, testing new policy measures before they become European law, and consulting with neighbouring countries on a regular basis regarding developments. Regional partnerships thus support mutual consensus for national challenges and lead to further integration of European electricity markets. Regional partnerships also play a key role in preparing the Federal Government's NECP. **Scope:** Numerous bilateral and multilateral partnerships have been set up between Germany and the EU Member States. A few examples of important partnerships are listed here: • The group of electricity neighbours was recently used to inform neighbouring countries about Germany's coal phase-out and to discuss a basic consensus on the monitoring of supply security. • Among other things, the Pentalateral Energy Forum is currently working on regional supply security reports, more intensified cooperation on crisis prevention and a joint vision for the 2050 electricity system. • The five countries – Belgium, Luxembourg, the Netherlands, France and Germany – have been exchanging information on the security of the gas supply and current gas issues since 2009. • The institutionalised North Seas Energy Cooperation in the energy sector has existed since 2016, and is concerned with such topics as maritime spatial planning, grid development and coordination, funding and financial support for offshore wind energy and creating standards for offshore wind energy generation. In 2020, under the German co-presidency, the North Sea Energy Cooperation will investigate the possibility of removing obstacles to hybrid and joint offshore wind farm projects with connections to several countries in closer detail. The work currently conducted by the North Sea Energy Cooperation constitutes important input for addressing the topic of offshore wind energy in the EU Council under the German Presidency. • The Baltic Energy Market Interconnection Plan (BEMIP) is concerned with the coupling of regional electricity markets, as well as regional aspects of supply security and renewables. • The TEN-E regional groups for gas, oil and electricity cooperate with each other with respect to the corresponding transport infrastructure. • Examples of bilateral partnerships: The Smart Border Initiative between Germany and France, which aims to optimise the management of the distribution systems in the Saarland-Lothringen region by means of a virtual management tool and a new physical connection at the distribution system level. The electricity bridge between Germany and Belgium acts as a link between the two national power grids. Construction work has started on this project, which aims to stabilise grid operation in the region and to satisfy Belgian demand for electricity from Germany.
31.	Congestion management at the Austrian-German border	**Goal:** To reduce grid loads in Germany, Poland and the Czech Republic with greater supply security and savings for grid operators. **Scope:** Electricity trading between Germany and Austria has reached a level that exceeds the ability of grids to transport this energy. Both countries therefore agreed on introducing a congestion management scheme commencing in October 2018. Although electricity trading has been restricted since then, in an effort to bring it in line with the transmission capacity that is actually available at the border, at least 4.9 GW is to be available for trading at all times. **Status:** The congestion management scheme became effective in October 2018. **Facts and Figures:** German electricity customers will save several hundred million euros every year.

	Instrument	Implementation status
32.	Amended Trans-European Networks for Energy (TEN-E) Regulation	**Goal:** To introduce a new approach to cross-border infrastructure planning that takes into account the 2030 climate target, the achievement of EU greenhouse gas neutrality by 2050, the promotion of renewables and the implementation of the Green Deal. **Scope:** The purpose of the revision is to eliminate obstacles to sector integration and being the Regulation more in line with renewable energy sources. To this end, new categories are to be created for hydrogen, electrolyser projects and smart gas grids, and offshore projects are to be strengthened. The Regulation will not apply to conventional oil and gas projects. The planning of electricity grids is to be closely linked with the planning of gas grids, and rules for coordinated long-term and integrated offshore and onshore network planning are to be introduced. Measures will be introduced to simplify and streamline PCI approval procedures and greater focus will be given to transparency and participation in consultations. Apart from this, so-called projects of mutual interest, which enjoy PCI-like privileges, will be introduced for interconnectors to third countries. **Status:** The European Commission put forward a proposal on this in 15 December 2020. The Regulation is to come into force on 1 January 2022 and will therefore not apply until the 6th (next but one) PCI List is adopted.
33.	Electricity and gas infrastructure financing programmes	**Scope:** The EU operates a policy of setting up Trans-European Networks for Energy (TEN-Es). Various funding programs help to cover this need for investment, including the Connecting Europe Facility (CEF) or the European Energy Programme for Recovery (EEPR), for example. Financial support by the EU within the framework of the CEF is an important factor in the implementation of significant energy infrastructure Projects of Common Interest (PCIs) in the electricity and gas sectors. **Status:** The current budgetary period runs from 2014 to 2020. In March 2019, the European Council and Parliament agreed on a new CEF funding phase for the 2021–2027 budgetary period (CEF Regulation). The European Commission published what is now the fourth PCI List in October 2019. It includes a total of 151 projects in the energy infrastructure sector, around 70% of which are concerned with electricity and smart grids, and entered into force as Commission Delegated Regulation (EU) 2020/389 of 31 October 2019. **Facts and Figures:** The EU Commission has identified an aggregate need for investment in European electricity and gas infrastructures to the amount of more than €200 billion. The CEF has a budget of €30 billion for the current budget period, with a good €9 billion earmarked for the energy infrastructure. The new MFF 2021–2027 envisages a budget of around €18.4 billion, around €5.2 billion of which are to be allocated to the energy sector.
34.	Implementation of Directive (EU) 2019/692 amending Directive 2009/73/EC concerning common rules for the internal market in natural gas	**Goal:** To implement the Directive of 17 April 2019. **Scope:** The Directive extends the regulatory law of the 3rd internal market package to include gas pipeline connections with third countries, where such pipelines are routed through the territory or coastal waters of the Member States (concerns provisions on third-party access, tariff regulation, ownership unbundling and transparency). **Status:** The legislative process was concluded in November 2019.
35.	Gas infrastructure diversification measures	**Goal/Scope:** The amended Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply expands the options for ensuring an uninterrupted supply of gas for customers throughout the European Union. The key principles set forth in the Regulation form the basis for regional partnerships within the framework of crisis prevention and mutual support and solidarity among the Member States in the management of gas supply crises. Member States are to add a regional chapter to their respective risk analyses and prevention and contingency plans, and work on bilateral agreements on supportive gas deliveries in the event of supply shortfalls that the Member State concerned is unable to remedy with market-based measures. The purpose of the Regulation is to secure the gas supply, within the framework of both European gas transmission systems and distribution systems. Measures for security of supply in Europe are also closely coordinated and harmonised within the framework of the "Gas Coordination Group" in Brussels.
36.	Energy Diplomacy Action Plan	**Goal:** To establish a coherent EU foreign energy policy that identifies the geopolitical implications of the energy transition for the EU and formulates appropriate foreign policy strategies. **Scope:** The Energy Diplomacy Action Plan has identified four priority areas for action so far: diversifying sources, suppliers and routes, expanding energy partnerships and dialogues, the continual improvement of nuclear safety, and defining international energy architecture and multilateral initiatives. In this context, the Federal Foreign Office has commissioned the German Institute for International and Security Affairs (SWP) to conduct a series of workshops on the subject of "Geopolitics of Energy Transition". These are being conducted together with the EEAS, the European Commission, the French, Polish and Spanish Ministries of Foreign Affairs and other think tanks. A total of 5 workshops have been commissioned, as well as at least 3 scientific publications. The energy transition is also leading to a profound change in international relations and the geopolitical ramifications have not yet been investigated to an

	Instrument	Implementation status
36.	*Energy Diplomacy Action Plan*	adequate extent. Germany and the EU must take a stronger stand in the face of these developments and issues in the spirit of a preventive foreign policy. The time is right: a first comprehensive study on this topic was published by a Global Commission under the umbrella of IRENA in January 2019. It was initiated and co-financed by Germany (AA), NOR and ARE. **Status/Facts and Figures:** The Action Plan was adopted in July 2015. Since then, energy has become an important component of cooperation between the EU and neighbouring countries. Plans provide for an even greater exchange of data between the EU and third countries in order to promote an exchange of knowledge and a transfer of technology. The ongoing AA-SWP project was concluded with a final workshop in October 2020. The European External Action Service, the European Commission and the AA are planning to launch Council conclusions in early 2021 that will better dovetail the EU's external energy and climate policies in the light of the Green Deal.
37.	Market Stability Reserve for the EU Emissions Trading System	**Goal:** To reduce the surplus of EU ETS allowances. **Scope:** If the total number of allowances in circulation exceeds €833 million, allowances are withdrawn from the market at a certain rate by reducing the auctioned quantities. If the total number of allowances in circulation falls below €400 million, allowances are issued from the Market Stability Reserve (MSR). In this way, the EU ETS can also take some of the reduction effects attributable to additional national measures into account and reduce the number of allowances. Apart from this, if electricity generating capacities are shut down due to additional national climate protection measures, the Member States may now delete a corresponding number of allowances from national auctions in accordance with the Emissions Trading Directive. The Federal Government has not yet decided whether to make use of the option to delete emission allowances. Although allowances will be deleted as a result of the coal phase-out, the number and the exact process have not yet been determined. **Status:** The Market Stability Reserve has been effective since 1 January 2019. **Facts and Figures:** The EU ETS reform for the fourth trading period also stipulates that the number of emission allowances absorbed by the MSR should amount to 24% each year for five years (instead of the 12% envisaged so far).
38.	Reform of the EU emissions trading system for the period 2021–2030	**Goal:** To strengthen the price signals of the EU ETS and maintain the international competitiveness of the energy-intensive industry. **Scope:** The total number of emission allowances will decline by 2.2% per year from 2021 onwards, so that emissions in the EU ETS sectors in 2030 will be 43% lower than in 2005. It is no longer possible to use allowances from international project mechanisms. In addition, the rules on the free allocation of allowances to certain polluters, who will be facing high emissions and strong international competition at the same time, will still be in place. The list of sectors affected by possible carbon leakage is compiled on the basis of trade and emission intensities. Furthermore, a number of funds will be set up for the modernisation of energy systems and promotion of innovate technologies for climate change mitigation. **Facts and Figures:** The reform will lead to a reduction of around 484 million tonnes of CO_2 equivalent between 2021 and 2023 – this is equivalent to more than half of the total annual greenhouse gases produced in Germany. **Status:** Entered into force in April 2018.
39.	Transferring backloading allowances into the Market Stability Reserve	**Goal:** To retain the functionality of the EU-ETS in the face of high surpluses in emission allowances and price erosion. **Scope/Status/Facts and Figures:** A total of 900 million EU ETS allowances were held back between 2014 and 2016 that should actually have been auctioned in the period 2019–2020 (backloading). These emission allowances are to be transferred to the Market Stability Reserve.
40.	Linking the European Emissions Trading System (EU ETS) with the Swiss Emissions Trading System (CH ETS)	**Goal:** First step towards the long-term goal of an international emissions trading market. **Scope:** The linkage is intended to level the playing field for European and Swiss companies by means of converging certificate prices. **Status:** The agreement on linking the two systems was signed in November 2017 and entered into force on 1 January 2020.
41.	CORSIA	**Goal/Scope:** The Carbon Offsetting and Reduction Scheme for International Aviation, or CORSIA for short, was adopted in 2016 as a global, market-based climate protection measure to limit emissions. In this scheme, aircraft operators can compensate for CO_2 emissions above the CORSIA baseline by purchasing credits from climate protection projects to reduce emissions outside the sector (offsetting). **Status:** The CORSIA reporting obligations have been in effect since 1 January 2019 and the pilot phase is due to start in 2021. Aircraft operators will have to surrender allowances under CORSIA in 2025 for the first time for the growth emissions during the three-year period 2021–2023.

	Instrument	Implementation status
42.	EU Climate Action Regulation	**Goal:** To set binding national emission targets in the non-ETS sectors for the EU Member States by 2030. **Scope:** The national targets range between 0 and 40% GHG reductions compared with 2005, depending on the GDP per capita in the respective Member State. However, flexible mechanisms are allowed for reaching the targets. **Status:** The new Effort Sharing Regulation entered into force in the summer of 2018. **Facts and Figures:** The resulting reduction target for Germany amounts to 38% compared with 2005.
43.	European Climate Initiative	**Goal/Scope/Status:** Funding is made available for projects that promote the exchange of good practices between sub-state players, civil society, business and scientists.
44.	Meseberg Climate Working Group	**Goal/Scope:** The decision to create this high-level, inter-ministerial working group on climate change was made during Franco-German government consultations in Meseberg in June 2018, which were held to intensify cooperation on this cross-cutting issue. This also includes the development of common views on the energy transition and sustainable funding instruments, as well as economic incentives, including aspects of carbon pricing. **Status:** The third session of the Climate Working Group was held in a virtual format on 28 April 2020. The Working Group meets at least once a year under the leadership of the state secretaries responsible for climate change.
45.	Europe on the Move Mobility Package	See Chapter 7.
46.	Second mobility package for the regulation of CO_2 emissions of passenger cars and light commercial vehicles after 2020	See Chapter 7.
47.	Initial introduction of CO_2 emission targets for new heavy commercial vehicles	See Chapter 7.
48.	Declaration of EU Member States on the future of clean energy and mobility	See Chapter 7.
49.	Improving the framework conditions for the use of shore-side electricity in ports	**Goal:** To reduce emissions of greenhouse gases, air pollutants and noise produced as a result of ships using marine diesel engines to generate electricity during their lay time in ports. **Scope/Facts and Figures:** A comprehensive package of measures is currently being implemented in an effort to meet this goal and improve the economic efficiency of shore-side electricity by comparison with on-board electricity: • A new Special Equalisation Scheme for shore-side electricity in maritime ports (restriction of the EEG surcharge to 20%). • Grid fees in maritime parts based on a daily rate instead of the usual annual or monthly fees. • Investigation of other framework conditions relating to energy law and technical aspects and possible regulatory loopholes that are currently hampering the use of shore-side power systems. • €176 million from the Energy and Climate Fund between 2020 and 2023 in the form of financial assistance from the Federal Government for the Länder to invest in onshore power plants in maritime and inland ports. • EU initiative for better use of shore-side electricity **Status:** • The Special Equalisation Scheme is addressed in the current EEG Amendment. • The Ordinance on Grid Fees for Shore-side Power Supply and on the Editorial Adaptation of Provisions in Regulatory Law came into force on 31 December 2019. • The need to adapt specific regulations is currently being evaluated. • An administrative agreement on the granting of financial assistance was mutually agreed between the Federal Government and the Länder and entered into force on 3 November 2020. • The first key points of a possible EU initiative have been developed and are currently under discussion within the Working Group on Shore-side Electricity.

	Instrument	Implementation status
50.	25th World Climate Conference (COP 25)	**Goal:** To adopt the uniform rules on implementing the Paris Climate Agreement that have still not been clarified. **Scope:** All of the Parties are to present revised climate change mitigation pledges for the next decade and a long-term strategy up to 2050 by the next World Climate Conference. **Status:** The conference took place in Madrid in December 2019. The 26th World Climate Conference was postponed until November 2021 due to the COVID-19 pandemic.
51.	Petersberg Climate Dialogue	**Goal/Scope:** The Petersberg Climate Dialogue (PCD) was launched in 2010 at the suggestion of Chancellor Angela Merkel. Since then, the PCD has created a space for a trusting and constructive exchange between ministers. A central component of this has always been the joint organisation of the PCD with the country holding the Presidency of the next UN Climate Change Conference. **Status:** The 11th Petersberg Climate Dialogue took the form of a video conference, which was held on 27 and 28 April 2020. Co-hosted by the United Kingdom as Presidency of the next UN Climate Change Conference, COP 26, ministers from around 30 countries discussed measures for a sustainable way out of the economic crisis at the invitation of Federal Environment Minister Svenja Schulze.
52.	Bilateral energy partnerships and dialogues	**Goal/Scope:** Collaboration on energy policy and exchange of experience with Algeria Angola Ethiopia Australia Brazil Chile China India Iran Japan Jordan Canada Kazakhstan Morocco Mexico Nigeria Russia South Africa South Korea Tunisia Turkey Ukraine USA UAE on many subjects, including renewable energy sources, energy efficiency, integration of renewables, hydrogen, coal phase-out, digitisation. **Status:** Activities within the energy partnerships and dialogues include high-level steering group meetings, energy days, WG meetings, study and delegation trips, workshops, advisory councils for local businesses. Detailed information relating to the individual countries can be found in the annual reports for 2018 at (https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/jahresbericht-energiepartnerschaften2018.pdf?blob=publication File&v=10) and 2019 at (https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/jahresbericht-energiepartnerschaften2019.pdf?blob=publication File&v=10).
53.	Berlin Energy Transition Dialogue (BETD)	**Goal:** This conference provides a forum for international decision makers in energy and foreign policy, for industry, the scientific community and the general public, in order to discuss current developments in energy policy, innovative policy mechanisms, new investment opportunities and business models in connection with the global energy transition. **Status/Scope:** Planned for April 2020, the sixth BETD was cancelled in the wake of the Covid-19 crisis and took place in the form of a virtual campaign. The seventh BETD is scheduled to take place on 16/17 March 2021 under the motto: Energy Transition – Towards Climate Neutrality.

