Long-Term Renovation Strategy of the Federal Government

Pursuant to Article 2a of Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings (Energy performance of buildings directive, EPBD 2018)

1 Development of the roadmap

With the energy transition, the Federal Republic of Germany has embarked on a major and profound transformation of its energy supply and energy use. The Federal Government has set itself the objective of reducing greenhouse gas emissions in Germany by at least 55% by 2030 as compared with the base year 1990, reducing primary energy consumption by 30% as compared with 2008 and increasing the share of renewable energy in the heating and cooling sector to 27%. Germany is also pursuing the long-term objective of net-zero greenhouse gas emissions by 2050. With these objectives, the Federal Government also aims to contribute to the attainment of Europe's energy and climate objectives. Not least, the energy transition can only succeed if it is embedded in Europe.

The national law on climate protection (the Federal Climate Change Act) entered into force on 18 December 2019. The Climate Change Act sets statutory norms for the climate change objectives and makes it mandatory for the buildings, energy, industry, transport, agriculture, forestry and waste sectors to determine the level of greenhouse gas emissions that can still be permitted in 2030. In the buildings sector, Germany has set out in the Climate Change Act a reduction in greenhouse gas emissions to 70 million tonnes of CO_2 equivalents in 2030, representing a decrease of 67% compared to 1990 (210 million tonnes of CO_2). In order to attain the national climate protection objectives, annual reduction targets are also set for the sectors mentioned above by setting annual emission levels. For periods after 2030, the Federal Government will set out annually decreasing emission levels in 2025 by issuing a Regulation.

The Federal Government is pursuing the energy and climate objectives in the buildings sector through a broad package of measures. These measures contain a mix of support, demand and information. Broad consensus in society is required for measures to be accepted. Due account is taken of affordable construction and housing in the choice of measures to attain the targets as an equivalent objective. With the Energy Efficiency Strategy for Buildings (ESG), the Federal Ministry of Economic Affairs and Energy (BMWi) at the end of 2015 first presented an overall strategy for the buildings sector, which provides an integrated picture of the areas of heating, cooling, electricity, efficiency and renewable forms of energy by 2050, and in so doing has set out a framework for action on the energy transition in the buildings sector, taking into account the potential limits on renewable energy and efficiency improvements in buildings. The objective of the ESG was to achieve a nearly climate-neutral building stock in 2050.

Significant progress has already been made in the area of climate protection and energy performance in the buildings sector with the measures implemented to date. The energy performance of buildings improved by more than 25% between 2008 and 2018. Greenhouse gas emissions in the buildings sector were reduced by around 42% between 1990 and 2019. The share of renewable energy in final energy consumption for heating and cooling in 2018 was over 14%. This means that Germany's 14% target for 2020 under the Renewable Energy Sources Act, which preceded the Renewable Energy Directive (2009/28/EC), was already met in 2018.

The European Commission (COM) presented first plans for future EU climate policy, accompanied by an indicative roadmap for key actions, with the European Green Deal published in December 2019. The strategy focuses on a European climate change act, for which a draft was presented in March 2020, as well as on the planned European 'wave of renovation' (anticipated in Q3/2020) and on the funding of the climate change package (Investment Plan for a Sustainable Europe, 14 January 2020).

Germany will regularly update the Long-Term Renovation Strategy (LTRS) in accordance with Directive (EU) 2018/844 amending Directive (EU) 2010/31 on the energy performance of buildings (Energy Performance of Buildings Directive, EPBD 2018) and the EU Governance Regulation, taking due account of national and European decisions.

This does not imply any prejudging of public budgets. The measures enumerated in the LTRS will have to be funded by the individual plans concerned within the applicable budget estimates in the preparation of the respective federal budget.

1.1 Choice of indicators

The LTRS aims to provide each Member State with a roadmap with measures and nationally defined measurable progress indicators to achieve the long-term climate objectives and to identify pathways and incentives for energy renovation of the national building stock. The EPBD 2018 sets out the objective of ensuring a highly energy-efficient and decarbonised national building stock and facilitating the cost-effective conversion of existing buildings into net zero energy buildings.

Given that the contributions of each sector to the reduction of greenhouse gas emissions in Germany for the period after 2030 have not yet been determined at national level and that substantial determinations are still to be made at European level, Germany will quantify the milestones for 2040 and 2050 when the necessary course has been set at national and European level. This will be the case at the latest when the annual emission levels in the Climate Change Act are updated in 2025. The existing LTRS provides a qualitative classification for the period after 2030. The indicators and indicative milestones will be developed further as part of the LTRS update by 30 June 2024.

Germany sets energy performance as the first indicator. In addition, as part of the work on updating the LTRS, Germany is examining the design of further indicators, in particular for final energy consumption. Other indicators can also be seen from the perspective of the consolidation of the buildings database (e.g. in terms of rate and depth of refurbishment), approaches to the classification of energy performance certificates and the heating label.

1.1.1 Energy performance

The first indicator chosen by Germany is ‘energy performance’ in accordance with the EU Directives on the energy performance of buildings. The reasons for this are:

- energy performance was introduced as an energy indicator in Germany in 2002 with the first Energy Savings Regulations (EnEV) and at European level in 2002 with the first Energy Performance of Buildings Directive (Directive 2002/91/EC), and has proved its worth since;
- energy performance is thus compatible with Directive 2010/31/EU on the energy performance of buildings (recast) (EU Buildings Directive 2010, Energy Performance of Buildings Directive 2010, EBPD 2010) and in Germany the level of evidence introduced for energy balances for the purpose of regulatory evidence and support in the buildings sector. Directive (EU) 2018/844 amending Directive 2010/31/EU on the Energy Performance of Buildings (EPBD 2018) maintains this approach;
- energy performance takes into account the effects of improved energy efficiency, the share of renewable energy and waste heat, and the degree of decarbonisation of energy sources supplied by pipeline and cable (electricity, district heating, gas) equally (polluter pays principle);
- German monitoring of the energy transition has also been based on energy performance for the buildings sector since 2011;
- the upstream sub-balance of energy performance is final energy consumption, from which greenhouse gas emissions and cost/economic studies are derived;
- in addition to the use phase (heating, cooling, hot water and, where applicable, lighting), energy performance also takes into account upstream process chains (energy costs of the production, conversion and transport/distribution of energy sources) and is therefore the most comprehensive approach to energy and climate change assessment.

1.1.2 Consolidated pool of data

In order to be able to make valid statements on the German building stock, the body of data in the buildings sector needs to be improved. The currently available pool of data is based on different sources that are not aligned in an integrated manner. A statistically verified pool of data will be created in Germany over the next few years with a consolidated data collection concept and will be updated regularly. Initial expert documentation has already been commissioned or prepared in recent years. Based on centrally collected data on the German building stock, it will be possible in future to make statements on the number of residential and non-residential buildings, their age, size and energy status, their annual energy consumption, etc. Under the terms of Section 9(2) of the Energy Services Act (EDL-G), the Federal Government has assigned the task to the Federal Energy Efficiency Agency. Existing data will be examined and duly taken into account in improving the body of data available.

The improved pool of data is crucial to the definition of further indicators. The consolidated pool of data is intended to measure the rate and depth of refurbishment reliably and consistently over time and to be illustrated by two appropriate indicators. In the absence of generally applicable definitions of the rate and depth of refurbishment, these two indicators must first be methodologically developed. As part of the updating of the LTRS, a specific indicator classification for recording of the rate and depth of refurbishment will therefore be developed, building on the consolidated data collection.

1.1.3 Energy performance certificates

Energy performance certificates show the energy performance of a building on the basis of indicators. They have been established since they were introduced in 2008 as an information tool. There are two types of energy performance certificate in Germany, an energy consumption certificate and an energy demand certificate. The principles of the energy performance certificate are regulated by the Energy Conservation Regulation (EnEV). The EnEV implements the EU Energy Performance of Buildings Directive 2010 (Directive 2010/31/EU).

An energy performance certificate must be issued and made available when a property is newly built, newly let or sold. In certain cases (in particular in buildings used by public authorities and large numbers of members of the public), the energy performance certificate must be displayed. Furthermore, an energy performance certificate is usually mandatory when a building is extensively refurbished, i.e. when more than just individual measures are carried out.

The energy performance certificate documents the actual energy status of the building, contains data on the building and building systems and provides a statement on the energy status of the building. The purpose of the energy performance certificate is to allow an overall comparison of buildings. The certificate has to comply with the requirements of the EnEV in force at the time of issue. It contains a date of issue and a central registration number. The issuer of the energy performance certificate also has to sign it. The energy performance certificate additionally provides the building owner with non-binding modernisation recommendations to improve the energy status of their building. The Federal Government will examine whether, and to what extent, energy performance certificate data can be used to develop further indicators.

1.1.4 Heating label

The heating label created for the first time an energy efficiency label that assesses and classifies existing heating systems. With the heating label, the Federal Government is working towards improving consumer information in order to encourage and speed up the replacement of old heating systems and to encourage investment in further energy-related measures, in conjunction with more

extensive advice and support. An evaluation of the measure is nearing completion and will show how far the heating label encourages consumers to replace boilers.

The introduction of the label is part of the National Energy Efficiency Action Plan (NAPE) of December 2014 and has been implemented by amendment of the Energy Labelling Act (EnVKG). The Act entered into force on 1 January 2016. As a result, gas and liquid fuel boilers with a rated output of up to 400 kW beyond a certain age are to be progressively labelled with the heating label.

The heating label corresponds in terms of design and basis of calculation, to the EU energy label for energy efficiency labelling of heaters newly placed on the market. It has been compulsory to issue a heating label since 2017.

The data on the heating labels makes it possible to assess the technical characteristics of the heating systems in the existing building stock, such as the type of fuel and rated heat output, as well as information on the labelling, such as the heating label number and the date of the label. In the best case, it is possible to ascertain the annual rate of replacement or loss of heating systems, for example by changing the type of heating or through demolition of a building. In the evaluation of the heating label, this data was provided and assessed voluntarily by a proportion of the authorised district chimney sweeps in two reference years; this data can be used only for evaluation of the heating label. It is planned that it will be examined, in consultation with the chimney sweeps' guild (ZIV), whether and how further evaluation of the data on the heating label can contribute to monitoring of the LTRS.