	Instrument	Implementation status
54.	Energy Efficiency Hub	**Goal:** To expand international collaboration in the field of energy efficiency. **Scope:** The Energy Efficiency Hub will bundle and coordinate the work of various working groups (on products, funding, energy management, etc.). It is also to act as a platform for the future collaboration of international organisations and initiatives for strengthening energy efficiency. **Status:** Founded in 2019, the Energy Efficiency Hub reports to the International Energy Agency and at present has just under 20 members. The secretariat is in the process of being set up.
55.	Energy Export Initiative	**Goal:** The Federal Government specifically supports German businesses in tapping into foreign markets and expanding exports of climate-friendly energy technologies. The main target groups are small to medium-sized enterprises (SMEs). The Energy Export Initiative was created in 2015 as the follow-up organisation of the Renewable Energy Export Initiative and the Energy Efficiency Export Initiative. **Scope:** The focus is on technical solutions and services in the fields of renewable energy sources, energy efficiency, storage technologies and smart grids, as well as new technologies, such as power-to-gas or fuel cells. Please see the following link for more detailed information: www.german-energy-solutions.de. **Status/Facts and Figures:** Around 160 events are organised within the initiative each year.
56.	Development cooperation for promotion of the global energy transition	**Goal:** To provide a sustainable, needs-based energy supply in line with the 2030 Agenda (SDG 7) in partner countries of the German development cooperation. **Scope:** The cooperation is promoted by means of financial cooperation (FC), which provides investments in property, plant and equipment, and technical cooperation (TC), which promotes the development of appropriate framework conditions, structures and capacities by means of policy advice. Renewable energy systems are being expanded in an effort to overcome energy poverty for households, SMEs and industrial applications, while at the same time achieving decarbonisation of the energy sector. **Status:** Apart from various bilateral projects implemented by KfW (FC) and GIZ (TC), the Federal Ministry of Economic Cooperation and Development (BMZ) also supports multilateral and global projects. The Energising Development project aims to make sustainable energy available to 22 million people by 2021. The GET.pro platform offers instruments for the implementation of international and German initiatives, including advisory services and the mobilisation of private investments. The "Green People's Energy for Africa" ministerial initiative supports the development of decentralised renewable energy systems in African communities. In the hydrogen sector, the BMZ aims to provide funding for reference plants for the production of green hydrogen in partner countries (plans are underway for a first plant in Morocco). The BMZ also participates in international energy policy dialogue within the framework of international processes. **Facts and Figures:** In 2019, commitments for FC amounted to €2.03 billion. The total volume for TC amounted to €690 million.
57.	Travelling exhibition: Germany's Energy Transition	**Goal:** The purpose of the exhibition is to provide information about the basic elements of the global energy transition and associated aspects and to advertise for better international networking for a more sustainable energy policy worldwide. It focuses on the potential unfolded by a global energy transition. It also draws attention to success stories and national and regional reform plans, which should provide an incentive for the implementation of the energy transition worldwide. The target audience of the exhibition is the general public, interested individuals and the international community. **Scope:** The central element is the so-called "Cube", which has four interactive projection surfaces and is intended to introduce visitors to the exhibition. Another three cubes are dedicated to the main topics of renewable energy sources – Just Transition (the question of a just energy transition) and mobility. Each of these issues is examined from the political, economy, societal and scientific points of view. The content has been digitally processed to facilitate updating and enable the incorporation of different language versions. **Status/Facts and Figures:** The exhibition opened in the Federal Foreign Office Atrium in December and is scheduled to set off on a world tour in January 2021. Plans for 2021 currently include 15 stops in 11 countries.

	Instrument	Implementation status
	Chapter 4: Renewable energy	
58.	Omnibus Energy Act	**Goal:** This Act provides the framework for the special bidding processes for onshore wind and photovoltaics (PV) set forth in the EEG, as stipulated in the Coalition Agreement between the CDU, CSU and SPD. In addition to this, the Act addresses other urgent energy policy issues. **Scope:** Among other things, the EEG 2017 provides for additional auction volumes of 4 gigawatts each for onshore wind and PV from 2019 to 2021. Cross-technology innovation auctions will also be conducted between 2019 and 2021. They are to provide a testing ground for innovate concepts for especially useful grid and system projects as well as for new pricing mechanisms and auction processes. An on-demand night-time marking system will be introduced, which is designed to increase acceptance of onshore wind in particular. This will put an end to the continual blinking of wind turbines at night. They only light up if an airplane is in the vicinity. **Status:** The Omnibus Energy Act entered into force in December 2018.
59.	Ordinance on Innovation Auctions	**Goal:** To test innovative auctions in practice. **Scope:** The ordinance will introduce joint auctions for various renewable technologies for a pilot phase of 3 years (2019–2021). The results will be evaluated and incorporated into the further development of the EEG. **Status:** The Ordinance entered into force on 30 November 2020. **Facts and Figures:** The planned auction volume throughout the entire period amounts to 1,150 megawatts.
60.	Abolition of the PV cap/exemption clause on distance regulations for wind turbines	**Goal:** To further promote solar plants in the fixed tariff segment as a consequence of favourable cost development and increase acceptance for further expansion of onshore wind. **Scope:** Abolition of the 52 GW cap for solar plants in the EEG 2017, introduction of a Länder exemption clause for distance regulations with regard to onshore wind energy plants in the Federal Building Code (BauGB); both implemented as part of the Amendment to the Buildings Energy Act (GEG). **Status:** See status of the Amendment to the Buildings Energy Act (GEG).
61.	Act amending the Renewable Energy Sources Act (EEG) 2017 and other provisions of energy law	**Goal:** To ensure equitable participation of people's energy in onshore wind auctions and prevent Covid-19-related missed deadlines. **Scope:** Elimination of privileges for people's energy companies in the auctions, extension of statutory time limit regulations for the auctions and within the framework of the EEG equalisation mechanism. **Status:** The Act entered into force at the end of May 2020.
62.	Adjustment of the EEG expansion targets	**Goal:** To implement the Federal Government's Climate Action Programme 2030. **Scope:** Adjustment of the expansion targets in §1 EEG 2017, implemented within the framework of the Coal Phase-out Act. **Status:** See status of the Amendment to the Coal Phase-out Act. **Facts and Figures:** The EEG now aims to increase the share of electricity generated from renewable energy sources in gross electricity consumption to 65% by 2030.
63.	Amendment to the Renewable Energy Sources Act (EEG 2021)	**Goal:** To substantially reduce greenhouse gas emissions and advance the expansion of renewable energy sources. **Scope:** Among other things, the EEG 2021 lays down expansion paths to achieve the 65% target and stipulates that all electricity generated or consumed in Germany should be generated in a greenhouse gas-neutral manner before the year 2050 as a long-term goal. **Status:** The Act was adopted by the Bundestag and Bundesrat in December 2020 and entered into force in January 2021.
64.	Offshore Wind Energy Act (WindSeeG)	**Goal:** To expand the use of offshore wind energy, especially in the interest of climate change mitigation and environmental protection. **Scope:** Stepping up the expansion targets laid down in §1 Offshore Wind Energy Act (WindSeeG). **Status:** The Offshore Wind Energy Act (WindSeeG) entered into force in December 2020. **Facts and Figures:** The expansion target for 2030 is being increased from 15 to 20 gigawatts. A long-term target of 40 gigawatts has been set for 2040.

	Instrument	Implementation status
65.	Amendment to the Renewable Energies Ordinance (EEV) to reduce the EEG surcharge	**Goal:** To relieve the burden on electricity prices by reducing the EEG surcharge. **Scope:** Amendment to the Renewable Energies Ordinance (EEV) in order to make state subsidies available for the EEG surcharge, whereby the decisions regarding the specific use of the subsidies and the amount of funding are made by the budget legislator. **Status:** The amending regulation was adopted by the Federal Cabinet in mid-July 2020 with the approval of the Bundestag. **Facts and Figures:** The EEG surcharge is to be reduced to 6.5 cents per kilowatt hour in 2021 and to 6.0 cents per kilowatt hour in 2022.
66.	Registry of Guarantees of regional Origin (RNR) for electricity generated with renewable energy	**Goal/Scope:** The Guarantee of Regional Origin makes it possible for consumers to buy EEG power from their region. The region is comprised of postal code areas in a 50-km radius of a postal code area in which electricity is consumed. Plant operators can use the Registry to apply for a Guarantee of Regional Origin and send it to electricity suppliers with the electricity. These suppliers validate the Guarantee of Regional Origin and indicate the regional source of the EEG power in the fuel mix disclosure. By paying the EEG surcharge that finances power plants using solar, wind, water and biomass, every consumer is participating in the energy transition. This is indicated by the electricity labelling, in the information showing the EEG share (Renewable energies, financed with the EEG surcharge). With the new instrument this share can be drawn regionally, that is, from EEG power from the region. The Guarantee of Regional Origin provides the mapping required for this, and protects consumers from double marketing and false advertising. The legal basis for the new Registry, the amended Implementing Ordinance on Guarantees of Origin and Guarantees of Regional Origin – HkRNDV – entered into force in November 2018. **Status:** The Registry of Guarantees of Regional Origin was launched in January 2019. The first guarantee of regional origin will be declared with the electricity labelling for delivery year 2019, which is due on 1 November 2020. The Federal Environment Agency will publish recommendations for the type of declaration in August 2020, and there will then be binding requirements for the 2020 delivery year.
67.	EU Ruling on Biofuels and Indirect Land Use Change (ILUC)	See Chapter 7.
68.	KfW Renewable Energy Storage programme	**Goal:** To support the usefulness of domestic battery storage systems for the grid and deliver more cost reduction in storage technologies. **Scope:** The programme supports investments in battery storage units that are installed in conjunction with a PV installation and connected to the electricity grid. **Status:** The programme ran from 2013 to 2018. **Facts and Figures:** The KfW approved of around 32,600 applications for funding, and the funding amount was around €80 million.
69.	Renewable Energy Export Initiative	See Chapter 3.
70.	Renewable Energies Heat Act (EEWärmeG)	See Chapter 6.
71.	Market Incentive Programme for Renewable Energies in the Heating Market (MAP)	See Chapter 6.
72.	Low temperature heat networks with seasonal thermal energy storage (Model Project Heat Network Systems 4.0)	**Goal:** To prepare for broader market introduction of innovative 4th generation heat network systems with a high share of renewable energy sources and efficiently used waste heat. **Scope:** Funding for a total of four modules: funding for up to 60% of the costs of feasibility studies, up to 50% of the project costs for implementation of a heating network system 4.0, supplementary funding for scientific collaborations (capacity building) and for information campaigns for potential customers in an effort to attract more subscribers for the model projects. **Status:** Entered into force July 2017. **Facts and Figures:** The market response is far surpassing expectations. 163 applications for feasibility studies and 9 applications for the implementation of heating network systems 4.0 had already been submitted by the beginning of July 2020.

	Instrument	Implementation status
	Chapter 5: Energy consumption and energy efficiency	
73.	KfW Energy Efficiency Programme for Production Facilities and Processes	Please refer to Chapter 5 for details of the monitoring concept for central measures.
74.	Energy Efficiency Networks Initiative (IEEN)	
75.	Mandatory energy audits for non-SMEs	
76.	Cross-sectional technologies	
77.	Waste Heat Directive	
78.	Funding of energy-saving contracting	
79.	SME Energy Transition and Climate Action Initiative	
80.	Energy-efficient and climate-friendly production processes	
81.	Support for market monitoring	
82.	National Top Runner Initiative (NTRI)	
83.	EU Energy Labelling Framework Regulation	
84.	STEP up! Exploiting electrical energy efficiency potential	
85.	Energy Savings Meter pilot programme	
86.	Energy management systems	
87.	Energy Efficiency Strategy 2050	**Goal:** The Federal Government is pursuing the goal of transforming the German economy into the world's most energy-efficient economy and is aiming to achieve greenhouse gas neutrality by 2050. **Scope:** The 2050 Energy Efficiency Strategy is paving the way for a strengthened energy efficiency policy while making Germany's contribution to achieving the EU energy efficiency target at the same time. By reducing primary energy consumption by 30% compared with 2008, the Strategy sets a new energy efficiency target for 2030, bundles the measures to be taken by the Federal Government in a new National Action Plan on Energy Efficiency (NAPE 2.0) and includes stipulations for the design of a 2050 Energy Efficiency Roadmap dialogue process. **Status:** The 2050 Energy Efficiency Strategy was adopted at the end of 2019 and the measures defined by the Strategy (also described in this Monitoring Report) are in the process of being implemented.
88.	2050 Energy Efficiency Roadmap	**Goal:** In its capacity as the Federal Government's central dialogue forum, the 2050 Energy Efficiency Roadmap aims to join forces with stakeholders in order to expedite the urgently needed progress in energy efficiency. **Scope:** The Roadmap is part of the German Energy Efficiency Strategy and it has been devised for the purpose of discussing cross-sectoral pathways for achievement of the 2050 reduction target in an exchange with representatives from the scientific community, industry and civil society, and the development of instruments and measures to increase energy efficiency. Sector-specific working groups (buildings, industry and transport) have been set up for this purpose, along with cross-sectoral working groups (digitisation, training, personnel and system issues). The former Energy Transition Energy Efficiency Platform will also be incorporated into the plenary sessions of the Roadmap process. **Status:** The Roadmap was launched in May 2020 and the working groups have begun their work. The dialogue process initiated within the framework of the Energy Efficiency Roadmap is to be concluded in autumn 2022 with the adoption of a keynote strategy paper on energy efficiency by 2050.

	Instrument	Implementation status
89.	ACE II	**Goal:** The ACE – Asset Class Energy Efficiency (ACE) project devises solutions to make energy efficiency measures more attractive for external financiers. **Scope:** It addresses key implementation problems for energy efficiency investments and develops an Energy Efficiency Asset Class in the process. This particularly includes due diligence procedures for a standardised evaluation of specific energy efficiency measures, the bundling of energy efficiency projects in an effort to achieve larger investment volumes and proposals for adaptation of the Federal Government's funding structure. The resulting deliverables and project tools are to be validated and enhanced in practice during a second phase of the project in order to make them more widely available for use. **Status:** The project was launched with a kick-off meeting in spring 2020 and is scheduled to run for about 2 years.
90.	Federal Funding for Energy Efficiency in Commerce package	**Goal:** To implement some 24,000 measures by the end of 2023, thereby reducing greenhouse gas emissions by a total of 2.8 million tonnes of CO_2 per year and 11 TWh of final energy. **Scope:** The BMWi is bundling six previous funding programmes into two policies in a new technology-neutral, cross-sector funding package. The BMWi's new funding offer will support companies in all sectors and sizes in saving energy and in the direct generation of process heat from renewable energy sources. Companies can apply for funding in the form of a grant, a loan or within the framework of a competitive procurement process. **Status:** Implementation of the package has been in progress since 2019 with a consistently high level of demand. A derivative is to focus on efficiency and substitution of resources and digitalisation.
91.	Germany Makes it Efficient awareness-raising and mobilisation campaign	**Goal:** The Germany Makes it Efficient awareness-raising and mobilisation campaign is aimed at informing all stakeholders about the joint project that is the energy transition, and convincing them of the need for even more efficient use of energy. **Scope:** The campaign is geared to private households, business enterprises and public institutions alike, and involves all the stakeholders in a stakeholder dialogue. **Status:** While the campaign has been running since May 2016, consumer information is an ongoing task.
92.	Energy and climate action campaigns	**Goal:** The campaigns run by the Federal Environment Ministry (BMU) are some of the first and largest industry campaigns for climate action in Germany. The primary goal is to provide sector-specific information and to advice on climate change mitigation measures. **Scope:** Launched in 2019 on the basis of the highly successful DEHOGA energy campaign, a climate protection campaign is being established for businesses belonging to the German Association for Wholesale and International Trade and Services (BGA). DEHOGA and BGA intend to use this joint project to organise the transfer of know-how from the DEHOGA model project. Information and experience garnered by DEHOGA are actively passed on to BGA and synergies are exploited where they are useful for issues involving both organisations. The BMU has been funding another campaign with the Federation of German Food and Drink Industries (BVE) since September 2019, with a term of 36 months. The aim of this project is to contribute towards reducing CO_2 emissions in the food industry by accelerating the implementation of climate protection and energy efficiency measures. This is also the first time that an industry association has succeeded in winning support for such a campaign. Funded by the National Climate Protection Initiative (NKI), the Climate Protection Policy Offensive of the German retail trade has been well implemented as a broad-based information campaign, which is due to end in December 2020. Possible follow-up projects with the German Retail Federation (HDE) are currently under discussion. **Status:** The campaigns make a major contribution towards reducing carbon and to climate protection. They serve as models for the development of other sector-specific campaigns. Plans are in place for sharing experience with other industries/associations.

	Instrument	Implementation status
93.	Funding of energy efficiency managers to leverage potential, e.g. in business parks	**Goal:** To promote climate action measures in industrial estates and business parks. **Scope:** Funding of concepts and personnel to implement the measures. **Status:** As part of the KfW Energy-efficient Urban Redevelopment Programme (432) financed by the Federal Ministry of the Interior, Building and Community (BMI), funding can be provided for reorganisation managers in urban neighbourhoods, which may also include business parks. The directive of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) promoting climate action projects at municipal level, provided for funding until the end of 2018 for the climate action sub-category in "Industrial Estates and Business Parks" and a municipal climate protection management system for the implementation of the measures identified. Energy management at municipal level has been funded for the entire energy consumption of a municipality as of the beginning of 2019 in line with the amended directive. Funding for the climate action sub-category in Industrial estates and Business Parks was discontinued. However, it is still possible to apply for funding to complete a study on the potential of using waste heat from industry and commerce. The BMU is responsible for the directive promoting climate action projects at municipal level. **Facts and Figures:** Around 300 urban neighbourhoods are currently being funded as part of a reorganisation management programme within the framework of the "Energy-efficient Urban Redevelopment Programme". There is no data available to indicate the number of urban neighbourhoods which include business parks. A total of 24 climate action projects in the Industrial Estates and Business Parks category were funded between 2013 and 2019. No studies on the potential for using waste heat from industry and commerce were funded in 2019.
94.	Energy Efficiency Export Initiative	See Chapter 3.
95.	Development of KPIs and benchmarks in the commercial sector	**Goal:** To capture data on current and future energy consumption and to compare them with recognised, objective benchmarks. **Scope:** Funding was granted for R&D projects focusing on the development of comparative KPIs, standards and benchmarks for the commerce, trade and services (CTS) sector and industry. The major finding of the UFOPLAN project was that the reporting mechanisms for energy policy instruments (especially the special compensation arrangement, energy tax cap, energy audit requirement under the Energy Services Act (EDL-G), EU emissions trading and electricity price compensation) do not provide an adequate database for generation of energy efficiency KPIs and benchmarks. **Status:** The project started in January 2016 and was concluded in March 2018.
96.	BMEL Federal Programme to Promote Energy Efficiency in Agriculture and Horticulture	**Goal/Scope:** Funding for measures to increase energy efficiency in agricultural and landscape production processes within the businesses by providing advice, transferring know-how and providing funding for investments. Funding is provided as a proportional grant depending on the relevant savings potential. **Status/Facts and Figures:** The federal programme was launched in 2016 and was successfully evaluated in the first half of 2018. The programme was terminated at the end of February 2020 in order to develop a new funding guideline in accordance with the requirements of the Federal Government's Climate Action Programme 2030. Around 5,200 applications had been submitted by February 2020, with a funding volume of €138 million. This means that all the available budget funds have been allocated. The programme is to be further developed into a carbon savings programme for energy use by individual enterprises in agriculture and horticulture. Plans for the new funding period provide for €156 million to be made available over the next four years, starting in 2020.
97.	Review of the efficiency requirement in the Federal Immission Control Act (BImSchG)	**Goal/Scope:** The Federal Government has reviewed the extent to which the economical and efficient use of energy under the Federal Immission Control Act (BImSchG) can be further specified as an operator's obligation. The aim of the research project "Defining energy-efficiency related operator obligations under the Federal Immission Control Act" was to set out the more detailed legal contours of the operator's obligations under the Federal Immission Control Act (BImSchG) and to clarify the legal operating framework for more specific requirements. **Status:** An evaluation of the results of the research project, which are now available, showed that there was no need to change the procedure or use of the results under applicable law.