1.2 Indicative milestones

In the LTRS, indicative milestones are to be defined in accordance with the 2018 EPBD for the selected indicators. Furthermore, the EU Energy Efficiency Directive (EED 2018) (Directive 2018/2002/EU amending Directive 2012/27/EU) aims to describe how these contribute to the EU's 2030 energy efficiency targets. The Commission's recommendations on the EPBD 2018 (Recommendation (EU) 2019/786) clarify that Member States can set quantitative or qualitative milestones and choose them in accordance with national specific features.

1.2.1 Milestones for the energy performance indicator

1.2.1.1 Baseline situation

Based on the EPBD 2018 and the EnEV, Germany chooses energy performance as the first indicator for the LTRS and illustrates this numerically through non-renewable primary energy consumption ($PEV_{n.E.}$). In addition to the provision of heating, cooling and hot water, as well as for lighting for non-residential buildings, energy performance takes into account the non-renewable costs of producing, converting and distributing energy sources (the polluter-pays principle). Energy performance can thus be improved both by improving energy efficiency and by increasing the share of renewable energy in meeting the demand for heating.

The $PEV_{n.E.}$ of a building is to be determined under the technical regulations referred to in the Energy Savings Regulation (DIN V 18599: 2018-09 or alternatively DIN V 4108-6: 2003-06 and DIN V 4701-10: 2003-08, as amended by A1: 2012-07). The standard defines $PEV_{n.E.}$ as the calculated amount of energy that includes, in addition to the energy content of the necessary fuel and auxiliary energy for building systems, the energy generated by upstream process chains outside the building in the extraction, conversion and distribution of the fuels used. The $PEV_{n.E.}$ is determined on the basis of final energy demand, where final energy is assessed with environmental efficiency factors (primary energy factors) depending on the energy source.

The energy transition relates its objectives in the building sector to the base year 2008. The 2008 base year was established for the first time by the Federal Government with the energy concept

(2010) for the building sector and retained in the ESG (2015). In order to ensure coherence with these national strategies, the base year 2008 is also used in the LTRS to assess successes up to 2018 and to demonstrate attainment of the indicative milestones.

In 2**018, non-renewable primary energy consumption ($PEV_{n.E.}$) in buildings** was **3 283 PJ** (preliminary estimate according to BMWi (2019)). This represents an **improvement in energy performance** of more than 4% compared to the previous year (2017: 3 429 PJ) and **of more than 25% since 2008** (see Table 1).

Table 1: Energy performance

Energy source	$PEV_{n.E.}$ in the German buildings sector [PJ]	
	2008	2018
Fossil oil products	1 023	663
Fossil gases	1 581	1 412
Electricity (electricity mix Germany [1)])	1 175	676
Heating networks [2)]	404	297
Environmental energy [3)]	0	0
Solid biomass (wood)	81	78
Liquid and gaseous biomass [4)]	59	121
Coal briquettes	82	37
Total	4 405	3 283

BMWi (2019) based on AGEB (10/2019). Provisional calculations for 2018.

[1)] Electricity mix Germany: in 2008 primary energy factor of 2.7 and in 2018 primary energy factor of 1.8.

[2)] Local/district heating from cogeneration, heating plants and environmental heat

[3)] Geothermal, solar, ambient heat

[4)] In the calculation of primary energy demand, in accordance with the method of calculation for residential buildings (EnEV Section 3(3), Annex 1 No 2), the value for the non-renewable portion 'heating oil EL' is used for liquid biomass and the value for the non-renewable portion 'natural gas H' for gaseous biomass.

1.2.1.2 Reconciliation of the energy performance indicator with the decision to reduce greenhouse gas emissions

The allocation of greenhouse gas (GHG) emissions to the sectors in the Federal Climate Change Act that entered into force on 8 December 2019, unlike energy performance, is based on the rectification at source principle established in international greenhouse gas reporting (see Table 2).

Table 2: Emission reduction obligations in particular sectors under the Climate Change Act

Annual level of emissions in millions of tonnes of CO_2-equivalent	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Buildings	118	113	108	103	99	94	89	84	80	75	70
Act introducing a Federal Climate Change Act and amending other provisions (2019).											

According to the rectification at source principle, only the direct emissions in or on the building are attributed to the buildings sector. These are usually CO_2 emissions from the combustion of gas or fuel oil in heating boilers or building-specific combined heat and power plants (CHP plants). On the other hand, GHG emissions from the supply of electricity and heating to buildings by public utilities (for example heating networks) are attributed to the energy sector and referred to as indirect emissions. Further GHG emissions from upstream production, conversion or distribution/transport process chains are likewise not attributed to the building sector, but to industry (for example the oil industry) or the transport sector, according to the rectification at source principle. The direct GHG emission factors for the buildings sector are included in Table 3.

Table 3: GHG emission factors for the buildings sector

Energy source	Direct CO2 equivalent emission factors for the buildings sector according to the 'rectification at source principle'	Compare CO_2 equivalent emission factors according to the 'polluter pays principle' (including upstream chains)
	in kg CO_2 equivalents per kWh	
Fossil oil products	0.267	0.318
Fossil gases	0.202	0.246
Environmental energy (by heat pump)	0	0,175-0,235
Solar thermal	0	0
Solid biomass (wood)	0	0.011-0.027
Liquid and gaseous biomass	0	1)
Electricity (electricity mix Germany)	0	0.551 2)
Photovoltaic electricity (on the building)	0	0
Heating networks	0	3)
Coal briquettes	0.376-0.384	0.428-0.443

Emissions performance of renewable energy sources, Federal Environment Agency (2019). Reporting under the United Nations Framework Convention on Climate Change and the Kyoto Protocol 2019, Federal Environment Agency (2019).

1) Range of emission factors, see Tables 84 and 91 in the renewable energy sources emission balance, Federal Environment Agency (2019)

2) GHG emission factor in 2018

3) GHG emission factor depending on energy source input.

In **2019, direct GHG emissions** in the buildings sector totalled **122 million tonnes of CO_2 equivalents** (preliminary estimate by the Federal Environment Agency) and were thus reduced by 42% as compared with 1990 (210 million tonnes of CO_2 equivalents). Year-on-year, emissions from the buildings sector increased by around 4.4% or 5 million tonnes of CO_2 equivalents (2018: 117 million tonnes of CO_2). Fuel oil sales as a result of lower fuel oil prices and a cooler heating season in large parts of Germany than in 2018 drove the increase in emissions as compared with the previous year.

1.2.1.3 Indicative milestone for 2030

As an indicative milestone for **energy performance**, Germany intends to reduce **non-renewable primary energy consumption ($PEV_{n.E.}$)** by 2030 to 2 000 PJ (556 TWh). The indicative milestone corresponds to a reduction in **$PEV_{n.E.}$** of around 55% as compared with the base year 2008 (4 400 PJ). In 2018, when $PEV_{n.E.}$ was around 3 300 PJ (preliminary estimate according to AGEB), a reduction in **$PEV_{n.E.}$** of around 25% was already achieved as compared with 2008.

The indicative milestone for 2030 for energy performance is in line with the national decisions on climate and energy policy (Climate Action Programme 2030, Climate Change Act), which in 2030 allow the buildings sector to emit 70 million tonnes of CO_2 (rectification at source principle). The buildings sector also makes a corresponding contribution to the objectives of the other sectors through the approach of increasing energy performance.

With the indicative milestone for 2030, the buildings sector additionally makes an appropriate contribution to the European cross-sectoral objectives and is thus in line with the European decisions to improve energy efficiency (EED), to increase the share of renewable energy (Renewable Energy Directive, RED II; Directive (EU) 2018/2001 and to reduce CO_2 emissions in the non-ETS sector (Effort Sharing Regulation, ESR). As a result, the German contributions to the European targets for energy efficiency in the heating and cooling sector are 30% as compared with 2008 and for the renewable share are 27% in 2030.

The indicative milestone 2030 for energy performance is to be achieved through a clear increase in energy efficiency and a significant increase in the use of renewable energy in the buildings sector (see section 1.4 on actions and instruments).

1.2.1.4 Indicative milestones for 2040 and 2050

In the light of the forthcoming determination of the contributions of individual sectors to reducing greenhouse gas emissions in Germany and European dynamics (see section 1.1), Germany is only able at present to provide a qualitative description of its indicative milestones for the buildings sector after 2030.

Germany will continue to push for a steady and substantial improvement in energy performance beyond 2030. A continued dynamic impact, in particular the measures and instruments adopted in the past year in the Climate Action Programme 2030, will increase the potential for significant gains in energy performance. This can be expected to be reinforced by the investment and renovation cycles in the building stock over the next few years, which will be used to implement energy efficiency, renewable energy, sector coupling and decarbonisation of energy supply and to exploit cross-sectoral synergies such as electro-mobility. Innovation and digitisation, as well as important achievements from energy research that will enter the market, also have the potential to generate further positive effects on energy performance. In addition, the right incentives will further boost the potential for cost reduction in energy performance.

1.2.2 Milestones for further indicators

The pool of data and the continuous collection of this data are foreseen as a future basis for defining and monitoring the attainment of further indicative milestones.

In order to substantiate the objectives set by national and European decisions with appropriate indicators and indicative milestones in the future, the pool of data on the German building stock needs to be significantly improved. This will help to identify the pathway towards attaining the objectives set and to determine the success of different actions.

In addition to the projects already launched by the Federal Government, as part of the further development of the LTRS by 30 June 2024, further indicators will be defined as a first step on the

basis of the consolidated data on the building stock (in particular the rate and depth of refurbishment) and the data on energy performance certificates and heating labels and, as a second step, with indicative milestones for 2030, 2040 and 2050. Germany will closely follow the Commission's recommendations in developing the indicators and indicative milestones in the LTRS update.

1.3 Potential and restrictions

In order to improve energy performance, the energy efficiency of buildings and building systems, as well as the efficiency of the provision of heating, cooling, electricity, gas, etc. need to be significantly increased and the share of renewable and decarbonised energy sources or other heat sources needs to be significantly increased. There are both technical and economic potential and restrictions in equal measure.

1.3.1 Energy efficiency in the buildings sector

There is significant energy efficiency potential and thus energy consumption reduction potential in the buildings sector. The 'efficiency first' principle is applied in the buildings sector. Measures such as insulation of the building envelope, the installation of efficient windows or other façade units, the airtight construction of buildings and the use of high-efficiency technical systems for heating, cooling and lighting can raise the efficiency potential. However, there are both technical and economic limitations, as well as barriers in view of other parameters such as behaviour and information transparency that need to be addressed.

Technical limitations result from the fact that, although the energy quality of components and technical installations, such as exterior walls and windows or the efficiency of heating systems, can be optimised, it cannot be improved at will. At the same time, there is further potential for innovation in this area.

Economic limitations result from the fact that the increase in energy efficiency has a decreasing marginal utility, making the ratio of costs to increase in energy efficiency less favourable and making an investment unprofitable, taking into account cost savings on a case-by-case basis. Targeted incentives and price-governing factors, such as carbon pricing, have a direct impact on the cost-benefit calculation. Added value beyond energy cost savings (e.g. comfort, housing health and comfort) offers further benefits to investors. Further economic limitations arise in particular for private households in the absence of financial capacity, which ultimately requires the realisation of larger investment measures, even if a positive cost-benefit assessment is made.

Scientific studies for the preparation of the Energy Efficiency Strategy for Buildings (ESG) 2015 have shown that, from the present-day point of view and taking into account the technical limit of potential to increase energy efficiency, **final energy consumption in the buildings sector could be reduced by around half compared to the national base year 2008** (according to ESG, a maximum of -54% while predicting an increase in energy consumption in the cooling, ventilation and home systems sectors).

1.3.2 Renewable energy and decarbonised energy sources in the buildings sector

The use of renewable energy sources (e.g. solar thermal, photovoltaic and biomass/biomethane in sustainable production and availability), sources of heat (e.g. environmental heat, environmental heat, waste heat or wastewater heat) and, in the long term, hydrogen and its derivatives in parts of the heating market can create significant renewable energy potential to improve energy performance.

Restrictions consist of limited availability at present and competition with other sectors, in particular transport, industry and energy management. Economic limits on their use result, firstly, from

competition for use and the associated price effects and, secondly, from a decline in the economic viability of the necessary investments for the use of renewable energy compared with the remaining energy consumers. Costs of renewable energy technologies are influenced by targeted incentives or price-steering instruments, such as carbon pricing, as these measures directly increase the economic viability of energy investments.

The ESG showed that the **potential for renewable energy** that could currently be used for the buildings sector is around 1 600 PJ (from 1 400 to 1 800 PJ depending on source and assumptions). It should be noted, however, that the result of a longer-term forecast is highly uncertain and can therefore only be considered provisional. Furthermore, the ESG does not take into account the potential for decarbonised energy sources (e.g. for biogenic or synthetic gases).

1.3.2.1 Direct renewable energy and waste heat

Direct renewable energy is understood to mean forms of renewable energy that are directly available and usable, i.e. without conversion losses. These are, firstly, solar energy that can be used for solar thermal or photovoltaic purposes Waste heat and wastewater heat can also be used a source of heat for heat pumps.

With regard to the potential for direct use of renewable energy generated by solar thermal energy, account should be taken of the available roof area potential of buildings in connection with on-roof photovoltaic installations and of the fact that the yield from the solar thermal installation does not increase in a straight line with the collector area (asymptotic yield pattern). The level of coverage is limited by building efficiency and storage size.

The potential for using environmental heat (heat pumps, heat exchangers) may be limited by aspects of heat demand and heat sources. The heat transmission system determines the temperature level to be provided and therefore the demand – heat pumps function more efficiently, the lower the required end temperature, and can therefore be used efficiently, especially in buildings with space heating. The achievable potential of heat pumps is determined by the different dynamic development of the market.

1.3.2.2 Biomass

Biomass currently makes a significant contribution to GHG reduction in the buildings sector and will continue to contribute to the decarbonisation of buildings within its set framework. However, the production of the raw materials for liquid and gaseous biomass competes with the other (conventional) agricultural products. This also applies to the extraction of forest and industrial wood for solid biomass (pellets, wood chips, firewood). The alternative uses in the energy sector (biomass heating plants, biogas electricity generation), in the transport sector (biogenic liquid, gaseous fuels) or in the production of industrial process heat (solid biomass) should also be taken into account in the overall picture of available biomass for all sectors. The demand for biomass on the time axis should also be taken into account in the overall picture of available biomass for all sectors, in order not to exceed the potential limits. The demand for biomass in the buildings sector, for example, will decline in the longer term as buildings become more efficient. In addition, issues relating to limited residual material and also import potential (the needs of producer countries themselves) as well as storage capacity and basic availability of land play a crucial role.

It must therefore be ensured that Germany guarantees its agreement in the Climate Action Programme 2030. For example, the following questions will be clarified in the future update of the LTRS: compliance with the potential limits of sustainably produced and available biomass, competition for use and land, optimal sectoral distribution of biomass from the point of view of climate protection, and air quality management.

1.3.2.3 Liquid energy sources

Liquid biogenic or synthetic (decarbonised) fuels play a minor role in the strategic set-up for the future energy supply of buildings. From the present-day point of view, it is not yet possible to assess the extent to which their use will become more important in the future.

1.3.2.4 Gaseous energy sources

Natural gas is currently the main energy source in the buildings sector with a share of around 46%, and a wide range of gas-based technologies are available, in particular condensing boilers, hybrid systems, fuel cells or CHP.

Future use of gas-based technologies to supply energy to buildings requires substitution of fossil gas.

Decarbonisation will be achieved mainly through energy efficiency measures, efficient electricity-based technologies (e.g. heat pumps) and renewable energy. Hydrogen and derivatives of hydrogen can also contribute to the decarbonisation of parts of the heating market in various ways in the long term. Like all energy sources, as buildings become more energy efficient the demand for gaseous energy sources will decrease.

The overall picture of the available decarbonised gaseous energy sources for all sectors () should also take account of the alternative uses in the energy sector, or for the production of industrial process heat () in the transport sector. Synthetic hydrogen is not considered as a possible option for the buildings sector until after 2030; here too, the needs of other sectors (e.g. industry, transport) are primarily to be taken into account. In December 2018, the Federal Ministry of Economic Affairs and Energy launched the 'Gas 2030' dialogue process in order to discuss with stakeholders and representatives of the federal states the future role of gaseous energy sources and to derive recommendations for action.

The initial assessment of the stakeholders involved in the dialogue process is that in order to achieve the climate policy objectives, fossil gas consumption needs to be significantly reduced, while at the same time switching to low-carbon energy sources, and that gaseous energy sources are considered as a long-term component of the energy transition. The stakeholders involved in the dialogue process for the ambitious climate targets for 2030, having analysed the renovation trend so far, have found that efficiency measures alone may have an insufficient impact on the 2030 targets, but would contribute in particular to the long-term climate targets after 2030, and that, in parallel, switching to efficient heating technologies (e.g. heat pumps, solar thermal installations, biomass installations (with the limited potential of biogenic energy sources), CHP installations, condensing boilers (in particular as hybrid energy systems) and low-carbon or decarbonised energy sources are therefore crucial for the 2030 targets. From the point of view of stakeholders, the outcome paper of the Gas 2030 Dialogue identifies the following needs for action in the buildings sector:

- System-based design of heating, electricity and gas; gas needs to be considered with other supply structures and energy efficiency (heat planning).
- The affordability and socially acceptable design of gas-based and other heat supply should be ensured.
- The legal framework for energy efficiency should facilitate the use of low-carbon gases or low-carbon heating in buildings; this includes energy and heat grid planning in municipalities and neighbourhoods.
- Innovative technologies should be introduced into the market and market penetration needs to be facilitated.
- Digitisation to further exploit the efficiency potential of connected systems should be financially incentivised.

The macroeconomic potential of biogas/biomethane and possible other decarbonisation potential will be discussed and developed in the continued course of the BMWi's Gas 2030 dialogue process.

An important milestone is the National Hydrogen Strategy. It should be noted that once the potential for efficiency and electrification in the buildings sector has been exhausted, there will still be a demand for gaseous energy sources in the long term, and hydrogen and derivatives of hydrogen can contribute in various ways to the decarbonisation of parts of the heating market in the long term. Further questions will be clarified in the future update of the LTRS.

1.3.2.5 Electricity

Increased use of electricity in the buildings sector is to be taken into account in the expansion paths for renewable electricity. The use of electricity for heating and cooling purposes is already very significant in the buildings sector. Decarbonisation of electricity is therefore a prerequisite for improving the energy performance of the building sector.

The decarbonisation of electricity is increasingly driven by the decline of coal-fired electricity generation (to be phased out by 2038 at the latest), the expansion of renewable energy sources in gross electricity consumption (65% by 2030) and the use of combined heat and power (CHP) increasingly employing and in combination with carbon-free and low-carbon energy sources. The buildings sector can contribute to this to a greater extent through efficiency technologies and direct self-generation and storage of electricity in buildings or in the neighbourhood. The direct self-generation of renewable electricity on the building or in the neighbourhood also offers the opportunity to increase the participation of citizens in the energy transition.

1.3.2.6 Heating networks

Heating networks already play an important role in energy supply in the buildings sector. Over time, the climate impact will also change significantly in the case of heating networks. Decarbonisation of heating networks is achieved through the decline in coal-fired electricity generation (heat from coal CHP), the expansion of renewable energy in networks (e.g. large heat pumps, solar and geothermal), the use of unavoidable waste heat, the use of gas CHP, increasingly based on carbon-free/low-carbon gas, and increased efficiency of district heating networks (e.g. lowering of system temperatures; heating networks 4.0) Large-scale solar installations compete with agriculture and nature conservation for land use and are also subject to local and regional circumstances (heating networks for feed-in, existence of other low-cost heat sources, willingness to occupy agricultural land). The buildings sector can contribute to a greater extent through efficiency technologies to the transformation of heating networks and coupling technologies, such as building-based solar thermal energy.

1.3.3 Energy infrastructure (networks)

1.3.3.1 Electricity networks

The interaction of the electricity and heating markets will become more extensive and complex in the future. This is to be expected firstly because of the increasing number of electric heat pumps. Secondly, the heating market could provide an opportunity to take off electricity and store it in the form of heat. However, the importance of what are known as flexibility options in the short, medium and long term and the interaction of the potential options (network expansion, production management, load management, storage) are not yet conclusive.

In the buildings sector, electricity consumption ranks third after gas and oil as an energy source for heating systems. The increase in heat pumps, digitisation, smart technologies and cooled buildings, especially in the area of non-residential buildings, will initially offset reductions in consumption through improved efficiency. In the long term, however, there is also expected to be a substantial

reduction for electricity in the buildings sector. Self-generation, self-use and electricity storage in buildings and neighbourhoods at the same time smooth output and voltage peaks in generation and in the electricity network.