	Instrument	Implementation status
	Chapter 6: Buildings and heat transition	
98.	CO_2 Building Modernisation Programme: Non-residential buildings	Please refer to Chapter 6 for details of the monitoring concept for central measures.
99.	CO_2 Building Modernisation Programme: Residential buildings	
100.	Market Incentive Programme for the Funding of Renewable Energies in the Heating Market (MAP)	
101.	Energy Efficiency Incentive Programme (APEE)	
102.	National efficiency label for old heating systems	
103.	Funding of heating optimisation measures using high-efficiency pumps and hydraulic balancing	
104.	Energy-efficient Buildings 2050 – Innovative Projects for a Virtually Climate-Neutral Building Stock in 2050	
105.	Energy consulting	
106.	Energy Transition Construction Research Network	**Goal:** To strengthen an exchange of information at the interface between research, policy and practice. Faster transfer of results and further development of research funding. **Scope:** An online platform is provided for an exchange of information. This is supplemented by events and workshops held at regular intervals, e.g. the 2nd Energy Transition Construction conference, attended by more than 350 delegates in January 2019, or the workshop on Building Monitoring and Building Tools, and Solar Exteriors (the latter in cooperation with the Renewable Energies Research Network) in November 2019. The accompanying research programmes Energy Transition Construction and Energy-efficient Buildings 2050 act as drivers of the network. A ministerial advisory board was set up at the end of 2017 in order to create a system for organising the exchange between the departments of the BMWi. **Status:** The research network established in 2014 now has over 950 members. Recommendations from experts in the research network formed the basis for the 7th Energy Research Programme. Various funding proposals, such as Living Labs of the Energy Transition, or the Solar Construction/Energy-efficient City funding initiative, received assistance from experts in the research network.
107.	Efficiency House Plus funding initiative	**Goal:** To further develop affordable, climate-friendly buildings. A federal Efficiency House Plus building standard is to be established, which advocates a coherent analysis of primary and final energy demand and the use of renewables in the buildings sector. **Scope:** Knowledge is transferred by means of exemplary model projects, a network, an information and competence centre for future-oriented construction operated by the Federal Government in Berlin and via online platforms. Information relating to this energy-saving, sustainable building standard is also communicated through pilot projects, workshops, trade fairs and special events held at regular intervals (e.g. national and international building trade fairs, Berlin Energy Days). The Efficiency House Plus initiative and its network build on the accompanying research of the Efficiency House Plus model project and other research themes associated with this building standard. The government Information and Competency Centre for Future-oriented Construction opened in 2017 as part of the government's Efficiency House Plus pilot project to promote further incentives for society as a whole and an active dialogue with citizens. **Status:** Since 2017, more than 40 model projects throughout the country have confirmed that this building standard is feasible for residential buildings and is climate-friendly. Scientific projections predict potential carbon savings of 18 million tonnes a year from 2050 onwards, assuming 15% market penetration of this building standard in new and existing buildings. Furthermore, the energy surplus generated by Efficiency House Plus houses can also make up for buildings that are not able to achieve climate neutrality by 2050. The Efficiency House Plus initiative is to be put on a permanent footing and expanded.

	Instrument	Implementation status
108.	Energy Conservation Legislation for Buildings – Buildings Energy Act (GEG)	**Goal:** On 18 June 2020, the German Bundestag adopted the Buildings Energy Act (GEG), which was put forward by the Federal Government at the proposal of the BMWi and the Federal Ministry of the Interior, Building and Community (BMI). This was confirmed by the Bundesrat on 3 July 2020. It entered into force on 1 November 2020. **Scope:** The Buildings Energy Act brings the Energy Conservation Act (EnEG), the Energy Conservation Ordinance (EnEV) and the Renewable Energies Heat Act (EEWärmeG) together and creates a new standardised and coordinated set of regulations to cover the energy requirements for new buildings, for existing buildings and for the use of renewable energy sources to supply buildings with heating and cooling. This will facilitate implementation and completion. The Building Energy Act implements the European requirements for the overall energy performance of buildings and integrates the regulation on nearly zero-energy buildings (nZEB) into the unified Energy Conservation Legislation. The Act retains the current energy standards for new buildings and modernisation projects.
109.	Energy Transition Platform for Buildings	**Goal:** To establish an evolving dialogue platform for further development of energy efficiency policy. **Scope:** The Energy Transition for Buildings Platform was founded in 2014. 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. **Status:** The 10th meeting of the platform took place in November 2019.
110.	Tailored Modernisation Roadmap for buildings	**Goal:** To establish a standardised tool for tailor-made, gradual energy retrofits **Scope:** Tailored Modernisation Roadmaps (iSFP) provide building owners with a clear overview for a phased renovation of their buildings. Besides strictly energy-related aspects, the roadmap also focuses on the specific options for the building owner and the specific condition of the building when identifying the renovation approach. **Status:** Tailored modernisation roadmaps for buildings have been subsidised with grants amounting to 80% of the cost through the Energy Advice for Residential Building (EBW) programme (local advice, tailored modernisation roadmap) since June 2017 (in accordance with the Climate Action Programme 2030).
	Chapter 7: Transport	
111.	Continued development of the 2013 Mobility and Fuels Strategy (MKS)	**Goal:** The Mobility and Fuels Strategy adopted by the Federal Cabinet in 2013 is being continued as a vehicle for implementing the energy transition in the transport sector as defined in the national sustainability strategy. It provides an overview of technologies, in addition to energy and fuel options for the various modes of transport. Demonstration projects on promising technological options are being initiated within the framework of the Mobility and Fuels Strategy. **Scope:** The Mobility and Fuels Strategy shows ways in which the energy transition can be implemented in the transport sector in the long term in the form of a “learning strategy”. The market for alternative drives and fuels must be ramped up in order to achieve the goals of the Federal Government’s Energy Concept. The keys to achieving this are the promotion of electric mobility with battery and fuel cells and the intensification of efforts to shift transport from road to rail.
112.	National Future of Mobility Platform	**Goal:** This platform involves the government, industry and society in the development of ideas and concepts to ensure affordable, sustainable and climate-friendly mobility in the future. **Scope/Status:** Work on the Platform began in September 2018. A steering committee and seven working groups were subsequently set up under the Platform umbrella. The working groups focus on climate protection in the transport sector, sustainable mobility (alternative drives and fuels), digitisation, automated driving and new mobility options (including social aspects of mobility), securing mobility and production sites, battery cell production, sustainable natural resources and recycling, education and training, sector coupling (linking transport and energy networks in particular), in addition to standardisation, certification and approval. A commission for drawing up a strategy on the future of affordable and sustainable mobility is integrated into the Platform, as set out by the Coalition Agreement between the CDU, CSU and SPD. Working Group 1 deals with climate protection in the transport sector, and published an initial interim report in March 2019.

	Instrument	Implementation status
113.	Sustainable Urban Mobility research agenda	**Goal:** The research agenda outlines the way in which the scientific community and practical application can pave the way to a humane and environmentally-friendly mobility system. **Scope:** The BMBF research agenda integrates the results of participatory consultation processes in which numerous experts from the scientific community, local government, business and society in general present their perspectives, needs and ideas. It focuses on systemic, interdisciplinary mobility research, in which the possibilities of new technologies are to be combined with constitutive possibilities, especially at municipal level, and the mobility needs of local citizens. By adopting a systemic approach, technological and social innovations can be linked together to reach the goal of sustainable mobility. **Status:** Published in December 2018.
114.	Funding guideline for MobilitätsWerkStadt 2025 (mobility concepts for the city)	**Goal:** To support local government in working together with key stakeholders and multipliers from business, society and the scientific community to create the mobility transition. **Scope:** A phased pilot programme allows municipalities to join in with low entry requirements and helps promote mobility. A common goal is to develop sustainable, innovative and custom-made local mobility concepts. **Status:** Entered into force in February 2019.
115.	Funding guideline for MobilitätsZukunftsLabor 2050 (mobility concepts for the future)	**Goal:** To provide funding for interdisciplinary research projects developing new systemic approaches and create the basis for innovative mobility concepts of the future. **Scope:** Among other things, the project is to investigate how social transformation can be linked to more sustainable forms of mobility. Efforts are to focus on developing a sound basis for long-term innovation and transformation management. **Status:** Entered into force in February 2019.
116.	Immediate Action Programme for Clean Air	**Goal:** The Immediate Action Programme for Clean Air was launched to finance implementation of measures in municipalities where nitrogen dioxide thresholds are exceeded. Nitrogen dioxide emissions are to be significantly reduced and compliance with the limit values assured as soon as possible, but by 2020 at the latest. The programme is based on existing funding guidelines. **Scope:** The programme focuses on the electrification of urban vehicle fleets (taxis and public buses in particular), including the expansion of the charging infrastructure and measures to stabilise the grid, as well as the conversion of diesel buses providing passenger services to low-emission engines, improved traffic management and the digitisation and networking of municipal transport systems. Supplementary measures include a purchase premium for electric vehicles, improved logistics strategies and measures to promote cycling as a mode of transport. **Status/Facts and Figures:** Adopted in November 2017. Funds for the programme were augmented by €1.5 billion in December 2018. An additional €432 million are earmarked for specific upgrades.
117.	Funding guideline for the Digitisation of Municipal Transport Systems	**Goal/Scope:** The aim of the funding is to implement digitisation projects in the transport sector that can contribute towards short or medium-term reductions in nitrogen dioxide emissions in towns and cities where limit values are exceeded. This includes measures to create intermodal transport networks, ideas for making local public passenger transport more attractive, efficient logistics, demand-driven use of automated vehicles in city traffic and rail services, as well as the provision of comprehensive environmental, mobility and transport data. **Status:** Entered into force in January 2018.
118.	Guideline for the promotion of sales of electrically powered vehicles (Environmental Bonus)	**Goal/Scope:** To create incentives for the purchase of electric vehicles by means of the Environmental Bonus and the Innovation Bonus. **Status:** Entered into force in July 2016.
119.	Amendments to the Environmental Bonus Guideline	**Goal/Scope:** 1st amendment: cancels the non-combination rule. The incentive to purchase an electric vehicle is to be increased by being able to combine different funding instruments, while price differences between electric vehicles and traditional combustion engines are to be reduced. 2nd amendment: extends the validity of the guideline to the end of 2020 and includes a requirement for installation of acoustic warning systems for electric vehicles that are barely audible in certain situations for the benefit of blind and visually impaired road users. 3rd amendment: extends the validity of the guideline to the end of 2025, extends the list of eligible vehicles to include relatively new used vehicles and increases the subsidy rates substantially. 4th amendment: for practical reasons, the total price of a new vehicle will be used to determine the reduced purchase price from which a used vehicle is eligible for funding in future. 5th amendment: increases the Federal Government's share (Innovation Bonus) and introduces a non-combination rule. 6th amendment: staggers subsidy rates according to the leasing period to avoid over-subsidisation and cancels the non-combination rule. **Status:** The 7th amendment is being prepared: extends the Innovation Bonus to the end of 2025.

	Instrument	Implementation status
120.	Electric Mobility Market Incentive Package	**Goal:** To accelerate the expansion and market development of electric mobility and the charging infrastructure. **Scope:** A purchase premium amounting to €9,000 is to be paid for new vehicles (all-electric and fuel-cell powered vehicles) and €6,750 for plug-in hybrid vehicles (Environmental Bonus plus Innovation Bonus). The Federal Government is providing €300 million to improve the vehicle charging infrastructure. **Status:** Adopted in May 2016. Vehicle buyers have been able to submit applications to the Federal Office for Economic Affairs and Export Control (BAFA) since July 2016. **Facts and Figures:** Funds amounting to a total of €6.48 billion have been earmarked for the Environmental Bonus and the expansion of the charging infrastructure in order to accelerate the development of the market for electric vehicles. Of this, a total of €6.18 billion has been set aside for the Environmental Bonus, whereby the Federal Government's share amounts to €4.09 billion and €2.09 billion is to be provided by the automotive industry. The Federal Government is providing up to €300 million to improve the vehicle charging infrastructure.
121.	Electrically Mobile funding directive (electric mobility)	**Goal/Scope:** The Electrically Mobile funding initiative subsidises research and development in the electric mobility sector. Examples include projects in the fields of automotive technology, powertrains, charging infrastructures and other cross-cutting issues associated with electric mobility. Funding is also provided for research, development and demonstration of innovative charging infrastructures, the monitoring of such measures and investigations into ways of reducing obstacles to the expansion and stability of the electricity grid. To this end, charging infrastructures are being set up in the public, publicly accessible, non-public commercial and purely private sectors and demonstrated under real-life operating conditions. **Status:** Entered into force in December 2017.
122.	Call for funding applications for battery cell production	**Goal:** To establish an alliance with other European countries for the production of the latest generation of battery cells. **Scope:** Project funding. Mission statement: proprietary know-how is crucial for future business success in the market within the framework of a value creation chain for competitive, innovative and environmentally friendly battery cell production in Germany and Europe. **Status:** The BMWi's funding opportunity announcement was published in the Federal Gazette in February 2019, becoming effective on 15 March 2019. Funding is being provided for a broad spectrum of research and demonstration projects, including the establishment of battery cell production capacities in Germany and throughout Europe, within the context of a Summer IPCEI and an Autumn IPCEI, whereby the Autumn IPCEI is being coordinated by the BMWi. The two calls for the Summer and Autumn IPCEIs have been completed and the outlines and applications are currently under review prior to the decision process. **Facts and Figures:** The BMWi is planning to make up to €3 billion available for the period from 2019 to 2024.
123.	Funding guideline for upgrading diesel buses in the Euro 3, 4, 5 and EEV emissions classes in local public transport	**Goal/Scope:** The funding programme aims to make an appreciable contribution to reducing nitrogen dioxide pollution in cities where limit values are exceeded by encouraging demand for nitrogen reduction systems by means of financial incentives to upgrade buses with compression-ignition engines (diesel), an upgrade which is not yet prescribed by law. **Status:** Entered into force in March 2018.
124.	Funding guidelines for upgrading heavy municipal vehicles and commercial light and heavy delivery vehicles and tradesman vehicles with nitrogen oxide reduction systems	**Goal/Scope:** Tradesman and delivery vehicles, such as those operated by glaziers, plumbers or delivery services, as well as heavy municipal vehicles, such as refuse collection and street cleaning vehicles are common in the municipal traffic scene. Because they are usually powered by diesel engines, they contribute to nitrogen dioxide pollution in the inner cities. On the roads for many hours every day, they offer tremendous emission reduction potential, which should be exploited in cities where nitrogen dioxide limit values are exceeded. **Status:** Entered into force in January 2019.
125.	Thirteenth Act amending the Federal Immissions Control Act	**Goal/Scope:** The purpose of the amendment to the Federal Immissions Control Act is to standardise requirements for the proportionality of traffic bans imposed as a result of the nitrogen dioxide limit values stipulated by European law being exceeded and for nationwide exemptions from such traffic bans, thereby creating a level of legal certainty. **Status:** Entered into force in April 2019.

	Instrument	Implementation status
126.	Ninth Act amending the Road Traffic Act	**Goal/Scope:** The competent Länder authorities are to be provided with an effective instrument for verifying compliance with traffic restrictions and traffic bans imposed by immission control legislation. This will offer the Länder authorities a means of determining whether a particular vehicle is permitted in a restricted area on an ad hoc basis. **Status:** Entered into force in April 2019.
127.	New Regulation (EU) 2018/858 on the approval and market surveillance of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles	**Goal/Scope:** Application of Regulation (EU) 2018/858 has been mandatory in all EU Member States since 1 September 2020. Compared with the previous regulatory framework the new provisions are particularly concerned with the introduction of specific requirements for market surveillance of categories M, N and O motor vehicles. Furthermore, the Commission has been granted the authority to carry out tests and inspections at its own expense to verify whether vehicles, systems, components and separate technical units meet the pertinent requirements. The Regulation particularly aims at ensuring uniform implementation and enforcement of any measures at Union level, e.g. in the case of recalls. Compared with the previous legal framework, these provisions are effective immediately in all EU Member States and in principle do not need to be transposed into national law.
128.	New World Harmonised Light Vehicle Test Procedure (WLTP)	**Goal:** To make more representative and reproducible values for CO_2 emissions and fuel consumption available so as to provide improved correlation between fuel consumption values measured during vehicle testing and the values displayed to the vehicle user while travelling. **Scope:** The emission standards and consumption standards for passenger cars and light commercial vehicles are defined on the basis of this new procedure, whereby the more stringent requirements of this procedure must be taken into account. The new test cycle will also be reflected in the passenger car label following the Amendment to the Ordinance on Energy Consumption Labelling for Passenger Cars, thereby increasing the credibility and effectiveness of the label.
129.	Europe on the Move Mobility Package	**Goal:** To devise road and mobility systems of the future, boost their competitiveness, strengthen social justice on the road and set a clear path for achieving zero emissions. **Scope:** Europe on the Move comprises: • a policy statement, outlining a long-term plan for clean, equitable and competitive mobility. • eight initiatives, which are directed particularly at improving the functionality of the road haulage market, conditions of employment and social protection for employees, as well as introducing a smart system for the collection of road user charges in Europe. • a set of non-legislative accompanying documents with supportive measures to accelerate the transition to a sustainable, digital and integrated mobility system (investment funding for infrastructure, research and innovation, collaborative platforms, etc.). **Status:** The Package was published in May 2017.
130.	Reform of the EU Regulations on reducing CO_2 emissions from new passenger vehicles and light commercial vehicles	**Goal:** To reduce CO_2 emissions in the transport sector. **Scope:** The CO_2 emissions from new vehicles are to be reduced by 15% between 2021 and 2025 and by 37.5% by 2030. The CO_2 emissions from a new light commercial vehicle are to be reduced by 15% between 2021 and 2025 and by 31% by 2030. **Status:** The package was adopted with the European Council of Ministers' approval in April 2019.
131.	EU Regulation to reduce CO_2 emissions of heavy-duty vehicles (HDVs)	**Goal:** To reduce CO_2 emissions in the transport sector. **Scope:** The CO_2 emissions from a new heavy-duty commercial vehicle are to be reduced by 15% between 2019 and 2025 and by 30% by 2030. Zero-emission vehicles and low-emission will be promoted by means of an incentive system. **Status:** A consensus was reached in February 2019 in a trialogue between the European Commission, the European Council of Ministers and the European Parliament. The European Parliament approved the agreement in April 2019. Approval by the European Council of Ministers is scheduled for June 2019.
132.	Declaration of EU Member States on the future of clean energy and mobility	**Goal:** To create a future with clean energy and mobility. **Scope:** The required measures have been defined in five areas: 1. rapid introduction of zero-emission vehicles and renewable fuel options; 2. mobility management; 3. promotion of active mobility (cycling, walking); 4. independence of mobility from social status; 5. intermeshing of different transport systems. **Status:** The declaration was adopted by the EU Member States in October 2018.

	Instrument	Implementation status
133.	Strategy for Automated and Connected Driving (AVF) – to remain a lead provider, become a lead market, introduce regular operations	**Goal:** To create the framework conditions and necessary preconditions for the introduction of automated and connected driving systems in conjunction with Intelligent Transportation Systems (ITS). **Scope:** Implementation of measures in the fields of infrastructure, legislation, innovation, interconnectivity, cyber security and data protection, and promote social dialogue to unlock the potential offered by the technologies – namely greater traffic safety, improved traffic efficiency, lower mobility-related emissions and the strengthening of Germany's position as a business and innovation hub.
134.	Energy consumption labelling for passenger cars	**Goal:** To reduce the fuel consumption and emissions of passenger cars. **Scope:** Every new vehicle has displayed a passenger car label that indicates the vehicle's efficiency class since 2011. It indicates the energy efficiency of the vehicle, with green standing for energy-efficient. It also provides concise data on fuel consumption, costs and CO_2 emissions. The Federal Government is planning to update the label in the near future and adapt it to the WLTP.
135.	Energy-efficient commercial vehicle funding programmes	**Goal:** To promote the market roll-out and penetration of energy-efficient and/or low-CO_2 commercial vehicles with a fixed-term funding programme. **Scope:** Funding is available for the purchase of trucks and tractor units powered by compressed natural gas (CNG), liquefied natural gas (LNG) and certain electric drives (all-electric vehicles and fuel cell vehicles) intended for road haulage services with a gross vehicle weight rating of at least 7.5 tonnes. **Status:** The programme started in June 2018 and will run until 31 March 2021. In 2021, according to the explanatory note, funding may only be granted for trucks and tractor units with electric drives. **Facts and Figures:** A total of €10 million is available per year.
136.	Local Electric Mobility funding programme	**Goal:** To support the ramp-up of the electric vehicle market by supporting procurement in the municipal context and associated measures to develop the charging infrastructure. To promote strategic research and demonstration projects in the local public transport and with electric delivery or commercial vehicles. **Scope/Status:** The funding guideline came into force in 2015, and was slightly updated in 2017. Seven calls for applications have been conducted up to now, one of them for implementation of the 2017–2020 Immediate Action Programme for Clean Air. **Facts and Figures:** Around €140 million are available for the period 2017–2020. Funding for vehicle procurement from the 2017–2020 Immediate Action Programme for Clean Air is also being augmented to the tune of €175 million. Subsidies for the procurement of approximately 2,300 electric vehicles, including the associated charging infrastructure, had been granted by the end of 2017. Funding was also provided for approximately 130 electric mobility concepts and several research and development projects.
137.	2015 Electric Mobility Act and new Regulations based on the act	**Goal/Scope:** The Electric Mobility Act and new regulations based on it – 50th Regulation amending Road Traffic Regulations and the accompanying General Administrative Regulation for Road Traffic Regulations (VwV-StVO) – give cities, towns and local authorities the legal framework to grant privileged status to electric cars. Local incentive measures could include the provision of free parking spaces or the exemption of electric vehicles from access restrictions. Another possibility would be to open bus lanes or special lanes to electric vehicles. By making an exception in driving licence legislation for electrically powered vehicles of category N2, 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).
138.	2011 Government Programme on Electric Mobility	**Goal:** To support the ramp-up of the market for electrically powered vehicles. Many measures from this programme have already been implemented.
139.	Procurement initiative for electric mobility	**Goal/Scope/Facts and Figures:** The number of vehicles emitting less than 50 grams of carbon per kilometre (or with a minimum range of 40 km on electric power alone) as a proportion of the total number of newly purchased or leased vehicles in future is to be increased from the previously agreed 10% to 20%.
140.	Tax regulations concerning the use of electric vehicles for private purposes	**Goal/Scope:** Under the Income Tax Act, employees who charge an electric or hybrid electric vehicle at their employer's place of business or at the premises of an affiliated business, and who use in-company charging facilities temporarily for private purposes can treat this as a tax-free benefit on 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). **Status:** The new regulations apply from 1 January 2017 through to 31 December 2020.

	Instrument	Implementation status
141.	ICT for electric mobility: Smart Applications for Mobility, Logistics and Energy	**Goal/Scope:** This funding measure aims to support the changes that are necessary on the road to achieving environmentally compatible, user-friendly connected mobility and the further development of transport and logistics systems with the help of information and communication technologies (ICT). The funding priority focuses on the development and testing of open, ICT-based system solutions that optimally incorporate (commercial) electric mobility into smart mobility, logistics and energy infrastructures and operating environments. **Status:** The announcement was made in January 2019. Project outlines may be submitted twice a year. The final submission date is 31 October 2021.
142.	Renewably Mobile funding programme	**Goal:** To provide funding for research projects in the field of electric mobility for the purpose of increasing its potential for climate, environmental and resource conservation, as well as contributing towards an increase in the quality of life and sustainable urban development. **Scope:** The BMU has been supporting companies and institutes conducting ambitious R&D projects for electric mobility since 2009. Successfully launched within the framework of the second economic stimulus package, the funding project has been continued in the form of the Renewably Mobile programme since 2012, focusing on vehicle and drive concepts and the coupling of electric vehicles with energy supply systems. The Renewably Mobile programme also provides funding for the field trials of trucks powered by overhead catenary lines, with additional funding from the BMU's National Climate Protection Initiative. **Status:** The fourth funding opportunity announcement for the Renewably Mobility Programme was published on 15 December 2017, this time as a joint initiative of the BMWi and the BMU. The BMU is also participating in the implementation of the Federal Government's Immediate Action Programme for Clean Air within the framework of Renewably Mobile by sponsoring purchases of electrically powered light commercial vehicles and/or passenger cars for taxi companies, as rental cars and for car sharing in urban transport. **Facts and Figures:** The Renewably Mobile programme has funded more than 100 projects in Germany since 2012, with more than 150 project partners and a funding volume of over €350 million (status: January 2019).
143.	Electric Mobility Funding Guideline	**Goal:** To promote application-based R&D measures and the procurement of electric vehicles (drives, optimisation of the value creation chain, information and communication technologies) across all modes of transport.
144.	Funding guideline for the procurement of electric buses for local public passenger transport systems	**Goal/Scope:** Procurement of electric buses or plug-in hybrid buses and the associated charging infrastructure, as well as other measures required for the commissioning of electric buses/plug-in hybrid buses (training and workshop facilities, for example). **Status:** Entered into force in March 2018.
145.	Motor vehicle tax	**Goal/Scope/Status:** The Traffic Tax Amendment Act of December 2012 extended the scope of the previous motor vehicle tax exemption, which had been limited to all-electric passenger cars, to include all-electric vehicles of all vehicle categories. The tax exemption for these vehicles was also extended from five to ten years for vehicles registered for the first time between 18 May 2011 and 31 December 2015. A five-year tax exemption period was envisaged for vehicles first registered between 1 January 2016 and 31 December 2020. The exemption period was uniformly set at ten years for all all-electric vehicles registered for the first time between 18 May 2011 and 31 December 2020 with the Act to Promote Electric Mobility in Road Transport through Tax Incentives of November 2016. Passenger cars re-engineered to all-electric drive systems are also eligible for preferential treatment as long as the conversion takes place between 18 May 2016 and 31 December 2020.
146.	Task force on LNG in heavy-duty vehicles	**Goal:** To accelerate the market launch of LNG in heavy-duty freight transport. **Scope:** 1. Development of measures for the development of the LNG market in Germany; 2. Evaluation of environmental and climate impacts and an assessment of economic viability based on real-life values from the BMVI demonstration projects; 3. Creation of an information base on economic viability and implementation aspects for users of LNG HDVs. **Status:** Founded at the initiative of the BMVI in November 2015.
147.	Charging Station Ordinance on minimum requirements for the establishment and operation of publicly accessible charging stations for electric vehicles	**Goal:** To establish uniform standards for the EV charging infrastructure. This promotes the expansion of publicly accessible charging stations to meet demand with funds from the private sector, thereby assisting the market ramp-up of electric vehicles in Germany. **Scope:** I. Contains charging plug standards and minimum requirements for the development and operation of publicly accessible charging stations for electric vehicles. II. Aims to standardise authentication and payment at charging stations. III: Supplements the existing Charging Station Ordinance to include EU requirements for intermittent charging, whereby operators of publicly accessible recharging stations must allow any electric vehicle user to use the recharging stations, even if there is no long-term electricity supply agreement. **Status:** Entered into force in June 2017. Amendment in preparation.

	Instrument	Implementation status
148.	2014 EU Directive on the Deployment of Alternative Fuels Infrastructure	**Goal:** To establish an appropriate minimum supply of refuelling and charging stations for alternative fuels and create the necessary minimum technical standards and minimum standards for consumer information. **Scope:** Implementation of the EU Directive is an integral part of the Mobility and Fuels Strategy, as the rapid development of an efficient refilling and charging infrastructure for alternative fuels is a core element of the energy transition in the transport sector. **Status:** 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.
149.	Funding guideline for an Electric Vehicle Charging Infrastructure in Germany	**Goal:** To establish a nationwide, publicly accessible charging infrastructure with 15,000 charging stations across the country. 10,000 of these will be normal charging stations and 5,000 will be rapid charging stations. The charging infrastructure funding guidelines are part of the Electric Mobility Market Incentive Package adopted by the Cabinet in May 2016. **Scope:** The funding guideline grants a subsidy (up to 60%) towards the investment costs for charging stations and connection to the grid. Regular calls for funding applications determine the conditions applicable for the respective funding phase. **Status/Facts and Figures:** Entered into force in February 2017. A total of €300 m will be mobilised for the funding programme which runs from 2017 to 2020. Two calls for funding applications were conducted in 2017, and 3,000 applications were submitted.
150.	Establishment of the hydrogen infrastructure (H2 Mobility project)	**Goal/Scope:** To install 400 hydrogen filling stations in Germany by 2025. The first 100 filling stations will be built regardless of vehicle uptake (chicken and egg dilemma). **Status:** The first 50 hydrogen filling stations are partly funded by the Federal Government within the framework of the National Hydrogen and Fuel Cell Technology Innovation Programme (NIP). Applications for funding of additional filling stations have been filed under NIP II (2016–2026). **Facts and Figures:** 68 hydrogen filling stations were in service in May 2019.
151.	National Policy Framework for the deployment of alternative fuels infrastructure (NPF)	**Goal:** The National Policy Framework sets targets for the publicly accessible refuelling and charging infrastructures and supports these with appropriate measures, which must be implemented by the Federal Government (in conjunction with the industry if necessary) in order to achieve the targets. **Scope:** The National Policy Framework adopted by the Federal Cabinet encompasses the charging infrastructure for electric vehicles, the infrastructure for the supply of natural gas (CNG and LNG) and the hydrogen supply infrastructure for vehicles powered by fuel cells. It forms part of the implementation of EU Directive 2014/94/EU. The National Policy Framework regards itself as being a learning strategy that is reviewed at regular intervals and, if necessary, adapted in the ongoing process of implementing the EU Directive. The BMVI will be setting up an ongoing monitoring procedure for this purpose. Under the provisions of the EU Directive, a report on the progress of infrastructure development must be submitted to the European Commission after three years. **Status:** The Federal Government communicated the National Policy Framework to the European Commission in November 2016.
152.	Promotion of multimodal transport (MT) through the expansion and new construction of transhipment terminals	**Goal:** To promote multimodal transport (MT) in an effort to transfer freight transport in standardised loading units from road to rail and federal waterways. **Scope:** The Federal Government is promoting multimodal transport (MT) by providing grants towards the cost of constructing transhipment terminals. This is being done through the Act on the Expansion of Federal Railways for Deutsche Bahn and through the BMVI funding guidelines for private terminals. The funding guideline for private multimodal transport (MT) transhipment terminals is providing support for up to 80% of the eligible costs for the upgrading and construction of terminals. Following a decision by the Federal Cabinet, an expenditure review of the programme of financial assistance to private terminals was conducted in 2015/2016. Within this context, special facilities were agreed with respect to securing possible replacement obligations to the Federal Government, which have already been implemented in the current funding guideline. **Status:** The current guideline has been in force since January 2017 and runs until the end of 2021. Work on the follow-up guideline has already begun. An evaluation report on the current funding guideline commissioned by the BMVI will be discussed with trade associations during the first quarter of 2021. The new funding guideline is to come into force at the end of 2021.
153.	Funding guideline for Urban Logistics	**Goal:** To reduce air pollutant emissions (NOx), greenhouse gas emissions (CO_2), particulate matter emissions (PM) and noise emissions attributable to urban delivery traffic in counties and municipalities and/or to improve the flow of traffic. **Scope:** Funding can be made available for the development of urban logistics concepts and feasibility studies for specific individual projects and for the establishment of micro depots for all providers. Municipalities and counties are eligible to apply. **Status:** The funding guideline has been in force since mid-2019 and runs until the end of 2021. The fourth and final call for funding applications will be published on 4 January 2021. Applications for funding can be submitted to the Federal Agency for Administrative Services up to 31 August 2021.