1.3.3.2 Heating networks

Smart control can optimise heating networks and thermal energy storage systems to couple carbon-free sources of heat, such as renewable energy and waste heat. The expansion and modernisation of district heating is a useful option, especially in densely populated areas.

1.3.3.3 Gas networks

The national gas infrastructure is of substantial significance to German and European energy security. The well-developed gas network with approximately 40 000 km of transport networks ('long-distance networks') and more than 470 000 km of distribution networks and a gas storage volume of approximately 23 billion m^3 is a significant element in German energy supply. While today it is used almost solely for the transport and storage of natural gas, it can also take other low-carbon or carbon-free gases, subject to any necessary adaptation measures.

The gas infrastructure will continue to play a role in energy security and in meeting the demand for gas in Germany. Long-distance networks will also be needed for intra-European gas transit. In addition, hydrogen and derivatives of hydrogen can contribute to the decarbonisation of parts of the heating market in different ways in the long term.

The combined planning of gas networks with electricity and heating networks, with the increased use of digital tools, aims to establish more efficient and system-based supply structures. In order to achieve the optimal solution in each case, incentives will be targeted, technologically open in the context of the agreed objectives and, as far as possible, market-oriented. The principle of 'efficiency first' must be followed. A systemic approach in neighbourhoods will include CHP and heat pump systems as well as renewable energy wherever possible and appropriate. For new neighbourhoods or those where energy supply needs to be fundamentally rethought, for example due to the need to renew gas networks, upstream integrated energy and heating network planning are envisaged at regional level, where infrastructures and their transformation pathways and urban development are considered together.

1.4 Actions and instruments to adequately contribute to the long-term climate protection target

The actions implemented to date to meet the energy and climate objectives have made significant progress in climate change protection and energy efficiency, reducing greenhouse gas emissions in the buildings sector between 1990 and 2019 by around 42% to 122 million tonnes of CO_2 (1990: 210 million tonnes of CO_2). The share of renewable energy in final energy consumption for heating and cooling increased by around 12 percentage points over the same period, reaching 14.4% in 2018. In the building sector, previous programmes such as the CO_2 buildings refurbishment programme, the Market Incentive Programme (MAP), the Energy Efficiency Incentive Programme (APEE) and the Heating Optimisation Programme (HZO) have already provided a significant boost to energy efficiency or to the share of renewable energy in the buildings sector, which have made a significant contribution to these positive developments. Nevertheless, scientific analysis shows that there is a need to speed up these developments to achieve the 2030 targets. In order to make the necessary progress in improving energy performance and reducing CO_2 emissions in the buildings sector, the 2030 Climate Action Programme adopted a comprehensive package of measures to improve energy efficiency and the use of renewable energy in the buildings sector, in addition to measures in other sectors.

1.4.1 Climate Action Programme 2030

In September 2019, the Federal Government presented key elements of a Climate Action Programme 2030 for all sectors, and in October 2019 it set out a detailed plan of work. The Climate Action Programme 2030 implements the Climate Action Plan 2050. The measures under the Climate Action Programme 2030 will be implemented step by step with legislation and support programmes. As a first step, a Climate Change Act was adopted and entered into force at the end of 2019.

The Climate Action Programme 2030 also provides for the following key actions for the buildings sector (see section 2.3 for additional explanations):

1.4.1.1 Carbon pricing for the buildings sector

A law concerning a national fuel emissions trading scheme (the Fuel Emissions Trading Act (BEHG)) entered into force on 19 December 2019. Under this Act, the Federal Government is introducing carbon pricing for the transport and heating (non-ETS) sectors with effect from 2021. The national emissions trading scheme (nEHS) covers emissions from the burning of fossil fuels (in particular fuel oil, liquefied petroleum gas, natural gas, coal). In the heating sector, the system covers the emissions from production of heating in the buildings sector and energy and industrial installations outside the EU Emissions Trading Scheme (EU ETS). First, a fixed price system is introduced in which allowances are sold at the upstream trading level to companies trading in heating and motor fuels. The participants in the nEHS are the distributors or suppliers of the fuels.

The carbon price is to be EUR 25 per tonne as of January 2021 and then gradually rise to EUR 55 in 2025. A price corridor of a minimum of EUR 55 and a maximum of EUR 65 is to apply for 2026. The Federal Government intends to launch a new legislative procedure in spring 2020 in order to adjust the price path of the BEHG already adopted accordingly.

1.4.1.2 Introduction of tax support for energy refurbishment measures in owner-occupied homes

A key measure in the buildings sector is the tax support for energy renovation of buildings, which was introduced on 1 January 2020 as an attractive support instrument to supplement existing support schemes as a further pillar of support. Tax support can be used as an alternative to the existing loan and grant schemes for investment in the buildings sector. Support is given to individual measures on owner-occupied housing, which are also considered eligible under the existing buildings support programmes. This includes, in particular, the replacement of heating, but also the installation of new windows or the insulation of roofs and exterior walls. Support will also be provided for the possibility of extensive refurbishment, if necessary on a step-by-step basis, accomplished through several individual measures. Eligible costs are 20% of the investment costs and of the costs of issuing the certificate to be submitted to the tax office in order to grant the tax relief, and 50% of the costs of an energy consultant charged with energy planning and supervision of the eligible measures. The support is provided through a deduction from tax liability spread over 3 years, for example in the replacement of old windows with modern thermally insulated windows. By designing the support as a deduction from tax liability without any progression, as many owners of residential buildings as possible can benefit from the measure.

1.4.1.3 Replenishment and optimisation of investment support programmes in the buildings sector

In order to increase the rate of replacement of oil heating systems, a ‘replacement premium’ with a support rate of up to 45 per cent was integrated into the MAP on 1 January 2020 for a new, more efficient heating system. The aim of the new support scheme is to provide an attractive incentive for all heating systems currently using fuel oil to be switched to renewable heating. The Federal Government has also proposed a statutory provision prohibiting the installation of oil heating

systems from 2026 in buildings where more climate-friendly production of heating is possible. Hybrid solutions will also be possible in the future in new buildings and the existing building stock.

The newly designed Federal Support for Efficient Buildings (BEG) will, from 2021 onwards, bring the existing investment support programmes in the buildings sector together in a single, comprehensive and modernised support package, taking into account aspects of energy efficiency and renewable energy. The new programme will significantly increase the addressee-friendliness and attractiveness of the support, gear it more closely tow ambitious measures and simplify the application procedures. A single application will be sufficient to support efficiency measures and renewable energy in the case of renovation or new construction projects. The budget of the programme is increased; in addition, parallel loan and grant support will be established across all sectors. The programme is currently in preparation.

1.4.1.4 Support of serial refurbishment

The Federal Government will also promote the industrial pre-production of façade and roof elements and standardised installation of building systems, including the supply of self-generated electricity, in conjunction with new investment and contract models. The serial refurbishment approaches developed as part of the pilot projects carried out will be put into practice using a newly adopted support programme from the end of 2020, with the aim of supporting the industrial pre-production of façade and roof elements and standardised installation of building systems, including the supply of self-generated electricity, in conjunction with new investment and contract models. The aim is to renovate buildings at high quality and shorten refurbishment times.

1.4.1.5 Energy-efficient urban redevelopment

The ‘Energy-Efficient Urban Redevelopment’ support programme implements extensive measures in the neighbourhood in terms of energy efficiency of buildings (indirectly) and supply infrastructure (heating/cooling/water/wastewater) in a conceptual and investment-based manner. The programme encourages energy efficiency in the local government sector. In addition to the planned continuation of the ‘Energy-Efficient Urban Renovation’ programme, new funding measures are to be developed or existing ones are to be improved in 2020. The grant scheme is intended, in particular, to take greater account of environmentally friendly mobility concepts, inter-municipal concepts, heating network planning measures in the concepts and in redevelopment management activity and concepts relating to mixed neighbourhoods (combination of new buildings and existing buildings).

1.4.1.6 Further development of energy efficiency standards

The affordability of construction and housing remains a key element to be taken into account in the future. The next review of the current energy standards will take place in 2023, as stipulated in European law. The energy standards of residential and non-residential buildings will then be immediately enhanced. The principles of cost-effectiveness and technological openness will be respected.

1.4.1.7 Expansion of energy advice and public relations

Energy advice for residential buildings will be improved. Energy advice helps to integrate energy efficiency and renewable energy into the planning and decision-making process, thus exploiting the efficiency potential at the most favourable individual point in time, in particular through the individual building renovation passport (iSFP) drawn up as part of the energy advisory process. This will also help building owners to understand better the added value of energy-efficient refurbishment measures. This is because investments are most useful if they are linked to pending maintenance or modernisation measures. On certain occasions (e.g. change of ownership) information on consultations is mandatory. The costs are covered by the existing funding programmes. In detail, energy advice will be further strengthened through measures including:

- increase in support in the ‘Energy Advisory Service for Residential Buildings (EBW)’ to a grant of up to 80% (to date 60%);
- renovation recommendations through subsidised energy advice for the preparation of an energy performance certificate (demand certificate);
- addressing energy advice following emission measurements by qualified chimney sweeps;
- other reasons for qualified advice (for example replacement of heating, use of synergies with barrier-free refurbishment or protection against burglary).

As part of the BMWi information campaign ‘Germany Does It Efficiently’, information will in future be given in an even more specialised and targeted manner. Under the iSFP, building owners will also be informed of the added value of energy-efficient refurbishment measures. The Federal Government will present a concept for this.

1.4.1.8 Federal buildings leading by example

Federal Government buildings must set an example in terms of energy efficiency, climate protection and sustainable construction for the entire building stock, and demonstrate that climate policy objectives can be achieved in harmony with the cost-effectiveness and functionality of construction measures. They will therefore at an early stage meet a standard that is appropriate to the objectives and integrate innovative technologies. Budgetary acknowledgement is based on the principle of economy with the fewest possible resources. According to the Climate Action Programme 2030, new Federal Government buildings are to meet at least EH 40 from 2020 onwards. Analogous objectives are to be developed for special uses. This objective will be made binding in the short term in a decree issued by the Federal Cabinet for climate-neutral Federal Government new buildings and extensions. As a second step, renovation targets for 2030 and 2050 are also specified for the existing Federal Government building stock in this decree. To this end, it is necessary for all new major renovation and modernisation projects to be based on at least the EH 55 standard from a date yet to be defined. Similar objectives must be developed for special buildings and exceptional situations (protection of scheduled monuments, etc.) must be taken into account. The decree will set an annual renovation rate in order to meet climate protection objectives. Measures to achieve the climate protection objectives in the existing building stock should preferably be planned and implemented in close association with major renovation or replacement building measures that are pending for other reasons.

1.4.2 The Federal Government’s energy efficiency strategy

Further support of energy efficiency is essential if the climate protection objectives are to be attained. The Federal Government has therefore adopted a comprehensive ‘Energy Efficiency Strategy 2050’ (EffSTRA), which also addresses the buildings sector. This strategy combines a wide range of energy efficiency measures for the decade 2021-2030 in the new National Energy Efficiency Action Plan (NAPE 2.0). It also takes into account the measures in the Climate Action Programme 2030.

With EffSTRA, the Federal Government sets the national energy efficiency target for 2030 required by EU law to reduce primary energy consumption by 2030 by 30% as compared with 2008. In addition, a broad dialogue process ‘Roadmap Energy Efficiency 2050’ (see section 3.3) will be launched to discuss sectoral pathways and develop specific measures to improve energy efficiency.

1.4.3 Building Energy Act

The standards set out in the Energy Conservation Act (EnEG), the Energy Conservation Ordinance (EnEV) and the Renewable Energy Heating Act (EEWärmeG) are merged into a Building Energy Act (GEG) and make an important contribution to achieving the Federal Government's energy and climate objectives. Further development towards a harmonised system of requirements is an important element in achieving the objective of a nearly climate-neutral building stock. In addition to simplifications, the structural re-design includes, in particular, provisions to improve the integration of renewable energy into the heating supply of buildings, as well as the introduction of the neighbourhood approach and an innovation clause. The next review of existing energy standards for new buildings and existing buildings will be carried out in 2023, while respecting the current cost-effectiveness principle and the principle of technological openness. The energy efficiency standards of residential and non-residential buildings will then immediately undergo further development based on the results of the review. The affordability of construction and housing is a key element to be taken into account.

1.4.3.1 Neighbourhood approach

Efficient and sustainable heating supply of buildings can also be implemented through neighbourhood solutions. The solution contained in the GEG is dependent on agreements between developers or building owners whose buildings are spatially linked on the joint supply of heating or cooling to their buildings and on the joint fulfilment of obligations to use renewable energy sources. The use of newly built and existing supply facilities is conceivable in the joint supply of heating or, where appropriate, cooling. The regulatory obligations may be fulfilled jointly for all buildings in a defined neighbourhood, provided that the total heating and cooling requirements of the buildings concerned are met to an extent at least equivalent to the sum resulting from the individual parts of the individual buildings covered.

1.4.3.2 Innovation clause for neighbourhoods

The GEG will in future allow innovative solutions for neighbourhood approaches in the form of a temporary scheme applicable until the end of 2025. To this end, the neighbourhood solution contained in the GEG, which focuses on joint heating supply in the neighbourhood, will be extended to include the possibility of an overall balancing in the event of changes to existing buildings. This allows the building owners involved to agree in an individual case that the energy requirements are not to be met on a building-by-building basis, but through an overall assessment of all the buildings in the neighbourhood covered by the agreement.

1.5 Perspectives in the updating of the LTRS

With a view to 2050, the policies and actions identified in the LTRS require continuous further development and consideration of other Federal Government policies and actions. Different challenges need to be addressed in this context.

In the course of the work on updating the LTRS, Germany is examining the design of further indicators, in particular on 'final energy consumption'. More specifically, the examination will address the following aspects:

- What further conclusions can be drawn from final energy consumption for the assessment of energy efficiency?
- How can the efficient use of renewable energy and decarbonised energy sources also be taken into account in final energy consumption?
- How can the core principle of 'efficiency first' best be reflected in the indicator of final energy consumption?

The assessment of an indicator on final energy consumption includes specification of the indicator (e.g. balance limit, absolute/relative calculation, adjustment for weather conditions). In addition, the assessment includes a possible future definition of indicative milestones for this indicator. The assessment will also take into account the previous national monitoring of the energy transition (see Article 7 EED).

Other challenges to be addressed include:

- Clear signal to the market: With a view to long-term development, security of planning and investment is of particular importance to stakeholders. For example, in the Climate Action Programme 2030, the Federal Government has already set out a clear framework of 'support and demand' for some areas. With this in mind, the Federal Government will examine at an early stage, as part of the preparatory work for the development of the LTRS, how support measures and regulative law can continue to be optimally coordinated in the future.
  The Climate Action Programme 2030 provides for the next review of existing energy standards in accordance with European legislation in 2023.
- Implementation of the Federal Government's energy efficiency strategy (including NAPE 2.0 and measures from the roadmap process)
- Sustainability and resource efficiency should increasingly also be reflected in energy-related instruments to avoid disincentives. Questions relating to the life cycle of the building, including the commitment of resources in the production of the building materials used, will be clarified.
  Meshing with climate adaptation measures under the German climate change adaptation strategy (DAS) and its implementation

2 Mandatory components of the long-term renovation strategy

2.1 Overview of the national building stock

2.1.1 Preliminary considerations

An overview of the German building stock is presented below. The building categories of 'residential buildings', 'non-residential buildings' and 'public buildings' are covered. It should be noted that the level of detail of available information on the German building stock in these categories of buildings is highly variable. While a variety of data from different sources is available for the stock of residential buildings, the volume of available data on the stock of non-residential buildings and public buildings in Germany in some cases is low. However, it should be stressed that projects are already being managed to bridge these gaps in data (see section 1.2.2).

The German building stock is highly heterogeneous and consists of a variety of different building types and age classes with very different energy efficiency characteristics.

2.1.2 Residential buildings

The energy efficiency potential in the residential sector is largely determined by the factors of existing building stock, current building ownership structures and the structure of tenants. This is because the different interests and constraints in each case have a significant impact on the choice of energy renovation and/or the use of renewable energy sources in the heating sector. The detailed assessment of the current starting point therefore makes it possible to identify options and restrictions with regard to energy renovations.

The housing stock in Germany comprises around 19 million buildings with almost 40 million dwellings. Of this total, there are around 14 million single and two-family houses with around 9 million dwellings and around 5 million apartment blocks with almost 21 million dwellings. In

addition, there are more than 1 million dwellings in non-residential buildings [Destatis]. In 2018, nearly 287 000 new homes were completed in Germany. The rate of new construction in relation to the housing stock is just over 0.5%.

Alongside the number of buildings and living space, the energy quality of the building stock plays the most important role in assessing the potential for energy-efficient refurbishment. A key indicator of this quality of buildings is the age of construction of the buildings and their state of refurbishment. For example, the age of construction may also give an initial pointer to a possible need for modernisation or maintenance.

A large proportion of the current building stock has been erected since the Second World War. From the present-day perspective, 26% of residential buildings were built before 1948, of which almost half (13%) were built before 1919. These buildings are often covered by protection of historic buildings and monuments and, as a rule, have to comply with the relevant rules on protection of historic buildings during refurbishment.

Between 1949 and the first regulation from 1977, which set minimum energy efficiency requirements (First Thermal Protection Regulation) (WSVo)), around 7 million buildings were erected. This means that around 64% of our present-day housing stock was built without consideration of energy efficiency standards being mandatory. A further 3.6 million buildings (20%) were erected before the Third Thermal Protection Regulation in 1995. By 2002, a further almost 2 million residential buildings (10%) were erected. The First Energy Conservation Ordinance (EnEV, 2002) has been in place since 2002. Since then, more than 1 million new residential buildings have been erected (6%). The breakdown of dwellings between the different age classes is shown in Table 4.

Table 4: Dwellings by year of construction in 2014

	Germany in thousands	Germany in%
Total dwellings (excluding residential homes)	39 95	100
of which built		
up to 1918	5 500	14
1919-1948	5 126	13
1949-1978	18 134	46
1979-1986	3 895	10
1987-1990	1 076	3
1991-2000	3 066	8
2001-2010	1 916	5
2011 and later	482	1
Federal Statistical Office		

2.1.2.1 Ownership structure

The ownership structure of residential buildings in Germany is presented in Table 5. In the case of single and two-family houses in particular, it can be seen that in most cases the owners are private individuals. In the case of apartment blocks, on the other hand, private owners account for just over 40% of the number of buildings. The housing companies, on the other hand, own about 5% of the total building stock. In terms of the number of dwellings, this figure is just under 18%. There is a different picture in the area of apartment blocks. In this case, the ownership shares of housing companies are about a quarter of residential buildings and about a third of dwellings. However, most of the dwellings in apartment blocks are owned by the housing owners' associations. These own around 36% of apartment blocks.

The tenant structure in Germany is highly heterogeneous. There are about 18 million tenant households.

Table 5: Residential buildings and dwellings in them by type of ownership

	Buildings	Dwellings
	All residential buildings	
Housing owners' associations	7.5%	20.1%
Private individual(s)	86.6%	61.0%
Housing companies [1)]	5.4%	17.7%
Other [2)]	0.5%	1.1%
Total	100%	100%
	Single/two-family houses	
Housing owners' associations	2.2%	2.6%
Private individual(s)	96.0%	95.5%
Housing companies [1)]	1.7%	1.7%
Other [2)]	0.1%	0.2%
Total	100%	100%
	Multiple-family houses	
Housing owners' associations	33.6%	35.6%
Private individual(s)	40.5%	30.6%
Housing companies [1)]	23.5%	31.8%
Other [2)]	2.3%	1.9%
Total	100%	100%
Based on: Dr Holger Cischinsky (IWU), Dr Nikolaus Diefenbach (IWU) (2018): Datenerhebung Wohngebäude [Data collection for residential buildings] 2016 The figures in this table are partly subject to relevant statistical uncertainties.		
Housing cooperative, private or municipal housing company, municipality [1)] Other private company, Federal Government, federal state, non-profit organisation (e.g. church)		

2.1.2.2 Energy efficiency status of the residential building stock – building envelope

The status of thermal insulation measures carried out in the residential building area is presented in Table 6. The results are broken down into the insulation of the exterior wall, the roof or upper storey ceiling and the floor or basement ceiling. The first part of the table describes the percentage of residential buildings with thermal insulation of the building unit mentioned. The exterior walls

account for a share of 50.4% for the total stock of residential buildings. The values for two different periods of construction are also presented. These are broken down into old buildings with a year of construction up to 1978 and new buildings with a year of construction from 2010 onwards. As expected, the share of thermally insulated old buildings is significantly below the average for residential buildings. Just under 46% of residential buildings have thermal insulation for the exterior wall in old buildings. In the case of new buildings, on the other hand, just under 77% of the buildings have thermal insulation of the exterior walls. It should be noted that in collecting this data a specific question was asked about layers of thermal insulation. Good insulated bricks, probably the dominant method of construction for the remaining quarter of new buildings, were not taken into account.