	Instrument	Implementation status
154.	2020 National Cycling Plan (NRVP 2020)	**Goal:** To promote bicycle transport as a common interest shared by the Federal Government, the Länder and the municipalities. **Facts and Figures:** Federal funding for non-investment innovative projects amounted to €5.0 million in 2019. In 2019, €20 million were made available for pilot investment projects for the first time. Apart from this, €98 million were earmarked for the construction and maintenance of cycle paths on existing federal trunk roads. Another €1.2 million were also provided for the improvement of towpaths along federal waterways. The estimated amounts were €1.296 million in 2018 and €1.087 in 2019. Around €1.3 billion in additional funds (so-called divestiture funds) are also made available for improving traffic conditions in the communities, etc. This level of funding will continue through to 2019 and the funds can also go towards the development of the cycling infrastructure.
155.	Initiative for Digital Connectivity in Public Transport	**Goal:** The core element of the initiative is a dialogue and stakeholder process with representatives of the Länder, transport authorities, municipalities, transport companies and associations, industry and consumer associations. **Scope:** Involved stakeholders and decision-makers have joined forces to develop a roadmap that outlines the areas where action is needed, the steps to be taken and the areas of responsibility. BMVI is making a financial contribution towards the implementation of the roadmap. **Status:** The Initiative started in early 2015. The roadmap was adopted in June 2016. **Facts and Figures:** A total of €16 million were available in the Future Investment Programme for the years between 2016 and 2018.
156.	Federal Transport Infrastructure Plan (BVWP)	**Goal:** To give maintenance and replacement priority over expansion and construction, to eliminate congestion on main routes and strengthen more climate-friendly modes of transport. **Scope:** The infrastructure expansion legislation adopted by the Bundestag forms the basis for the financing and implementation of infrastructure expansion and construction projects. **Status:** The 2030 BVWP was adopted in the Cabinet in August 2016. **Facts and Figures:** A total of €270 billion are earmarked for maintenance and replacement projects and for road, rail and waterway infrastructure expansion and construction projects.
157.	Promotion of hydrogen-based mobility in rail transport within the framework of the NIP	**Goal/Scope/Status/Facts and Figures:** The world's first-ever hydrogen-powered train was unveiled in September 2016. Between 2018 and 2020, diesel locomotives are to be replaced by 14 hydrogen trains on previously non-electrified lines in Lower Saxony. A total of 50 trains are to be rolled out in the passenger transport sector by 2021. This is being done in an effort to take advantage of the synergies from the development of hydrogen mobility in road transport, particularly with regard to the production, transportation and provision of the fuel.
158.	Further development of the HGV toll/adaptation of the European Infrastructure Costs Directive	**Goal/Scope:** The HGV toll system is to be developed further to make freight transport more climate-friendly. Efforts are being focused on including an effective CO_2 surcharge in the HGV toll from 2023 onwards in accordance with the Climate Action Programme 2030. This first requires an amendment to Directive 1999/62/EC (on the charging of heavy goods vehicles for the use of certain infrastructures) at EU level, which defines the legal framework for toll collection by the Member States. Directive 1999/62/EC does not currently provide for CO_2 differentiation. **Status:** The Directive is currently under revision. The EP issued a trialogue mandate as early as October 2018 on the basis of the EU Commission's proposal to amend the 2017 Directive. Under Germany's Presidency of the Council of the EU, the members will in all likelihood issue a mandate for trialogue negotiations at ambassador level on 18 December 2020. In this case, the trialogue negotiations will commence under Portugal's Presidency. The mandate in the Council is based on the current compromise text, which provides for the introduction of a differentiation in infrastructure charges according to CO_2 emissions (with differentiation optional initially and mandatory at a later date). Another alternative and/or cumulative option would be to levy a surcharge for CO_2 costs. The text also includes a provisional exemption option for zero-emission vehicles.
159.	Rail Future Alliance	**Goal/Scope:** The Rail Future Alliance (ZBS) agreed in the coalition agreement was launched in October 2018. The Federal Government and the railway sector resolved to attract twice the number of rail travel customers and increase the proportion of rail freight by at least 25% by 2030 with the Rail Pact of the Rail Future Alliance signed on 30 June 2020 and the associated Railway Masterplan. Various measures were agreed for the following central fields of action in order to achieve these and other objectives: introducing a nationwide synchronised timetable (Deutschlandtakt), expanding capacities, strengthening the competitiveness of rail transport, expediting noise abatement and climate change mitigation measures, promoting innovations and recruiting qualified personnel.

	Instrument	Implementation status
160.	Strengthening rail freight transport	**Goal/Scope/Status/Facts and Figures:** To accelerate the expansion of rail transport. Funds from the Future Investment Programme enabled significantly higher investments in the expansion of the rail transport infrastructure expansion between 2016 and 2018. Apart from implementing projects under the requirements plan, implementation of the measures of the Second Immediate Action Programme for Seaport Hinterland Transport, which are designed to increase capacity, commenced in 2015 and will run through to 2020. The financing agreement for a first tranche of the Second Immediate Action Programme for Seaport Hinterland Transport has been concluded. The following measures of the Rail Freight Masterplan must be implemented in order to strengthen rail freight transport in the long term: Funding of rail freight transport that provides for partial financing of approved track access charges with additional federal funds under the funding guideline for reducing track access charges in the rail freight sector that came into force in December 2018 aims to create an incentive to reduce prices in rail freight transport and to shift freight transport from the roads to the more environmentally-friendly rail. This is intended to improve the competitiveness of rail freight transport. Budget funds amounting to €175 million were made available from July 2018, to be followed by €350 million per year between 2019 and 2022, and €175 million in 2023. The funding measure is to be evaluated in 2021. Additional support for rail freight transport will be provided in the form of federal funding of private transhipment facilities for intermodal transport and private sidings, as well as facility pricing support with a focus on wagon-load freight and the promotion of innovations within the framework of the federal Future Rail Freight Transport programme.
161.	Strengthening waterways as a mode of transport	**Goal/Scope/Status/Facts and Figures:** Alternative drive systems (e.g. LNG, electricity, methanol) are being promoted within the framework of the funding guideline on the sustainable modernisation of inland waterway vessels of 1 January 2020. The Federal Government's funding guideline for private transhipment facilities for intermodal transport also applies to facilities for transhipment to inland waterways.
162.	Strengthening of regional economic cycles	**Goal/Scope/Status/Facts and Figures:** Preparations are underway for awarding a contract for 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 formulation of guidelines for local authorities.
163.	Strengthening of local public transport	**Goal/Scope/Status/Facts and Figures:** State subsidies for local and regional passenger services (regionalisation funds) were increased to €8.2 billion in 2016 and are being supplemented by a further 1.8% per year between 2017 and 2031 within the framework of the Federal Government's climate change mitigation package. As of 2020, the Länder are to receive compensation for the discontinuation of divestiture funding within the framework of general payments from VAT tax revenue.
164.	Strengthening of the cycling and pedestrian infrastructures	**Goal:** To further develop the cycling infrastructure and link the cycling system to other modes of transport by means of investment, non-investment and communication measures. To improve the framework conditions. **Status:** Funding was granted to 33 projects during the funding years 2018 and 2019. The adoption of the new National Cycling Plan is planned for spring 2021.
165.	Eighth Act amending the Road Traffic Act (automated driving)	**Goal:** To create a legal framework for highly or fully automated driving. **Status:** Entered into force in June 2017.
166.	Action plan to create the ethical guidelines for the computers in self-driving vehicles	**Goal:** To create the necessary framework for the development of these new technologies and ensure that Germany continues to play a leading role in this process. **Scope:** Action plan based on recommendations presented by the Ethics Commission for Automated and Connected Driving. **Status:** Published in September 2017.
167.	Reduced tax rate for local public transport under the Electricity Tax Act.	**Goal:** To promote the use of plug-in hybrid and electric vehicles in the local public transport. This action plan aims to establish a tax concession for plug-in hybrid and electric vehicles in line with technological advances in addition to the electricity tax concession for railways and the energy tax concession for fuels in local public transport. **Scope/Status:** The tax rate was reduced to €11.42 per MWh with the amendment to the Electricity Tax Act on 1 January 2018. **Facts and Figures:** Revenue shortfalls are estimated at €1 million per year.

	Instrument	Implementation status
168.	Continuation of reduced tax rates for natural gas and liquefied petroleum gas	**Goal:** To continue the tax concession as an incentive to use alternative fuels for public and private transport in the inner cities. **Scope/Status:** The amendment to the Energy Tax Act of 1 January 2018 extends the duration of the tax concession for natural gas up to and including 31 December 2026, with a degressive reduction in the tax rate from 1 January 2024. The tax reduction for LPG/LNG has been reduced degressively since 1 January 2019 and this will continue until the regular tax rate applies from 1 January 2023. **Facts and Figures:** Lost tax revenue due to the continuation of tax concessions for LNG and LPG are estimated at €1 billion for the entire term. The exact amount will depend on the actual fuel consumption.
169.	Act on the Avoidance of VAT Losses on the Trading of Goods on the Internet	**Goal:** This act includes incentives for electric mobility and other environmentally-friendly alternatives to vehicles with internal combustion engines. **Scope:** The provisions of this Act include the following: • Promotion of electric mobility by halving the assessment basis that applies to private use of electric and plug-in hybrid company vehicles purchased in the years 2019 to 2021 when calculating company car taxation; • Tax exemption for the private use of company electric bikes and conventional bicycles; • Tax exemption for employer's contributions to employees' expenses for travel by public transport on regular routes between the place of residence and the first place of work, as well as for corresponding benefits in kind. **Status:** Act of 11 December 2018. Entered into the force to the greatest extent possible on 1 January 2019.
	Chapter 8: Greenhouse gas emissions	
170.	Federal Climate Change Act	**Goal:** The purpose of the Federal Climate Change Act is to ensure that Germany meets its national and international climate targets. The Federal Climate Change Act focuses in particular on ensuring that Germany meets the climate target set for 2030 of reducing the country's greenhouse gas emissions by at least 55% compared with 1990. **Scope:** The Federal Climate Change Act sets annual mitigation targets for each sector by specifying annual emission levels. The Act provides for a mandatory monitoring process in order to determine whether the annual mitigation targets are achieved. In the event of failure to achieve the minimum targets, the responsible ministry is obliged to submit an Immediate Action Programme for overnight control within three months, which ensures compliance with the reduction targets for the years to come. **Status:** The Federal Climate Change Act has been in force since 18 December 2020.
171.	Climate Action Programme 2020 (APK 2020)	**Goal:** To reduce greenhouse gas emissions in Germany by at least 40% compared with the year 1990 as quickly as possible. **Scope:** More than 110 individual measures in all sectors of the economy. **Status:** In February 2019, the Federal Government passed a resolution on the 2018 Climate Action Report, which monitors implementation of measures laid down in the Climate Action Programme 2020. The Report describes the current trends in the development of emissions in the various fields of action, reports on the implementation status of measures outlined in the Climate Action Programme and provides a forecast of the anticipated GHG reducing impact of the individual measures up to 2020.
172.	2050 Climate Action Plan	**Goal:** To define the long-term strategy of German energy and climate policies. **Scope:** The 2050 Climate Action Plan addresses the following action areas: energy sector, buildings, transport, industry, agriculture as well as land use and forestry. It also outlines overarching objectives and strategic measures. **Status:** The Federal Government adopted the 2050 Climate Action Plan in November 2016. A Climate Action Programme that focuses on the period leading up to 2030 was adopted in September 2019.
173.	Climate Action Alliance	**Goal:** To support the measures adopted with the Climate Action Programme, facilitate the activation of potentials that are currently classified as not yet quantifiable, and identify further fields of action. **Scope:** So far, discussions on climate change mitigation have taken place in the transport sector, among local authorities, in the farming community, among small to medium-sized enterprises, among tradespeople and throughout industry. **Status:** The Action Alliance meets every six months and monitors the implementation of the 2050 Climate Action Plan.
174.	Recommendations from the Commission on Growth, Structural Change and Employment	See Chapter 9.

	Instrument	Implementation status
	Chapter 9: Power plants and security of supply	
175.	Electricity Market Act	**Goal:** To make the electricity market fit for growing shares of renewable energy and pave the way for competition between flexible generation, flexible demand and storage. **Scope:** Continued development of the electricity market into an Electricity Market 2.0, specifically: • Strengthening existing market mechanisms • Reduction of access barriers for providers of demand side management measures • More efficient grid planning • More extensive monitoring of security of supply • Greater transparency in the electricity market • Introduction of a capacity reserve established outside the electricity market • Establishment of a security standby reserve **Status:** In 2018, three power generation units with a total capacity of around 1,050 MW were transferred to security standby. Another two power generation units with a total capacity of around 750 MW followed in 2019.
176.	Omnibus Energy Act	**Scope:** • Extends the Combined Heat and Power Act (KWKG) by three years to 2025. The purpose of this is to improve the conditions for investments in new CHP plants. • Quantities of electricity passed on to third parties: Provisions will be made to enable an estimate of the amount of electricity passed on to third parties. The BAFA announced this in advance in a notice on Electricity Meters for the Special Equalisation Scheme. This ensures that the companies concerned will retain their renewable energy surcharge privileges. • Facilitating the modernisation of large steam busbar CHP installations: it was necessary to adjust the eligibility criteria in order to facilitate continued funding of large CHP modernisation projects to cover the possibility of an adjustment in state-aid rules. • Intended to guarantee security of supply even under exceptional unforeseeable circumstances, the capacity reserve was launched on 1 October 2020. **Status:** The Act entered into force in December 2018.
177.	Act to reduce and terminate coal-fired electricity generation and to amend other laws (Coal Phase-out Act)	**Goal:** The Coal Phase-out Act lays down provisions for the reduction and elimination of coal-fired electricity generation by 2038 at the latest. The purpose of this measure is to ensure that the Federal Government's energy policy objectives are implemented in a legally secure, economically reasonable and socially viable manner. **Scope:** The Act essentially implements the energy policy recommendations made by the Commission on Growth, Structural Change and Employment in 2019. Apart from provisions to reduce and terminate the production of electricity from coal and lignite by 2038 at the latest, the Act also contains measures for a continuous review of security of supply, cancellation of CO_2 certificates as they become available, authorisation to compensate electricity consumers in the event of an increase in electricity prices attributable to the coal phase-out and an adjustment benefit for older employees in the coal sector. The expansion target for renewable energy sources will be raised to 65% in 2030 in order to compensate for the gradual decline in coal-fired electricity generation. Funding for combined heat and power generation will also be extended and further developed to advance the conversion from coal to a flexible and more climate-friendly power source. **Status:** The Bundestag and the Bundesrat passed the Coal Phase-out Act on 3 July 2020.
178.	Capacity Reserve Ordinance	**Goal:** To keep 2 GW of capacity in reserve for unforeseeable exceptional circumstances. **Scope:** The grants for the period between 1 October 2020 and 30 September 2022 have been awarded and the capacity reserve is now operational with a volume of 1 GW. This is a type of strategic stockpiling on the part of the transmission system operators. It puts them in a position to secure the electricity supply in the event of unforeseeable emergencies by drawing on the plants in the capacity reserve to provide additional electricity feed-in. **Status:** The Federal Network Agency is reviewing the technical requirements for participation in the second round of auctions with the aim of increasing the offer in the next auction.
179.	Amendment to the Combined Heat and Power Act (KWKG)	**Goal:** To convert coal-fired combined heat and power (CHP) to gas, increase the flexibility of CHPs and integrate renewables into the heat supply to a greater extent. **Scope:** The Amendment extends the Combined Heat and Power Act (KWKG) until the end of 2029 and raises the subsidy cap to €1.8 billion per year. It introduces a coal replacement bonus according to the age of the plants concerned, which provides incentives to replace coal with gas and shut down coal-fired CHP plants ahead of schedule. Eligible full-load hours are being limited in order to ensure that the CHPs are operated in a flexible manner that is compatible with the electricity market. There are also greater incentives to use renewable energy sources for heat supply systems. **Status:** The Amendment to the Combined Heat and Power Act (KWKG) was adopted on 3 July 2020 and the state aid notification procedure is currently underway.

	Instrument	Implementation status
180.	Act reorganising responsibility for nuclear waste management	**Goal:** To ensure that financing for decommissioning and dismantling of nuclear power plants and for nuclear waste disposal is guaranteed. **Scope:** Operators of nuclear power plants (NPPs) will continue to be responsible for the management and reserve-backed financing of plant decommissioning and dismantling. The Federal Government has sole responsibility for interim and final storage of radioactive waste as of July 2017; the public-law foundation Fund for Financing Nuclear Waste Disposal (KENFO) reimburses the Federal Government all related costs incurred. **Status/Facts and Figures:** The Act entered into force in June 2017; NPP operators transferred funds amounting to around €24.1 billion to KENFO on 3 July 2017. KENFO is investing these funds at a profit.
181.	Act Modernising the Repository Site Selection Act and other Legislation	**Goal:** To implement the recommendations of the Final Repository Commission of 2016, thereby regulating the site selection procedure. **Scope:** The Act lays down the criteria for the site selection procedure, beginning with a blank map and ending up with the best possible final repository site. **Status:** The Act entered into force in May 2017.
182.	Core Energy Market Data Register	**Goal:** To establish a central register for the energy industry to simplify official and private sector reports, reduce the number of registers to which reports have to be made and enhance data quality and transparency. **Scope:** The Core Energy Market Data Register (MaStR) merges the core data for all grid-based energy supply installations in Germany's electricity and gas markets, as well as the plant operators, to create a single online database. **Status:** The Core Energy Market Data Register Ordinance (MaStRV) entered into force in July 2017. The Register started work in January 2019.
183.	Ordinance to improve the regulatory framework for the construction of the LNG infrastructure in Germany	**Goal:** To ensure that a secure natural gas supply is assured by diversifying import routes. **Scope:** The direct import of LNG using both European and German infrastructures is an important component of diversification. One hurdle to building the LNG infrastructure in Germany has been connecting the LNG plants to the national pipeline network. Under current laws, plant operators have been responsible for installing and paying for this connection themselves. In future, transmission operators will be required to set up the pipelines between the German LNG terminals and the pipeline network. 90% of the costs will be borne by the transmission system operator in future, with the terminal operator contributing 10% of the costs. The ordinance puts LNG import terminals on an equal footing with the landfall points for pipeline gas. **Status:** Cabinet decision in March 2019. The ordinance came into force on 20 June 2019.
184.	SMARD electricity market data	**Goal:** To provide a transparent representation of the German electricity market. **Scope:** Central electricity market data for Germany and some parts of Europe can be retrieved almost in real time, displayed clearly in charts and downloaded from www.smard.de. Electricity generation and consumption data, wholesale prices, imports and exports, as well as balancing energy data can be called up for different periods of time and visualised in the form of charts. **Status:** The platform has been online since July 2017.
	Chapter 10: Affordable energy and fair competition	
185.	Special Equalisation Scheme in the EEG	**Goal:** To ensure that the promotion of renewables in Germany does not put electricity-intensive companies and railway operators at a disadvantage compared with international and intermodal competitors and that jobs are not lost as a result. **Scope:** Electricity-intensive businesses in sectors facing international competition and railway operators facing competition from other modes of transport can apply to pay a lower EEG surcharge. **Facts and Figures:** 1,910 businesses in the manufacturing industry and 148 railway operators with an electricity consumption of approximately 111.8 TWh benefited from privileges under the Special Equalisation Scheme in 2019.