Table 6: Residential buildings with thermal insulation

	Exterior wall	Roof/upper storey ceiling	Floor/basement ceiling
	Residential buildings with insulation of the building unit concerned		
All residential buildings	50.4%	83.9%	40.4%
Old buildings up to year of construction 1978	45.5%	77.2%	26.8%
New buildings from year of construction 2010	76.5%	98.0%	84.2%
	Insulated proportions of surface area (if insulation is present) [1)]		
All residential buildings	82.7%	93.2%	91.3%
Old buildings up to year of construction 1978	74.2%	90.7%	85.4%
New buildings from year of construction 2010	97.5%	99.7%	97.6%
	insulated building unit surface area (building weighted by proportions of surface area)		
All residential buildings	41.7%	78.2%	36.9%
Old buildings up to year of construction 1978	33.7%	70.0%	22.9%
New buildings from year of construction 2010	74.6%	97.7%	82.1%

Based on: Dr Holger Cischinsky (IWU), Dr Nikolaus Diefenbach (IWU) (2018): Datenerhebung Wohngebäude [Data collection for residential buildings] 2016

The figures in this table are partly subject to relevant statistical uncertainties.

[1)] Percentages of surface area of roof/upper storey ceiling and floor/basement ceiling taken from the previous survey 'Database of buildings stock' (see [Diefenbach et al. 2010], Table 4.1-1 on p. 44)

The middle part of the table shows the insulated proportions of the surface area. The figures describe the average percentage of the surface area of a building provided with thermal insulation in the event that thermal insulation is present. The total share of insulated exterior walls is

therefore 50.4% x 82.7% = 41.7%. These results, and therefore the total insulated building unit surface areas, are presented in the last section of the table. It can be seen here that the proportions of thermal insulation vary greatly from one building unit to another. While these proportions are 41.7% for the external wall insulation and 36.9% for the floor/basement ceiling, 78.2% of the building unit surface areas are insulated in the case of roofs and upper storey ceilings. Here too, the values for the old building stock are below the average. At this point we wish to reiterate that the table represents only the presence of thermal insulation. It is not possible to make a statement on the actual energy quality of the building units.

The above table, which describes whether the component is thermally insulated and, if so, with what proportion of the surface area, does not yet distinguish between insulation when the building is erected and subsequent insulation. In collecting such data, this distinction poses particular difficulties for older buildings. In the case of closed building units in particular, the owner of the building is not always aware of whether and how these building units are insulated. Moreover, in this presentation the presence of layers of insulation does not necessarily mean better thermal protection, as this depends greatly on the construction materials used and the thickness of the thermal insulation.

Table 7shows the proportion of subsequent thermal insulation modernisation measures for the housing stock as a whole and for the stock of old buildings. In total, 25.1% of residential buildings have subsequent thermal insulation of the external wall. This proportion is higher in the old building stock at 37.6%. When looking at the subsequently insulated portions of surface area in the lower section of the table, the proportion is 18.8% for the total residential building stock and 27.8% for old buildings. The results differ significantly for the other building units.

In old construction, more than 60% of roofs or upper storey ceilings have been subsequently insulated. As can be seen from the middle section of the table, this subsequent insulation was carried out almost over the entire surface area of the building unit (90.1%). On the other hand, the proportion of thermal insulation of the floor and the basement ceiling is very low at 14.2%.

Table 7: Residential buildings with subsequent thermal insulation, i.e. installed as part of modernisation measures

	Exterior wall	Roof/upper storey ceiling	Floor/basement ceiling
	Residential buildings with subsequent insulation of the building unit concerned		
All residential buildings	25.1	41.1	12.1
Old buildings up to year of construction 1978	37.6	61.0	17.8
	Insulated portions of surface area (if subsequent insulation is present) [1)]		
All residential buildings	75.0	90.4	80.3
Old buildings up to year of construction 1978	73.9	90.1	80.1
	Subsequently insulated building unit surface area (building weighted by proportions of surface area)		
All residential buildings	18.8	37.2	9.7
Old buildings up to year of construction 1978	27.8	54.9	14.2

Based on: Dr Holger Cischinsky (IWU), Dr Nikolaus Diefenbach (IWU) (2018): Datenerhebung Wohngebäude [Data collection for residential buildings] 2016

The figures in this table are partly subject to relevant statistical uncertainties.

[1)] Percentages of surface area of roof/upper storey ceiling and floor/basement ceiling taken from the previous survey 'Database of buildings stock' (see [Diefenbach et al. 2010], Table 4.1-1 on p. 44)

The types of glazing in the entire stock of residential buildings are presented in Table 8. These in turn are divided into window years of construction and into age classes of building. A distinction is made between window construction periods up to 1995 and from 1995 onwards. The age classes of buildings age are broken down into 'all residential buildings', old buildings up to year of construction 1978 and 'new buildings with year of construction from 2010 onwards'. Double glazing occurs most commonly in the entire housing stock and in old buildings. Triple glazing is dominant in new buildings.

Table 8: Types of glazing and year of window construction

	All residential buildings	Old buildings up to year of construction 1978	New buildings with year of construction from 2010
	100%	100%	100%
Window year of construction up to 1995 (largely no thermal insulation glazing)			
Single glazing	3.3%	4.2%	
Double glazing [1)]	35.2%	37.6%	
Triple glazing	1.3%	0.9%	
Window year of construction from 1995 (largely thermal insulation glazing)			
Single glazing	1.1%	1.4%	0.1%
Double glazing [1)]	50.2%	49.7%	23.0%
Triple glazing	8.9%	6.1%	76.9%
Based on: Dr Holger Cischinsky (IWU), Dr Nikolaus Diefenbach (IWU) (2018): Datenerhebung Wohngebäude [Data collection for residential buildings] 2016 The figures in this table are partly subject to relevant statistical uncertainties.			
[1)] including box windows			

2.1.2.3 Heating structure

Around 21.3 million heat generators are installed in Germany. More than 10.5 million of the heat generators are gas-fired boilers. Oil-fired boilers make up the second large block with around 6 million installations. In addition, some 0.8 million biomass-fired boilers, some 110 000 coal-fired boilers and 1.5 million heat pumps are installed. Around 1.4 million dwellings (without heat pumps) are heated entirely or mainly by electricity, the majority of these using storage heaters. Some 1.2 million residential buildings are heated from heating networks.

The building stock is largely characterised by gas-fired and oil-fired heating systems, which can be classified as highly outdated. The average age of the heating technology in apartment blocks is around 20 years, while in single and two-family houses the heat generators are on average 16 years old. Around 13% of the stock of central heating generators are outdated constant-temperature boilers. Gas and oil-fired low-temperature boilers are particularly common. These account for approximately 60% of the stock. Gas condensing boilers represent the current state of the art in the field of oil and gas heat generators, currently accounting for only around 21%. In recent years, around 600 000 to 700 000 new heat generators have been installed annually. Gas remains the most important energy source in new buildings, while there is almost no longer any demand for oil-fired heating. The share of oil as an energy source in new residential buildings is below 2%, while the use of electric heat pumps is steadily rising. The share of gas-fired heat generators is slowly decreasing in favour of heat pumps and is currently just under 50%. The share of buildings supplied by heating networks is also increasing. This is due to the fact that construction activity is concentrated in particular in conurbations, where there is often a connection to a heating network (see Figure 1).

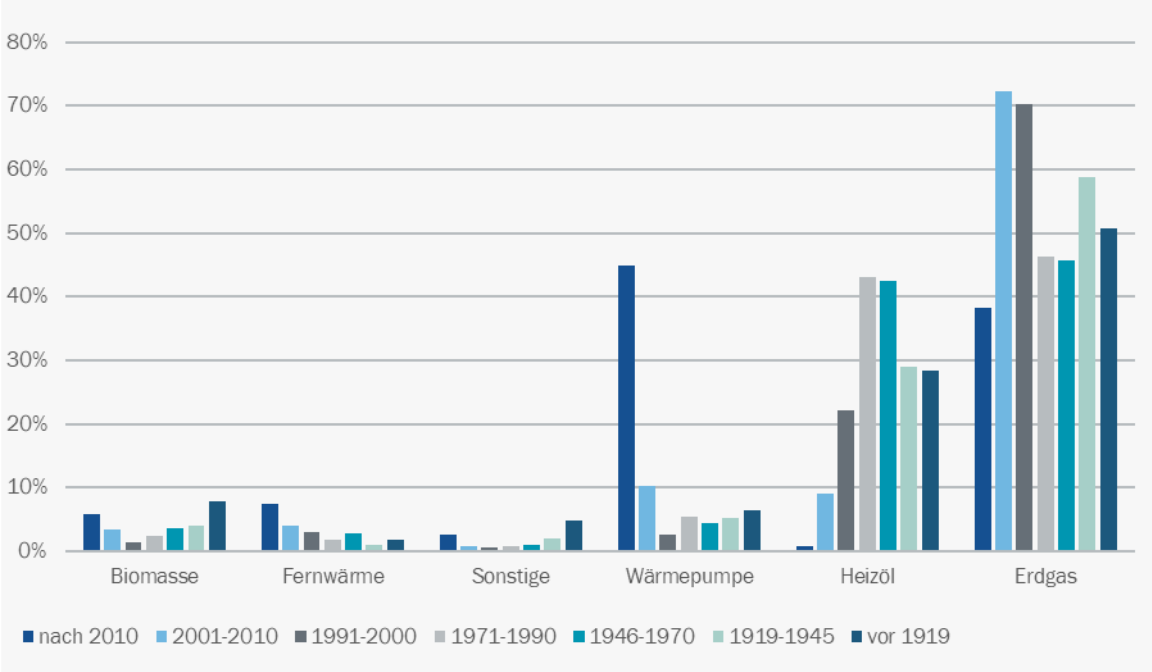

Figure 1: Principal energy sources in single and two-family houses; (Source: dena/ifeu/prognos et al. 2019)

Key: (left to right)
Biomass
District heating
Other
Heat pump
Fuel oil
Natural gas

nach = after

Natural gas is also the dominant energy source in apartment blocks up to the year of construction 2010. Fuel oil is much less common than in single-family houses. It is also striking that the use of district heating across all classes of year of construction is significantly higher in apartment blocks than in single-family houses and, in particular, accounts for around a third in new buildings from 2010 onwards. Biomass and heat pumps are also used in this newest class of age of construction, each in more than 10% of new buildings from 2010 onwards (see Figure 2).