	Instrument	Implementation status
186.	Reductions in the CHP surcharge	**Goal:** To ensure that the promotion of cogeneration concepts in Germany does not put German businesses at a disadvantage compared with international competitors and that jobs are not lost as a result. **Scope:** The CHP surcharge can be reduced for energy-intensive companies in international competition and railway operators. The CHP Act also provides for reductions in the CHP surcharge in special cases within the framework of self-supply. **Status/Facts and Figures:** The amount of the CHP surcharge reduction is determined on a case-by-case basis. A reduced CHP surcharge was paid for a total of just under 115 TWh in 2019, whereas a good 358 TWh were subject to the full CHP surcharge. The total amount paid in CHP surcharges was around €1 billion. The companies saved around €290 million through various reductions (compared with the current surcharge). The largest individual saving was made by the group of electricity-intensive business that benefited from the reduction in the CHP as a result of the reduction in the EEG surcharge within the framework of the Special Equalisation Scheme. The fact that the CHP surcharge would have been lower if it had not been for the various reductions must always be borne in mind. This being the case, the macroeconomic financial relief is lower than described above.
187.	Relief under the Energy Tax Act and Electricity Tax Act	**Goal:** To make tax concessions available under energy and electricity tax legislation, in addition to the tax relief prescribed by EU law in some areas, in order to secure competitiveness in an international comparison while allowing for climate change mitigation measures. **Scope:** Businesses can apply for tax relief on various legal grounds (e.g. relief for particularly energy-intensive or electricity-intensive processes, general energy and electricity tax relief for the manufacturing industry and what is referred to as the tax capping scheme). Additional energy efficiency requirements must be met in order to be eligible for the tax cap mechanism (certification in accordance with ISO 50001 or EMAS registration, concessions for SMEs and achievement of statutory target values to reduce energy intensity). **Status:** According to the information available at this time, around 15,000 companies have benefited from at least one of the listed energy tax relief schemes and around 33,000 companies have benefited from at least one of the listed electricity tax concessions. **Facts and Figures:** In 2019, relief from energy tax amounted to €795 million for the exemplary fiscal concessions mentioned above. Relief from electricity tax amounted to €3.36 billion in 2019.
188.	Electricity price compensation	**Goal:** To prevent the relocation of production facilities to other countries. **Scope:** Since the start of the third trading period, businesses with particularly electricity-intensive production processes that are likely to move their production facilities to other countries because of the high costs attributable to CO_2 emissions from electricity generation have been able to apply for compensation for the costs incurred within the framework of the indirect carbon costs of the EU emissions trading scheme, which are passed on in electricity prices. The amount of compensation is based on the price of the CO_2 allowance for the respective accounting year. **Facts and Figures:** For accounting year 2019, 322 companies with 903 installations received subsidies amounting to around €546 million, which were paid in 2020.
189.	Price of CO_2 allowances and free allocation of some allowances within the framework of the EU ETS	See Chapter 3.
190.	Relief from grid charges	**Goal:** The Grid Charge Modernisation Act (NEMoG) gradually reduces regional disparities in transmission system charges, creates more distribution equality and reduces network costs. **Scope:** 2019 saw the beginning of a graduated transmission system charge harmonisation process in five steps leading up to 2023. The refinancing of offshore connection charges by means of the grid fees ceased in 2019 to be replaced by the newly created offshore grid surcharge. Payments made by distribution system operators to power producers for avoided grid fees are being gradually discontinued, thereby lowering distribution system costs. **Status:** The Grid Charge Modernisation Act (NEMoG) entered into force in July 2017. Implementation was planned in more concrete terms by the Ordinance on the Gradual Introduction of Nationwide Transmission System Charges in 2018. **Facts and Figures:** Provisional figures indicate that the cost burden attributable to payments for avoided grid fees carried by the grid operators under the jurisdiction of the Federal Network Agency in 2019 was around €1.3 billion lower than in 2017 and was therefore halved during this period.

	Instrument	Implementation status
191.	Relief from the EEG surcharge in the context of the Fuel Emissions Trading Act (BEHG)	**Goal:** To relieve the burden on electricity consumers. **Scope:** When the Fuel Emissions Trading Act (BEHG) was introduced, it was decided to use part of the revenue to reduce the EEG surcharge from 2021 onwards. This will also offer a means of compensating for the burden on energy consumption in the heating and transport sectors arising from the BEHG. **Status:** This measure is being overshadowed by the effects of the Covid-19 pandemic. If no counteraction had been implemented, they would have led to an increase in the EEG surcharge – in spite of the subsidies from the BEHG. A further €11 billion were therefore made available by the second supplementary budget for 2020 to ensure that the EEG surcharge is reduced from 6.756 ct/kWh (2020) to 6.5 ct/kWh (2021) and 6 ct/kWh (2022) (see also measure 65).
	Chapter 11: Environmental compatibility of the energy supply system	
192.	Environmentally compatible expansion of renewable energy sources	**Goal:** To increase the share of renewables in the energy system while simultaneously reducing coal-fired power generation and phasing out nuclear energy. **Scope:** See Chapters 1, 4 and 9.
193.	Distance between residential areas and wind power plants as laid down in the Technical Instructions on Noise Abatement (TA Lärm)	**Goal:** To adhere to the specified limit values. **Scope:** Measurement and assessment of noise immissions in accordance with No. 6.1 as well as low-frequency noise immissions in accordance with No. 7.3 and A.1.5 of the Technical Instructions.
194.	Preparation of a general administrative regulation on the minimisation of electric and magnetic fields from newly erected substantially modified electricity supply installations and similar plants.	**Goal:** To minimise electric and magnetic fields in accordance with state-of-the-art requirements as a precautionary measure. **Scope:** Catalogue of technical measures, the implementation of which must be tested on the basis of a specified procedure during the erection and substantial modification of electricity lines, overhead contact lines, transformation and conversion stations and other comparable installations with a nominal voltage of 1,000 volts or more for low-frequency systems or 2,000 volts or more for direct-current systems. **Status:** Entered into force in 2016 (26th Ordinance Implementing the Federal Immission Control Act (26. BImSchVVwV)).
195.	Radiation Protection in the Process of Power Grid Expansion research programme	**Goal:** To reduce scientific uncertainties relating to the risks and effects of static and low-frequency electric and magnetic fields and to further improve the assessment and communication of risks with respect to these fields, where such risks arise while electricity is being transported and used. **Scope:** Implementation of a broad-based research programme coordinated by the Federal Office for Radiation Protection in parallel with the expansion of the electricity grid. The various projects focus on the following issues: Possible associations between low frequency magnetic fields and neurodegenerative diseases; Determination of perception and action thresholds; low-frequency magnetic fields and childhood leukaemia; co-carcinogenicity of magnetic field exposure; possible association between exposure to magnetic fields and the rate of miscarriage; occurrence, propagation and absorption of corona ions; exposure analysis, exposure assessment and current data on the exposure of the general public; risk perception and risk communication; oxidative stress; effects on flora and fauna. **Status:** The research programme was launched with a kick-off event in July 2017. As of June 2020, ten of the more than 40 individual projects have already been completed and a further six are in progress.
196.	Establishment of the Competence Centre for Electromagnetic Fields (KEMF)	**Goal:** While research into electric, magnetic and electromagnetic fields is to be promoted in the context of radiation protection and the protection of human health, more attention must also be given to the evaluation of research results and radiation exposure of the population. At the same time, efforts to inform and advise the population are to be intensified while establishing other communication formats, including the processing of research results for the public and the Federal Government. **Scope:** The Competence Centre is being set up at the Federal Office for Radiation Protection as the Federal Government's central contact point for all radiation protection and health issues relating to electric, magnetic and electromagnetic fields. **Status:** The Competence Centre was founded by Federal Environment Minister Schulze in February 2020 and is currently being set up in Cottbus. The first advisory services (so-called mayor's consultation hours) have already begun.

	Instrument	Implementation status
197.	German Resource Efficiency Programme II (ProgRess II)	**Goal:** In February 2012, the Federal Government decided to develop a national resource efficiency programme (ProgRess) on the basis of its natural resources strategy, which was updated in 2016 with ProgRess II and in 2020 with ProgRess III. The programme aims to reduce the use of primary raw materials to the greatest extent possible by using natural resources efficiently, thereby contributing towards decoupling economic growth from the use of natural resources. ProgRess relies on voluntary action and the creation of incentives to improve resource efficiency. **Scope:** The recommendations of ProgRess III for managing resources also refer to the resource demands of energy plants. Numerous current developments to strengthen sustainability in the supply of raw materials and suggestions from ProgRess II are being used to a considerable extent. **Status:** The concrete implementation is being monitored on the basis of several indicators. Total raw material productivity is one of these. The current development of this indicator implies that attempts to decouple economic growth from raw material use are being relatively successful and that the measures implemented under of ProgRess are taking effect.
	Chapter 12: Grid infrastructure	
198.	Amendment to the Incentive Regulation Ordinance (ARegV)	**Goal:** Economic incentives are to be created in an effort to increase transport capacity at transmission and distribution system levels. **Scope:** According to current legislation, congestion management costs are regarded as being so-called costs which cannot be influenced on a permanent basis and therefore constitute a transitory cost item within the framework of network cost calculation. In this respect, network operators have no direct economic incentive to reduce congestion management costs or to take this into account directly when weighing up measures to increase network capacity. **Status:** A draft of the revised version is being prepared.
199.	Federal Requirement Plan Act (BBPlG)	**Goal:** To establish a legal basis for the need to meet energy supply requirements and the urgent need for new transmission lines. **Status:** The Act was most recently amended in 2019 by the Act to Accelerate Energy Line Construction. It currently includes 43 projects with a total length of 5,826 kilometres. Of these, approx. 12% were completed or under construction at the end of the first quarter of 2020 (427 and 277 km respectively) and a further 75% approximately were in the regional planning/federal sectoral planning phase or going through the planning approval procedure (1,678 and 2,681 km respectively). Further measures are to be included in the Federal Requirements Plan Act on the basis of the 2019–2030 Grid Development Plan confirmed by the Federal Network Agency at the end of 2019. The measures from the 2017–2030 Grid Development Plan that have already been confirmed are also to be taken into account.
200.	Amendment to the Grid Expansion Acceleration Act (NABEG)	**Goal:** To accelerate the planning and approval process, especially for grid uprating measures. **Scope:** Faster notification procedures, waiver of planning steps for construction in existing power lines, future-driven planning, better coordination of recommendations from the Länder, enabling timely commencement of construction work. **Status:** The Act to Accelerate Energy Line Construction included in the Amendment entered into force in May 2019.
201.	Power Grid Expansion Act (EnLAG)	**Scope:** The Power Grid Expansion Act (EnLAG) defines the high priority given to the need for expansion and the need to meet energy supply requirements with 22 expansion projects covering a total distance of 1,825 km. Six of the projects can be implemented on sub-loops as pilot projects for the use of underground cables at the ultra-high voltage level. **Status:** The Act was adopted by the Bundestag and Bundesrat as early as 2009 and was last amended by the Act to Accelerate the Construction of Energy Lines in 2019. Around 50% of the 1,825 km of lines had been completed (913 km) at the end of the first quarter of 2020 and approximately another 26% (484 km) had been approved and were just entering or in the middle of the construction phase.
202.	Continued development of the German grid expansion project monitoring system and the system for monitoring system measures to increase utilisation of the electricity grid	**Goal:** To 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. Making better use of existing capacity is also important. **Scope/Status:** The Federal Network Agency's grid expansion monitoring system now includes all projects under the Power Grid Expansion Act (22) and the Federal Requirement Plan Act (43), as well as offshore projects (24), along with measures to optimise existing grids (use of overhead line monitoring or high-temperature conductor cables), and detailed information can be found at www.netzausbau.de. The status of the planning and approval procedures for the individual sections of the grid expansion projects is documented in the form of a report and a summary bar chart for each one.

	Instrument	Implementation status
203.	Forward-looking monitoring concept for grid expansion	**Goal:** To accelerate grid expansion by means of forward-looking grid expansion project monitoring by BMWi with six defined milestones for all federal and Länder grid expansion projects. **Scope:** The Federal Government and the Länder have agreed on specific timetables for all grid expansion projects with the transmission system operators and these were adopted at the meeting of energy ministers on 24 May 2019. They are reviewed at regular intervals and the current status is published at www.netzausbau.de. This offers the public a means of accessing information regarding the progress of grid expansion at any time. The timetables lay down targets to be used in further monitoring processes. The federal and Länder energy ministers and TSOs will meet once a year, or better, once every six months, to discuss the progress of grid expansion. The responsible heads of department will discuss and expedite the individual projects with the grid operators every six months as usual. **Status:** Of the grid expansion projects decided in 2015, 3,016 km (86%) are expected to be in the planning approval phase or at a more advanced stage at the end of 2020 (2019: 949 km/27%). 223 km of the projects included in the 2013 tranche are expected to be completed by the end of 2020 (2019: 183 km). As far as the measures identified since 2009 are concerned, more than 1,487 km or 90% are expected to be under construction or in operation by then (currently: 1.238 km/75%).
204.	Introduction of a monitoring system for offshore connection lines as well	**Goal:** To establish a forward-looking monitoring system to monitor progress in the implementation of offshore connection lines as is the case with those already in place for other grid expansion projects. **Scope:** The Federal Government, the coastal Länder and the transmission system operators concluded a joint offshore agreement in May 2020. This agreement commits all of the parties involved to a close cooperation in order to implement the expansion of wind energy in the North Sea and Baltic Sea to a capacity of 20 GW by 2030. The agreed time targets will be reviewed at regular intervals in future as part of the BMWi's grid expansion monitoring concept.
205.	Further development of the Ordinance on Agreements Concerning Interruptible Loads (AbLaV)	**Goal:** To ensure that grid stability and the associated security of supply are assured. **Scope/Status:** Interruptible loads are industrial enterprises that continuously consume large volumes of electricity, which can reduce their consumption temporarily in case of grid-related demand. The procurement and use of interruptible loads have undergone continuing and consistent development, and the usage possibilities have been optimised compared with the previous regulation. The new version of the Ordinance entered into force on 1 October 2020. The European Commission has confirmed that it complies with European rules on state aid. **Facts and Figures:** As of May 2020, plants accounting for a total of 1532 MW have prequalified, of which 802 MW qualifies as immediately interruptible load.
206.	Energy Transition Digitisation Act	See Chapter 13.
207.	Citizens' Dialogue on the Electricity Grid initiative	**Goal:** The Citizens' Dialogue on the Electricity Grid initiative aims to establish a broad-based social dialogue with all stakeholders on the expansion of the energy infrastructure that is necessary for the success of the energy transition. **Scope:** The initiative, which has been funded by the BMWi since 2015, provides basic information on the expansion of the electricity grid, the connection between grid expansion and the energy transition, and the opportunities for citizens to participate at an early stage. It also acts as a dialogue platform by being present locally in the regions particularly affected by the grid expansion with various events and discussion formats for citizens and stakeholders, as well as a dialogue mobile. The offered services are rounded off by an online presence with online citizens' office.
208.	Demand and procurement of ancillary services in the future	**Goal:** To determine and (further) develop the ancillary services required for the energy transition and develop efficient procurement systems. **Scope:** Investigations to determine the ancillary services required for safe, secure grid operation in the medium and long term, the technical requirements imposed on them, the extent to which they must be provided and the way in which cost-efficient coverage of demand could be achieved. The industry will be involved in the form of stakeholder workshops. **Status:** The process started at the end of 2019. An accompanying scientific project has been commissioned. Three stakeholder workshops have already been held and a report has been published.
209.	Improved congestion management	**Goal:** To make congestion management more efficient and less expensive. **Scope:** An optimised energy management system that includes all generation plants (from 100 kW), as well as renewable energy plants and combined heat and power (CHP) plants, which are given lower priority, in an effort to alleviate the load on the grid in the most efficient way possible. The feed-in priority for renewables and CHP plants remains in place. **Status:** Legal foundations have been created with the Amendment to the Grid Expansion Acceleration Act (NABEG). Federal Network Agency consultation on implementation rules currently underway. To enter into force on 1 October 2021.

	Instrument	Implementation status
210.	Ordinance on the Verification of Electrical Properties of Energy Modules (NELEV)	**Goal:** To uphold system safety and security by means of mandatory proof of compliance with technical standards. **Scope:** Introduction of obligations to provide evidence of compliance with technical requirements. The Ordinance supersedes the Ordinance on System Services by Wind Energy Plants (SDLWindV), which was mandatory for wind-powered installations. In contrast to the SDLWindV, this ordinance applies to all types of generation as well as to storage facilities. **Status:** The Ordinance entered into force on 1 July 2017.
211.	Amendment to the Energy Industry Act (EnWG) with respect to the market-based procurement of ancillary services	**Goal:** To introduce transparent, non-discriminatory, market-based procurement procedures for non-frequency-linked ancillary services. **Scope:** The amendment implements the requirements of the EU Directive on common rules for the internal market for electricity ((EU) 2019/944). According to this, grid operators are obliged to procure non-frequency-linked ancillary services within the framework of a transparent, non-discriminatory and market-based procedure. This facilitates participation by all potential market participants, e.g. renewable energy sources, storage facilities and consumers. The Federal Network Agency (BNetzA) will define the procurement system designs or approve them on the basis of drafts submitted by the grid operators. The Federal Network Agency will make provision for exceptions in the event that market-based procurement of an ancillary service is not economically efficient. **Status:** Entry into force of the regulation on 27 November 2020.
212.	Grid Charge Modernisation Act (NEMoG)	**Goal:** To regulate the gradual nationwide standardisation of transmission system charges by 2023. As of 1 January 2023, the grid transmission charges will be the same everywhere in Germany. The Act also provides for dissolution of the privileged treatment of avoided grid-use charges. **Status:** The Act entered into force in July 2017.
	Chapter 13: Sector coupling and digitisation of the energy transition	
213.	Electric Mobility Environmental Bonus	See Chapter 7.
214.	Market Incentives Programme for heating with renewable energy sources	See Chapter 6.
215.	Model Project Heat Network Systems 4.0 funding programme (low temperature heat networks with seasonal thermal energy storage)	**Goal:** To prepare for broader market introduction of innovative 4th generation heat network systems with a high share of renewable energy sources and efficiently used waste heat. **Scope:** Funding for a total of four modules: Funding for up to 60% of costs of feasibility studies, up to 50% of the project costs for implementation of a Heat Network System 4.0, supplementary funding for scientific collaborations (capacity building) and for information campaigns for potential customers in an effort to attract more subscribers for the model projects. **Status:** The funding programme has been in force since July 2017. **Facts and Figures:** The market response surpasses expectations by a long way. 163 applications for feasibility studies and 9 applications for the implementation of Heat Network Systems 4.0 had already been submitted by the beginning of July 2020.
216.	Promotion of innovative CHP systems under the CHP Act (KWKG)	See Chapter 9.
217.	Act on the Digitisation of the Energy Transition (GDEW)	**Goal:** To create the technical framework for demand and generation management measures and greater flexibility in the power grid. **Scope:** Introduction of smart metering systems: Smart Grid, Smart Meter, Smart Home. These are to serve as a secure communication platform to create a stronger network for the energy supply system. **Status:** The Act entered into force in September 2016. The mandatory rollout of smart metering systems has begun with the certification of three systems from independent manufacturers and the market analysis to determine availability of the technical prerequisites by the Federal Office for Information Security (BSI).