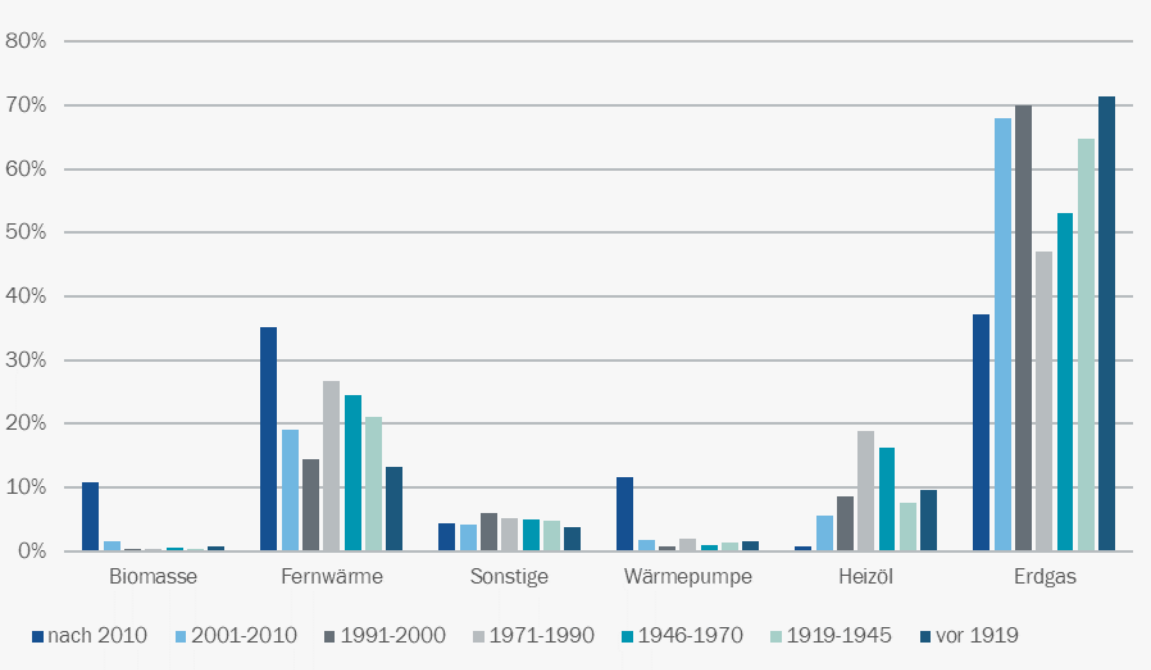

Figure 2: Principal energy sources in apartment blocks; (Source: dena/ifeu/prognos et al. 2019)

Key: (left to right)
Biomass
District heating
Other
Heat pump
Fuel oil
Natural gas

nach = after

2.1.3 Non-residential buildings

The correct identification and energy-based description of non-residential buildings is a challenge that has not yet been conclusively resolved, due to their multi-faceted use. These buildings account for a significant part of the building stock. Due to the incomplete body of data, it is only possible to estimate the current stock of non-residential buildings by extrapolation. All the data presented here is subject to great imprecision.

The extrapolations suggest a total stock of at least 3.5 million heated non-residential buildings in Germany, with an estimated net floor area of 2.35 billion m².

As the body of available data in the non-residential area is highly unsatisfactory, a project for data collection in this area, funded by the Federal Ministry for Economic Affairs and Energy, is currently in progress. The title of this project is ‘Research database of non-residential buildings, primary data collection to identify structure and energy quality of the non-residential building stock in Germany’ (ENOB:dataNWG). The implementation of this project will provide extensive information on the non-residential building stock in Germany.

As shown in Table 9, non-residential buildings can be divided into 14 different classes with regard to use:

Table 9: Typologies of non-residential buildings[1)]

Typology	Number	Net floor area in million m²	Energy consumption in TWh
Building industry	402 000	97	12
Sport	113 825	55	7
Accommodation, restaurants, homes	423 000	237	32
Education	110 832	156	25
Office-like businesses	687 279	316	19
Commerce	486 563	244	22
Industry	489 144	698	0
Manufacturing	200 000	86	9
Hospitals	17 000	53	18
Culture	83 176	70	0
Agriculture	299 000	254	20
Food industry	14 000	7	0
Textiles, clothing, haulage	188 000	74	4
Laundries	6 000	1	0
Total	3 519 818	2,346	168

Beuth Hochschule für Technik Berlin, ifeu (2015)

[1)] In accordance with GEMOD, a model developed at the Institute for Energy and Environmental Research (ifeu) to calculate energy consumption for space heating and domestic hot water in buildings.

The most common typology, with around 690 000 buildings, is that of office-like businesses. Industrial buildings rank second (approx. 490 000), followed by the category of commerce (490 000). However, when looking at the net floor area of the different typologies, industrial buildings come top with 698 million m² of net floor area. Buildings with office-like uses are ranked a distant second with 316 million m² of net floor area. However, with regard to energy consumption, there is a need to look more closely at the areas of accommodation, restaurants, homes, education and commerce. The highest building-related energy consumptions are also associated with the greatest possible savings.

Alongside use, the age of construction of non-residential buildings is an important indicator in assessing energy efficiency potential. To this end, age of construction classes A to J were defined. These describe the age of construction of the buildings in question.

The definition of age of construction class with the associated age of construction can be found in Table 10. The heat transfer coefficients of non-residential buildings, without subdividing them into different uses, are also shown here. Progress and improvement in U-values in all building units can be clearly seen.

Table 10: U-values of non-residential buildings depending on age category

			U values in W/m²K			
Age class	Age of construction		Window	Upper termination	Lower termination	Exterior wall
	from	to				
A		1859	3.5	1	1.2	2
B	1860	1918	2.7	1	1.2	2
C	1919	1948	3.5	1	1.2	1.5
D	1949	1957	3.5	1	1.2	1.5
E	1958	1968	3.5	1	1.2	1.5
F	1969	1978	2.9	1	1.2	1.5
G	1979	1983	2.9	0.45	0.85	1.2
H	1984	1994	1.9	0.3	0.4	0.85
I	1995	2001	1.9	0.3	0.4	0.35
Y	2002	2009	1.7	0.25	0.4	0.5
K	2010	2020	1.7	0.25	0.4	0.5
L	2021	2050	0.8	0.15	0.15	0.15
M			0.6	0.1	0.1	0.1

Beuth Hochschule für Technik Berlin, ifeu (2015)

The breakdown of some typologies across the age classes can be found in Table 11. Based on the current body of available data, the age classes had to be grouped into small groups in this table. A large proportion of the buildings fall into the age classes ABC, i.e. they were built before 1948. Buildings of this age class are even the most frequently represented in the categories ‘hospitals, homes’, ‘trade, commerce’ and ‘hotels’. As high a proportion as 40.4% of hospitals and homes in Germany are in this age class. The proportion of hotels built before 1948 is 38.6%. A large proportion of existing office, administrative and school buildings (35.4%) were built between 1979 and 1994 and are therefore to be allocated to age classes G and H. However, a very significant proportion (32.4%)

are also to be allocated to age classes ABC. Age classes I and J (1995-2009) account for the lowest proportion of existing buildings in all the typologies considered. Age classes D, E and F (1949-1978) are represented by a similar proportion in all typologies, with shares ranging from 22.2% to 29.0%.

Table 11: Breakdown of non-residential buildings by age class according to own presentation

	Non-residential buildings			
Age classes	Office, administration, school	Hospitals, care homes	Trade, commerce	Hotels
Classes ABC (up to 1948)	32.4%	40.4%	30.5%	38.6%
Classes DEF (1949-1978)	22.9%	25.3%	22.2%	29.0%
Classes GH (1979-1994)	35.4%	25.2%	29.6%	29.9%
Classes IJ (1995-2009)	9.3%	9.1%	17.7%	2.5%
Total	100%	100%	100%	100%
Based on: Leibnitz Institute (2013)				

2.1.4 Local government buildings

Germany's cities and municipalities have around 175 000 non-residential buildings. Most local authority buildings are used for education, mainly in the form of schools for general education. However, the body of available data on municipal non-residential buildings overall is incomplete. There is a need here for further analysis. The ENOB:DataNWG project, briefly presented in section 2.1.3, is intended to contribute significantly to improving the data set.

2.1.5 Historical trend in non-renewable primary energy consumption

In 2018, non-renewable primary energy consumption ($PEV_{n.E.}$) of buildings fell by 4.4% as compared with the previous year. In addition to the provision of heating, cooling and hot water (in addition lighting for non-residential buildings), $PEV_{n.E.}$ also takes into account the non-renewable costs of producing, converting and transporting or distributing the individual energy sources. However, $PEV_{n.E.}$ does not include renewable energy. It can therefore be reduced both by increasing energy efficiency and by increasing the share of renewable energy in meeting heat demand. In 2018, non-renewable primary energy consumption was 3 283 PJ, compared with 3 429 PJ in the previous year. Since 2008, non-renewable primary energy consumption has already decreased by 25.5%, equivalent to an average annual reduction of 2.6%. This shows that the right path to reducing non-renewable primary energy consumption has been embarked upon, although the dynamics flattened somewhat between 2014 and 2017 (see Figure 3).