	Instrument	Implementation status
218.	Ordinance creating a legal framework for conducting experiments and acquiring knowledge within the Smart Energy Showcases – Digital Agenda for the Energy Transition funding programme (SINTEG Ordinance)	**Goal:** To develop and test pilot solutions to meet the technical, economic and regulatory challenges associated with the energy supply of the future. **Scope:** The main emphasis is on the digitisation of the energy sector. The SINTEG Ordinance has created the necessary test environment for programme participants. **Status:** The Ordinance has been in force since 21 June 2017. The SINTEG programme is scheduled to run until 31 March 2021.
219.	Energy Savings Meter pilot programme	See Chapter 5.
220.	The Standardisation Strategy for Cross-sectoral Digitalisation under the Act on the Digitisation of the Energy Transition (GDEW) Roadmap published by the BMWi and the BSI	**Goal:** To further develop the Smart Meter Gateway into a comprehensive communication platform for the energy transition in order to unfold the full potential of digitalisation for the energy transition. This requires the continuous further development of minimum technical standards for smart metering systems. **Scope:** The necessary technical standards will be gradually formulated for all areas of application that are relevant to energy users, such as grid-oriented feed-in management, load management and electric mobility and/or adapted to the respective current requirements of the energy transition. These must provide added benefit for the consumer, work across different sectors through sector coupling (particularly heat and smart home), cover electric mobility, and be suitably equipped to withstand future threats, e.g. cyber attacks. **Status:** The roadmap was published in January 2019. Task forces have started their work in the field of Smart Metering, Smart Grid and Smart Mobility.
	Chapter 14: Energy research and innovations	
221.	7th Energy Research Programme on Innovations for the Energy Transition	**Goal:** To contribute towards the implementation of the energy transition. **Scope:** In its capacity as a strategic element of energy policy, the programme is oriented to the energy transition and it addresses current and anticipated challenges with a holistic approach to funding policy. Living Labs of the Energy Transition are putting a new focus on the transfer of technology and innovation. This new funding pillar can be used to prepare innovative solutions for introduction to the market. Dynamic transfer of practical experience is supplemented with stronger cooperation with start-ups. Apart from the main fields of research – energy efficiency and renewable energy sources – the programme sets new points of focus on sector coupling, digitisation and the energy transition in the heating, industrial and transport sectors, as well as on social issues. **Status:** Adopted in September 2018. **Facts and Figures:** The Federal Government has earmarked a total of around €6.4 billion for the 7th Energy Research Programme for the period between 2018 and 2022. This represents an increase of around 45% over the funds provided for the start-ups forerunner programme during the comparison period between 2013 and 2017.
222.	Funding initiative for the Live Labs of the Energy Transition ideas competition	**Goal:** Living Labs of the Energy Transition were established in the 7th Energy Research Programme of the Federal Government as a new funding pillar to accelerate the transfer of technology and innovation from research to practice. Living Labs of the Energy Transition test sustainable energy technologies under real conditions and on an industrial scale, thereby accelerating the transformation of the energy system. The BMWi is supporting German companies and researchers in selected living labs in their efforts to contribute their innovative strength to the implementation of the energy transition. The Living Labs of the Energy Transition can help to develop the regulatory framework in Germany with an eye to the future. In addition, they can assist traditional energy regions in developing sustainable energy and industrial policies. **Scope:** Initiated by the BMWi, the Living Labs of the Energy Transition ideas competition offers companies an opportunity to implement their technical and non-technical innovations and test them in a real environment in collaboration with researchers. This involves energy technologies and concepts that offer great potential for effective climate protection when designing the energy system, but have not yet achieved good market penetration. The support for new and innovative ideas in the context of large infrastructure-relevant projects should ease market access. At the same time, direct and large-scale application of promising technologies can indicate where and how regulatory hurdles can be overcome in order to speed up market positioning of energy innovations. In order to become one of the Living Labs of the Energy Transition, a project must have a systemic dimension and testing should be possible on a relevant, industrial scale. Accompanying research may also focus on socio-economic aspects and

	Instrument	Implementation status
222.	*Funding initiative for the Live Labs of the Energy Transition ideas competition*	social issues, as well as future market models, business models and regulatory schemes. The first call for proposals focused on concepts for sector coupling and hydrogen technologies (including P2X technologies in particular), large-scale energy storage in the electricity sector and energy-optimised urban quarters. **Facts and Figures:** Provision is being made for up to €100 million in funding per year during the period from 2018 to 2022. **Status:** The first projects of the 20 selected during the first ideas competition in 2019 are under implementation. Others will be launched in 2020 and 2021 according to the progress of the application process.
223.	Hydrogen Republic of Germany ideas competition	**Goal:** Module 1: Green hydrogen flagship projects: The flagship projects aim to bundle the expertise for hydrogen technologies in science, industry and civil society throughout Germany, thereby providing the initial spark for the development, conception and implementation of hydrogen solutions on an industrial scale. Module 2: Foundational research on green hydrogen: Funding for foundational research on highly innovative solutions for core issues relating to green hydrogen along the entire value-added chain (production, storage, transport and usage, including reconversion into electricity). **Status:** Module 1: Formation of appropriate consortia and evaluation by a panel of experts. Module 2: First projects to be launched at the end of 2020. **Facts and Figures:** A total of more than €800 million have been earmarked for the ideas competition until 2025, including funds from the 2020 economic stimulus package.
224.	Horizon 2020 / EU Framework Programme for Research and Innovation	**Goal:** To enhance Europe's competitiveness. **Status:** Horizon 2020, the EU Framework Programme for Research and Innovation, was launched in 2014. **Facts and Figures:** Around €5.9 billion are earmarked for safe, clean and efficient energy in non-nuclear energy research for the 2014–2020 funding period.
225.	Energy Transition Research and Innovation Platform (R&I platform)	**Goal:** To exchange views and establish a dialogue with representatives from the worlds of politics, business, science and society on the further development of energy research policy, and to accelerate the transfer of energy research results into practice. **Scope:** Discussions on current developments in energy research with particular focus on new formats and the scope of research funding. The R&I platform also bundles and coordinates the Energy Research Networks (see Measure 226). **Status:** Plenary meetings of the R&I platform are held every year. The innovations of the 7th Energy Research Programme, including the Living Labs of the Energy Transition were presented and discussed at the meeting held in February 2019, along with current developments from the Energy Research Networks. The platform's 8th meeting was held in February 2020. One of the main issues was hydrogen with particular focus on the content and objectives of the National Hydrogen Strategy.
226.	Energy Research Networks	**Goal/Scope/Status/Facts and Figures:** The BMWi Energy Research Networks has around 4,000 members. There are currently nine energy research networks: Renewable Energies, Flexible Energy Conversion, Electricity Networks, Energy System Analysis, Bioenergy, Energy Transition Construction, Energy Efficiency in Industry and Commerce, and Start-ups. These networks represent the broad research landscape in Germany. They supply valuable impetus to important research topics from the perspective of the scientific community and research, and provide a networking platform for researchers, business and government. In addition to participation and transparency, the research networks should provide a stronger incentive for the rapid transfer of research results to the energy sector. As part of the consultation procedure for a 7th Energy Research Programme, the Energy Research Networks grouped members into subject-based task groups that provided strategy input and expert recommendations. These not only relate to further development of federal energy research policy, but also to the relevant funding requirement and future use of various energy and efficiency technologies.
227.	Federal Report on Energy Research	**Goal:** To create transparency concerning the use of funds under the 7th Energy Research Programme vis-à-vis the public and parliament. **Scope:** The report provides a detailed overview of the Federal Government's funding policy for energy research and presents the progress of the 7th Energy Research Programme. **Status:** The 2020 Federal Report on Energy Research was adopted by the Federal Cabinet on 17 June 2020. **Facts and Figures:** The Federal Government spent around €1.15 billion on research, development and demonstration of modern energy and efficiency technologies for the energy transition in 2019. This represents an increase of about 9% compared with the previous year (2018: €1.05 billion).

	Instrument	Implementation status
228.	Research communication within the 7th Energy Research Programme	**Goal:** To promote the transfer of innovation and technology from energy research to economic application. **Scope:** Umbrella portal www.energieforschung.de as the central website and subject-specific portals www.energiesystem-forschung.de, www.industrie-energieforschung.de, www.strom-forschung.de and www.projektinfos.energiewendebauen.de with information on current projects, funding measures and trends. **Status:** Launch of www.energiesystem-forschung.de and www.industrie-energieforschung.de in the summer of 2020.
229.	Call for funding applications under Energy Transition and Society	**Goal:** To investigate the ways in which people's concerns can be taken into account to a better extent in the energy transition process within the framework of research projects. **Scope:** The energy system must undergo a radical restructuring process in the decades to come. The innovative technologies and new processes used for this will have an impact on society as a whole and on the living environment of every individual. The transformation of the energy system and with it the energy transition will only succeed if the transformation is borne jointly. This is why Energy Transition and Society is an issue that is anchored in the Federal Government's 7th Energy Research Programme as a cross-technology funding priority. **Status:** The first call for funding applications was published in April 2019. The first project was also launched in 2019. The second call for funding applications was published in September 2020. **Facts and Figures:** There was an enormous response to the first call for funding applications in the middle of 2019, with almost 60 research projects proposed.
230.	Ideas competition to promote the further development and implementation of the Smart Meter Gateway (SMGW) communication platform	**Goal:** To use funding to stimulate further developments in an effort to make devices with an extended range of functions that meet the latest specifications available to the market as quickly as possible. **Scope:** The dynamics of technological development and energy policy objectives are such that there is significant regulatory uncertainty for the manufacturers of Smart Meter Gateways and other system units in upgraded smart metering systems. Direct funding for research, development and innovation projects therefore constitutes another steering instrument for implementation of the Act on the Digitisation of the Energy Transition (GDEW, Measure 217), along with the roadmap for further development of energy regulation and the roadmap for further technical developments. Apart from further developing the equipment technology, it is also necessary to test the implemented functions in the field, and to gather experience in demonstrations that are suitable for the mass market with various stakeholders in the energy system. Direct and indirect climate change mitigation effects, such as an improvement in the integration of energy from renewable sources, are also expected in the long run. **Status:** The first call for funding applications was published in September 2020 and a second one is planned in 2021. **Facts and Figures:** A funding volume of €40 million has been announced for the first call for funding applications for the ideas competition.
231.	Copernicus Projects for the Energy Transition funding initiative	**Goal:** To facilitate the move from basic research to practical application in four key areas of the energy transition with the four Copernicus Projects. Efforts are to focus on establishing the basis for a technologically outstanding and economically competitive energy system during the first funding phase, which at the same time will find the highest possible level of public acceptance. **Scope:** Each project is dedicated to one of four central themes of the energy transition: • the storage of renewable energy by converting it into another energy carrier, such as hydrogen (P2X), • the development of electricity grids adapted to a high share of renewable energy sources (ENSURE), • the reorientation of industrial processes to a fluctuating energy supply (SynErgie), • the consideration of options for action for an economic, environmentally compatible, reliable and socially acceptable energy system and their effects on the various areas of society (Phase 1: ENavi, Phase 2: Ariadne). **Status:** Around 260 project partners are involved in the four Copernicus projects ENSURE, P2X, SynErgie and ENavi, which were launched in 2016. The projects were carried over into the second funding phase in 2019 and 2020 respectively. **Facts and Figures:** Funding is expected to amount to approximately €400 million.

	Instrument	Implementation status
232.	Carbon2Chem research project	**Goal:** To convert steel mill gases from steel production into basic chemicals using renewable energy sources. **Scope:** Carbon2Chem is to use the steel mill process gases to produce valuable chemical substances such as methanol or urea by means of a cross-industry interaction of steel production, electricity generation and chemical production. The project at the Duisburg steel mill aims to demonstrate the way in which the CO_2 emissions from the German steel industry can be used in a commercially viable manner. **Status:** The project started in 2016. In September 2018, the Technikum was opened in Duisburg, where steel mill process gases are being converted into methanol and ammonia under industrial conditions for the first time worldwide. Carbon2Chem was carried over into the second funding phase in 2020. **Facts and Figures:** The BMBF is making more than €130 million available during the first and second funding phases.
233.	Research Initiative Energy Transition in Transport and Sustainable Mobility through Synthetic Fuels (NAMOSYN) collaborative project	**Goal:** To develop synthetic fuels for diesel and petrol engines. **Scope:** The NAMOSYN project addresses the large-scale production of oxymethylene ether (OME) as a synthetic fuel based on renewable energy sources. **Status:** The project started in in April 2019. **Facts and Figures:** The BMBF is providing funding amounting to €24 million until 2022.
234.	Energy Systems of the Future Initiative of the German Academies of Sciences	**Goal/Scope/Status/Facts and Figures:** 120 representatives of the German Academies of Sciences are developing systemic policy options in the field of foundational research with a focus on the energy system of the future and, in doing so, are providing a scientifically sound basis for discussions on issues that are of medium to long-term relevance to the implementation of the energy transition in society as a whole. The project not only addresses questions of technological feasibility, economic and legal issues, but also efficient use of resources and public acceptance.
235.	Call for funding applications for Optimised Network Operation in the Transmission and Distribution Systems (OptiNet I)	**Goal/Scope:** Funds will be made available for projects that improve cooperation, collaboration and an exchange of information, particularly between transmission system operators (TSOs) and distribution system operators (DSOs), in order to allow higher proportions of renewable energy sources as a result of increased utilisation of capacity in the electricity grids, to reduce TSOs' and DSOs' operating and investment costs and to promote grid-serving contributions from decentralised plants, especially with respect to ancillary services. **Facts and Figures:** Funds totalling €20 million.
236.	Solar Construction / Energy-Efficient Towns funding initiative	**Goal:** Joint initiative of the BMWi and BMBF concerning new technologies and strategies for better energy efficiency and the integration of renewables to move the energy transition forward in buildings and urban areas. **Scope:** Module I (BMWi): Focus on demonstrating concepts for the refurbishment and new construction of multi-storey residential buildings. Eight collaborative projects in Module I were able to start work in 2017. Module II (BMWi and BMBF): Comprehensive and systemic flagship projects at urban quarter level in Esslingen, Heide (Holstein), Kaiserslautern, Oldenburg, Stuttgart/Überlingen and Zwickau. Five of the six flagship projects selected in Module II were launched in 2017. The sixth project started at the beginning of 2018. **Facts and Figures:** Module I: approx. €20 million. BMBF and BMWi are funding equal shares of the more than €100 million being provided for Module II.
237.	Research Campus – Public-Private Partnership for Innovation funding initiative (Mobility2Grid and Flexible Electrical Networks research campuses)	The BMBF is funding cooperation between the scientific community and business in energy research with the Mobility2Grid and Flexible Electrical Networks research campuses: • Mobility2Grid Research Campus **Goal:** To integrate commercial and private electric road vehicles in decentralised energy grids based on renewable energy resources. **Scope:** Establishment of a reference urban neighbourhood in Berlin-Schöneberg with research and industry stakeholders for a synergistic interaction of electric mobility, electricity and heating supply networks. **Status:** Funding started in January 2016, with the first five-year main phase. **Facts and Figures:** The BMBF is making up to €10 million available for the first main phase. • Flexible Electrical Networks Research Campus: **Goal:** To research innovative technologies for electrical networks using a high percentage of regenerative and decentralised energy sources. **Scope:** The research campus in Aachen is a joint effort between RWTH Aachen University and industry stakeholders. Transdisciplinary research is focused on the development and integration of direct current technologies. **Status:** 2020 saw the research campus entering its second phase, with five companies becoming directly involved for the first time, in addition to the academic partners. **Facts and Figures:** The BMBF is making €20 million available for the first and second phases.

	Instrument	Implementation status
238.	Pilot innovation competition for leapfrog innovations for a worldwide storage system	**Goal:** The purpose of the innovation competition is to initiate development of an electricity storage system for domestic use that performs as well if not better than available systems and is significantly more cost-effective and environmentally friendly. It is intended to upgrade the global use of electricity from renewable energy sources and improve the way in which they are integrated into the grids. **Status:** Six projects were selected for the concept phase in 2020. One or two of these concepts will be selected for the project following an evaluation. **Facts and Figures:** The BMBF is making around €12.5 million available during the period between 2020 and 2024.
239.	National Innovation Programme for Hydrogen and Fuel Cell Technology (NIP)	**Goal:** To accelerate the development of hydrogen and fuel cell technologies in an effort to demonstrate technological readiness. **Status:** The goals under NIP1 (2006 to 2016) were attained. NIP1 was superseded by the government program NIP2 which runs until 2026. **Facts and Figures:** The scope of funding for the programme that ran from 2006 to 2016 was around €1.4 billion, of which €700 million came from the industry and €700 million from the BMVI and BMW budgets.
240.	Government Hydrogen and Fuel Cell Technology Programme (NIP 2) for the 2016–2026 funding period	**Goal:** To supplement R&D funding from NIP1 to include measures for market activation of products and applications based on hydrogen and fuel cell technologies with the goal of achieving marketability and market uptake. **Scope:** NIP2 has been devised as a framework programme that is implemented with individual measures. **Facts and Figures:** Industry pledges of €2.0 billion for 2016 to 2026, to be supported by public funding of around €1.4 billion.
241.	Programme collaboration: Energy Transition Research Alliance at the German Federation of Industrial Research Associations (AiF)	**Goal/Scope:** Joint initiative of energy research and industrial collective research launched by the BMWi to specifically strengthen the innovative capacity of non-research-focused SMEs in the development of energy solutions. **Status:** After successful completion of the pilot phase, the collaboration is to be put on a permanent footing from 2020 onwards. Procedures will be simplified as a result of the crossover to the established format of the key Industrial Collective Research (IGF) technologies. **Facts and Figures:** €6 million of funding is available per year.
242.	Renewable Resources funding programme	**Goal:** BMEL initiative for the promotion of research, development and demonstration projects in the use of renewable resources as raw materials and sources of energy. **Facts and Figures:** €23.75 million were earmarked for bioenergy projects under the funding programme in 2018, supplemented by an additional €23.05 million from the Energy and Climate Fund (ECF). A total of €46.8 million was made available from the funding programme in 2019.
243.	Biomass Energy Use funding programme	**Goal:** Practical research and development work on forward-looking technologies and the optimisation of processes and techniques, which enable efficient, economic and sustainable use of bioenergy and contribute towards security of supply. **Scope:** Special focus on the funding of practical solutions for demonstration and pilot projects that contribute towards making the generation of electricity and heat from biomass more flexible. The programme aims to tap the potential of biomass by-products and waste in order to improve sustainable use as a source of energy in the (combined) heat and power sector. **Status:** The funding programme expired in 2018. Biomass energy use is included in the 7th Energy Research Programme as funding priority 3.7. **Facts and Figures:** A total of 388 individual projects, predominantly collaborative projects, have received funding since 2009, with grants amounting to around €67.3 million. €6 million were available in 2017 and €9.1 million were available in 2018.
244.	WIPANO – Knowledge and Technology Transfer via Patents and Standards	**Goal:** To promote public research, help companies to patent and exploit their inventions and support innovative projects. **Scope:** In patent funding, the costs incurred for patent advice, consulting a patent attorney or for filing the patent are covered on a pro-rata basis. **Status/Facts and Figures:** The programme ran from January 2016 to December 2019 with a volume of €23 million. Businesses, high-education institutes, universities and non-university research centres were eligible to apply.

	Instrument	Implementation status
245.	Funding for stationary fuel cell heating systems within the framework of the Energy Efficiency Incentive Programme	**Goal:** To support the introduction of fuel cell technology in the heating and electricity supply systems of residential buildings. **Scope:** Funding is granted for the installation of fuel cell systems with a capacity of between 0.25 kW_{el} and 5 kW_{el} 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. Funding is provided in the form of a grant and can be combined with funding under the CHP Act (KWKG). **Status:** Developed for the market launch of stationary fuel cell heating systems, the Energy-efficient Construction and Refurbishment – Fuel Cell Grant funding programme (KfW Programme No. 433) has been available to private homeowners, as well as companies (including contractors), municipal institutions and non-profit organisations, since July 2017. This means that support is provided for the installation of highly efficient fuel cell systems in residential and non-residential buildings. Budget funds are available for the programme within the framework of the Energy Efficiency Incentive Programme (APEE). **Facts and Figures:** In 2018, the funding volume for fuel cell heating systems amounted to €52.6 million, with around 3,600 funding applications. The funding volume was raised by 20% to €63.3 million in 2019 and the number of funding applications increased by just under a third, to around 4,750.
246.	New Vehicle and System Technologies funding programme	**Goal:** To improve the innovative potential and competitiveness of the German automotive industry. **Scope:** Financial support for practical technological innovations within the framework of two programme pillars – Automated Driving and Connected Driving and Innovative Vehicles – with a particular focus on lightweight construction and modern drivetrains. **Status:** Various ongoing funding projects on reducing weight, waste heat recovery, improving the combustion concept and using electricity-based fuels. In December 2018 funding was extended for another four years. **Facts and Figures:** Funding was raised by €60 million per year for both program pillars within the framework of the extension.
247.	Energy Transition in the Transport Sector: Sector Coupling through the use of Electricity-based Fuels research initiative	**Goal:** To accelerate the coupling of the electricity and transport sectors in order to enable a substantial reduction in greenhouse gas emissions. **Scope:** Alternative fuels are a particularly promising option for implementation of the energy transition in the transport sector, especially when large consignments are transported over long distances, as is the case in the aviation or shipping sector. The associated coupling of the energy and transport infrastructures also expands policy options. In the light of this, innovative research approaches to sector coupling are being funded to enable rapid application of the necessary advances. Within the framework of this initiative, research is being conducted on the production and use of innovative, electricity-based fuels in 16 projects devised as collaborations between industry and research. A roadmap based on research findings is planned for 2022, which should describe recommended courses of action for the development, production and market introduction of sustainable fuels. **Status:** The kick-off conference took place in February 2019. Interim results were discussed during a status conference in November 2020. **Facts and Diagrams:** The BMWi is funding the research initiative with around €87 million for the period between 2018 and 2022.
248.	Maritime Research Programme	**Goal/Scope:** The BMWi's Maritime Research Programme is the R&D programme for the maritime industry in the fields of marine engineering, marine system production, shipping and ocean technology. It addresses the entire technology spectrum relevant to innovation in the maritime sector. There are many points of contact for interdisciplinary, cross-sector innovations. Apart from strengthening innovation and competitiveness, research and development are to achieve progress in the following four areas: environmentally-friendly technologies (MARITIME.green), digitisation and smart technologies (MARITIME.smart), safety (MARITIME.safe) and resources (MARITIME.value). Funding is to focus primarily on projects that make a significant contribution towards the maritime energy transition. This requires effective funding instruments to expedite technological developments, planning security for businesses and a strategy spanning various sectors of industry. Current challenges include the mobility transition, avoidance and reduction of emissions, new environmentally friendly fuels, smart systems, process digitisation, new requirements for maritime security architectures and environmentally compatible, sustainable use of maritime resources. The long-term goal is a zero-emission ship. **Facts and Figures:** The Federal Government is providing a total of around €369 million in funding for maritime research up to 2025.

	Instrument	Implementation status
	Chapter 15: Investments, growth and employment	
249.	Structural Reinforcement Act	**Goal:** To mitigate the consequences of the phase-out of coal-fired power generation in the coal-mining districts, equalise economic potential, promote economic growth and create jobs in the coal-mining areas. **Scope:** In the years leading up to 2038, lignite regions will receive financial assistance of up to €14 billion for particularly important Länder and community investments. The Federal Government will also be supporting the regions by means of further measures within its own area of responsibility with up to €26 billion up to 2038. Furthermore, €1.09 billion will go to selected hard coal-fired power plants and the former Helmstedt coalfield. The disbursement of allocated funds is assured by a new Federal/Länder Coordination Committee. **Status:** The Structural Reinforcement Act for Mining Regions (StStG) entered into force on 14 August 2020. **Facts and Figures:** Funds totalling up to €41.09 billion are being made available for the mining regions concerned.
250.	Energy elements of the economic stimulus package of June 2020, particularly including the following:	**Goal:** The package is intended to stimulate and sustain the economy in the wake of the Covid-19 pandemic and to cushion social hardship. **Scope:** The package includes a number of different elements, such as a reduction in VAT rates, various tax relief measures, an interim financial aid programme, diverse support measures for families and, last but not least, a number of energy supply elements. **Status:** The package was adopted in June 2020.
	• Reduction of the EEG surcharge	See Chapters 4 and 10.
	• Expansion of project-based research programmes, such as SINTEG and living labs	See Measures, Chapters 13 and 14. Project-based research programmes (including SINTEG and live labs) are to be expanded to the tune of €300 million. Efforts are to be focused on the next major upheavals in the energy system: digitalisation and sector coupling. **Status:** Some of the projects started as early as 2020 and the remaining projects will be launched in 2021.
	• Transport sector: a) Car tax b) Innovation bonus c) Charging stations/ Battery cells d) Fleet modernisation e) Purchase premium	See Measures, Chapter 7.
	• National Hydrogen Strategy	**Goal:** To expedite the market run-up for hydrogen technologies and contribute towards overcoming the economic consequences of the Covid-19 pandemic, thereby establishing the foundation for a sustainable focus of the German economy. **Scope:** The Federal Government has put forward its National Hydrogen Strategy, which aims to make Germany the world's leading supplier of state-of-the-art hydrogen technologies. The strategy will provide the basis on which the funds of the economic stimulus package will be used to implement various measures to expedite the market run-up for hydrogen technologies. **Facts and Figures:** €7 billion have been earmarked for national activities and €1.99 billion for foreign trade projects.
	• Elimination of the PV cap, expansion of renewables	See Measures, Chapter 4.
	• Increase in funds for the CO_2 Building Modernisation Programme	**Goal:** To increase the renovation rate and create incentives for energy-efficient new construction while simultaneously stimulating the economy. **Scope:** The conditions for the funding of energy-efficient building modernisation measures were improved substantially at the beginning of 2020. The elevated funding rates have led to a significant increase in the number of funding applications. The available funds were augmented within the framework of the economic stimulus package. **Status:** The Federation of German Heating Industry (BDH) is reporting significant growth in the heating market, with particular focus on heating systems based on renewable energy sources. The current funding programmes will be bundled into the new Federal Funding for Efficient Buildings (BEG) from 2021 onwards. This provides for further improvements in the funding conditions in certain cases. **Facts and Figures:** Funds for the CO_2 Building Modernisation Programme were augmented by €2 billion in the second supplementary budget.

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List of abbreviations

a	Year
AA	Federal Foreign Office
ADEME	French Ministry of the Ecological Transition
AGEB	Working Group on Energy Balances
AGEE-Stat	Working Group on Renewable Energy Statistics
AiF	German Federation of Industrial Research Associations
APEE	Energy Efficiency Incentive Programme
ARegV	Incentive Regulation Ordinance
AVF	Automated and connected driving
AVV	General Administrative Regulation for the Marking and Lighting of Obstacles to Air Navigation
BAFA	Federal Office for Economic Affairs and Export Control
BBPlG	Federal Requirement Plan Act
BDEW	German Association of Energy and Water Industries
BEG	Federal Funding for Efficient Buildings
BEHG	Fuel Emissions Trading Act
BET	Bureau for Energy Economy and Technical Planning
BETD	Berlin Energy Transition Dialogue
BGE	Federal Company for Radioactive Waste Disposal
BIM	Building Information Modeling
BImSchG	Federal Immission Control Act
BKartA	Federal Cartel Office
BLAG KliNa	Federal Government/Länder Working Group on Climate Protection and Sustainability
BLE	Federal Office of Agriculture and Food
BMBF	Federal Ministry of Education and Research
BMEL	Federal Ministry of Food and Agriculture
BMI	Federal Ministry of the Interior, Building and Community
BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
BMVI	Federal Ministry of Transport and Digital Infrastructure
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 Railway
BNK	On-demand night-time marking
BSI	Federal Office for Information Security
BVWP	Federal Transport Infrastructure Plan
CDM	Clean Development Mechanism
CEER	Council of European Energy Regulators
CH_4	Methane
CHP	Combined heat and power
CNG	Compressed natural gas
CO_2	Carbon dioxide

CO_2-eq.	Carbon dioxide equivalents
COP25	United Nations Framework Convention on Climate Change, 25th Conference of the Parties
ct	Cent
CTS	Commerce, trade and services
DEHSt	German Emissions Trading Authority
dena	German Energy Agency
DIW	German Institute for Economic Research
DLR	German Aerospace Center
DPMA	German Patent and Trade Mark Office
DSO	Distribution system operator
ECF	Energy and Climate Fund
EDL-G	Act on Energy Services and Other Energy Efficiency Measures (Energy Services Act)
EEA	European Environment Agency
EED	Energy Efficiency Directive
EEG	Renewable Energy Sources Act
EEWärmeG	Renewable Energies Heat Act
EEX	European Energy Exchange
EffSTRA	Energy Efficiency Strategy
EIB	European Investment Bank
EnEG	Energy Conservation Act
EnergieStG	Energy Tax Act
EnEV	Energy Conservation Ordinance
EnLAG	Power Grid Expansion Act
EnSaG	Omnibus Energy Act
EnStatG	Energy Statistics Act
ENTSO-E	European Network of Transmission System Operators for Electricity
EnVKG	Energy Consumption Labelling Act
EnWG	Energy Industry Act
EPBD	Energy Performance of Buildings Directive
ERDF	European Regional Development Fund
ESB	Energetic Renovation Roadmap for Federal Properties
ESD	Effort Sharing Decision
ESG	Energy Efficiency Strategy for Buildings
ESR	Effort Sharing Regulation
ETS	Emissions Trading System
EU	European Union
EUA	EU-Allowance
EWI	Institute of Energy Economics at the University of Cologne
EWK	Expert Commission on the Energy of the Future Monitoring Process
EWR	European Economic Area
EZ	Development corporation
Fh-ISI	Fraunhofer Institute for Systems and Innovation Research
GasNZV	Gas Network Access Ordinance
GDEW	Act on the Digitisation of the Energy Transition
GDP	Gross Domestic Product
GEG	Buildings Energy Act

GEIG	Building Electromobility Infrastructure Act
GHG	Greenhouse gas
GVFG	Municipal Transport Infrastructure Financing Act
GW	Gigawatt
GWh	Gigawatt hour
GWS	Institute of Economic Structures Research
ha	Hectares
HGV	Heavy goods vehicles
HkRNDV	Implementing Ordinance on Guarantees of Origin and Guarantees of Regional Origin
HVDC	High-voltage direct current (transmission)
HZO	Heating Optimisation Funding Programme
IAEW	Institute of High Voltage Equipment and Grids, Digitalisation and Energy Economics at RWTH Aachen University
ICAO	International Civil Aviation Organization
ICT	Information and communication technology
IEA	International Energy Agency
IFAM	Fraunhofer Institute for Manufacturing Technology and Advanced Materials
ifeu	Institute for Energy and Environmental Research Heidelberg
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
iSFP	Tailored Modernisation Roadmap
ITD	Institute of Transportation Design
JI	Joint implementation
KapResV	Capacity Reserve Ordinance
KENFO	German Nuclear Waste Management Fund
KFK	Commission to Review the Financing of the Nuclear Phase-Out
KfW	Reconstruction Loan Corporation
kg	Kilogram
km	Kilometre
KNE	Competence Centre for Nature Conservation and Energy Transition
KOM	European Commission
KSB	Climate Protection Report
KSP	Climate Protection Plan
KStG	Corporation Tax Act
kt	Kiloton
kW	Kilowatt
kWh	Kilowatt hour
KWKG	Combined Heat and Power Act
KWSB	Commission “Growth, Structural Change and Employment”
LEK	Federal Property Roadmaps
LNG	Liquefied natural gas
LTRS	Long-Term Renovation Strategy
LULUCF	Land Use, Land-Use Change and Forestry
m	Million
MAP	Market Incentive Programme for Renewable Energies in the Heating Market

MaStR	Core Energy Market Data Register
MaStRV	Core Energy Market Data Register Ordinance
MKS	Mobility and Fuel Strategy
MMS	With-Measures-Scenario
MPO	Metering point operator
MsbG	Metering Point Operation Act
MSR	Market stability reserve
MT	Multimodal transport
MW	Megawatt
MWh	Megawatt hour
MWMS	With-Additional-Measures-Scenario
N	Nitrogen
NABEG	Grid Expansion Acceleration Act
NAPE	National Action Plan on Energy Efficiency
NDCs	Nationally determined contributions
NECP	National Energy and Climate Plan
NEMoG	Grid Charge Modernisation Act
NEP	Grid Development Plan
NIP	National Hydrogen and Fuel Cell Technology Innovation Programme
NKI	National Climate Protection Programme
NO_2	Nitrogen dioxide
NPE	National Platform Electromobility
NPM	National Platform Future of Mobility
NREAP	National Renewable Energy Action Plan
NRVP	National Cycling Plan
P2X	Power-to-X
PJ	Petajoule
Pkm	Passenger kilometre
Pkw	Passenger vehicle
PP	Power plant
PV	Photovoltaics
REN21	Renewable Energy Policy Network for the 21st Century
RES	Renewable energy sources
R&I	Research and innovation
R&D	Research and development
SAIDI	System Average Interruption Duration Index
SINTEG	Smart Energy Showcases - Digital Agenda for the Energy Transition
SMEs	Small to medium-sized enterprises
SMGW	Smart meter gateways
SNG	Synthetic natural gas
StBA	Federal Statistical Office
StromNZV	Power Grid Access Ordinance
StStG	Structural Reinforcement Act for Mining Regions
StVO	German Road Traffic Regulations
t	Tonne
TAP	Trans Adriatic Pipeline

TCP	Technology Collaboration Programme of the IEA
tkm	Tonne-kilometre
TSO	Transmission system operator
TWh	Terawatt hour
UBA	German Environment Agency
UNEP	UN Environment Programme
UNFCCC	UN Framework Convention on Climate Change
VAT	Value-added tax
VwV	Administrative regulation
WEMoG	Condominium Modernisation Act
WindSeeG	Offshore Wind Energy Act
WLTP	World Harmonised Light Vehicle Test Procedure
ZIM	Central Innovation Programme for Small to Medium-sized Enterprises
ZSW	Centre for Solar Energy and Hydrogen Research Baden-Württemberg