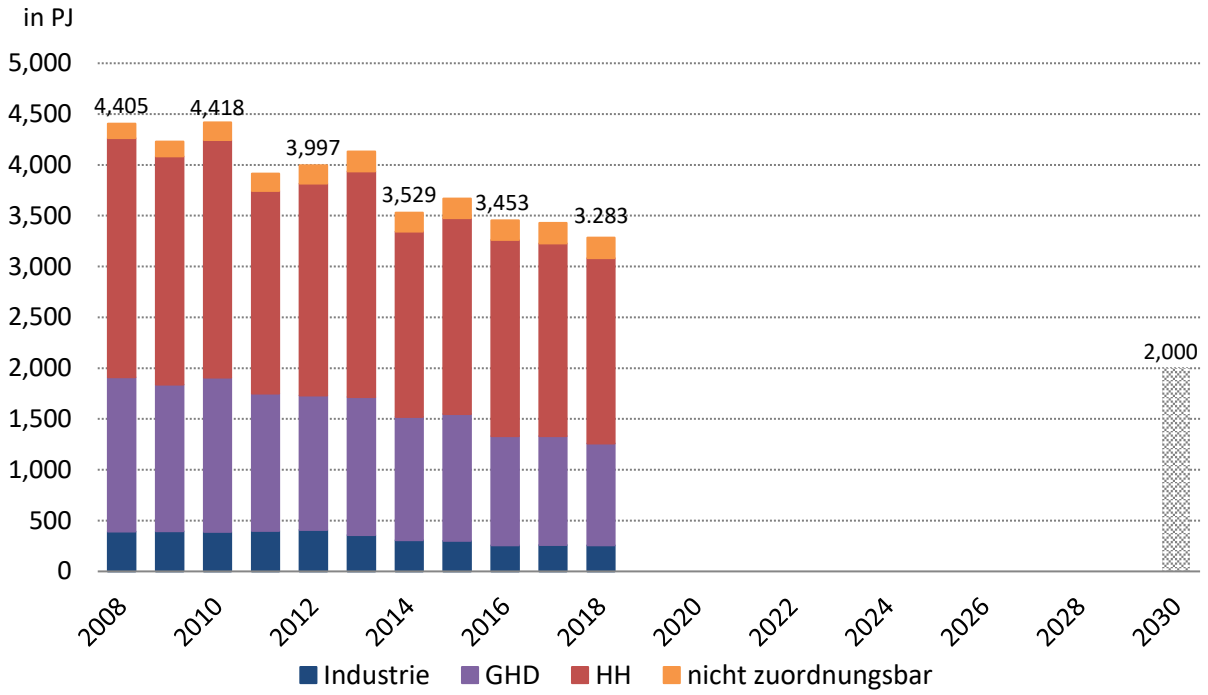

Figure 3: Trend in non-renewable primary energy consumption (source: BMWi (2019) based on AGEB 10/2019

Key (left to right):
Industry
Business, commerce and services
Households
Not attributable

2.1.6 Historical trend in final energy consumption

Final energy consumption in buildings decreased in 2018 as compared with the previous year. The consumption values for heating, cooling and hot water are shown as building-related final energy consumption for heating (heating demand). In addition, electricity consumption for (permanently installed) lighting is balanced in non-residential buildings. In 2018, building-related final energy consumption was around 2 983 PJ, a decrease of 4.2% on the previous year. Although final energy consumption increased slightly between 2014 and 2016, it has decreased overall by 13.6% since 2008. This means that final energy consumption decreased on average by around 1.4% per year over this period (see Figure 4).

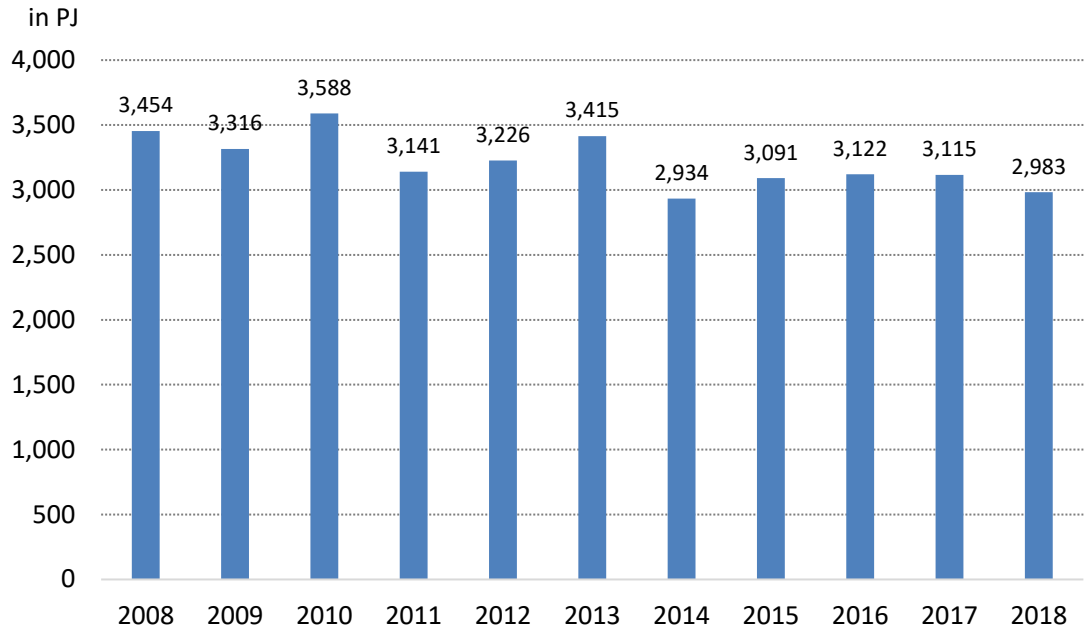

Figure 4: Reduction in building-related final energy consumption (heating demand) (source: BMWi (2019) based on AGEB 10/2019)

2.1.7 Refurbishment and investment in the buildings sector

In 2018, construction permits were granted for the refurbishment or construction of a total of around 340 000 housing units, and around 282 000 completions were recorded in the housing sector. With a constant number of permits, this is equivalent to an increase in completions of around 1% on the previous year. Among the permits, new construction accounted for around 302 000, i.e. around 89% of the 340 000 housing units. In 2018, new construction projects with around 90 000 housing units were funded under the 'Energy Efficient Construction' programme of the Kreditanstalt für Wiederaufbau (KfW) as part of the CO_2 building refurbishment programme. This means that around 30% of the new housing units approved in 2017 were supported by the Federal Government and were built to a higher energy efficiency standard than required by the Energy Conservation Ordinance (EnEV). In 2018, KfW's 'Energy-Efficient Refurbishment' support programme improved the energy efficiency of a total of around 270 000 housing units. Energy-efficient construction unlocks potential for economic solutions. In the field of renewable energy for heating, the installation of approximately 50 000 renewable heating installations, mainly in residential buildings, was supported in 2018 under the 'Renewable Energy in the Heating Market Incentive Programme' (MAP). The technologies used are based on solar thermal, biomass and ambient heat. The total level of investment grants paid out in 2018 was EUR 182.2 million. This is 14% down on the previous year. The investment volume of these measures was around EUR 734 million.

2.1.8 Expected share of renovated buildings – anticipated classification

In order to be able to make a valid statement on the (expected) proportion of renovated buildings for 2020, a statistically verified and consistent database of residential and non-residential buildings is first needed (see section 1.2.2).

In the context of the present LTRS, on the basis of the estimated trend in the average refurbishment rate in accordance with the Energy Efficiency Strategy for Buildings, only a broad classification of refurbishment activities in the building sector can initially be made. It was shown in relation to the Energy Efficiency Strategy for Buildings (ESG) that the average refurbishment rate of residential buildings rises steadily up to 2030 in all scenarios. From 2030 onwards, depending on the ESG

scenarios, the refurbishment rate (full refurbishment equivalent) is around 1.3% to over 2% for single and two-family houses and around 1.5% to over 2% for apartment blocks. The same assumptions were used for non-residential buildings as for apartment blocks.

As sole designation of a proportion of refurbished buildings raises the question of the extent to which the energy performance of the buildings has been influenced by the refurbishment, it is planned that the LTRS update will combine information on the expected proportion of refurbished buildings with information on refurbishment efficiency. Only if both indicators are taken into account together will the need to consider both the quantity of refurbishments (refurbishment rate) and their energy quality (refurbishment efficiency) be met in an overall assessment.

2.1.9 Expected proportion of renovated buildings – public buildings

2.1.9.1 Central government buildings

Federal Government buildings must set an example in terms of energy efficiency, climate protection and sustainable construction for the entire building stock and demonstrate that climate policy objectives can be implemented in harmony with the cost-effectiveness and functionality of construction measures. They will at an early stage attain a standard that is commensurate with the climate policy objectives and integrate innovative technologies. To this end, efficiency house standards will be introduced for new construction and federal refurbishment and modernisation projects with minimum resources, in accordance with the principle of economy. The renovation of existing federal buildings is to be based on at least an EH 55 standard. Similar targets are defined for special buildings and exceptional situations (protection of scheduled monuments, etc.). The measures to meet the climate protection objectives in the existing stock should preferably be planned and implemented in close connection with major renovation or replacement building measures that are pending for other reasons (see section 1.4.1.8).

2.1.9.2 Federal state buildings

Refurbishment roadmaps can be effective tools for implementing an energy fitness concept for large building stock portfolios. Particularly if the energy targets are combined with long-term stable investment planning, economically viable solutions will also emerge to ensure continued development of the building stock from the perspective of real estate use. The Federal Government will exchange experience with the federal states in accordance with the Section 15 of the Federal Climate Change Act, ‘Climate-neutral federal administration’. To this end, the activities already in place in the federal states should also form part of an overall strategy. Energy-efficient refurbishment roadmaps have to date been prepared for example in Baden-Württemberg, Brandenburg and Hessen.

The energy-efficient refurbishment roadmap in Baden-Württemberg aims to meet the state’s energy targets by 2050, i.e. a 50% reduction in energy consumption, 80% energy from renewables and a 90% reduction in greenhouse gas emissions. Brandenburg’s refurbishment roadmap includes compliance with the federal state's 2030 energy strategy (23% final energy savings by 2030). With the refurbishment roadmap, the state of Hessen is implementing the objective of climate-neutral federal state administration.

2.1.9.3 Local government buildings

A wide range of support schemes are available to local government in the field of climate protection and energy efficiency in Germany. Support from the Federal Government plays a key role in this respect. The National Climate Action Initiative (NCI) of the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU) has supported climate protection projects

since 2008, particularly in the local authority area. In addition, the local authorities have access to Federal Office for Economic Affairs and Export Control (BAFA) support and KfW loan-based support.

Climate protection and energy efficiency are not mandatory local authority tasks and are implemented in very different ways depending on local authority resources. Nevertheless, some of the 12 000 cities and municipalities are already well on track to reduce their energy consumption, especially in the buildings sector. It is also, however, part of the reality of local government that, as a rule, there is no or only a small local government budget available for the implementation of efficiency and climate protection measures.

Local governments generally have good knowledge of their building stock, but often find it difficult to carry out the wide range of tasks with their existing staff (especially in the building administrations). Energy efficiency investments in many cities and municipalities are affected by necessity (for example for urgent repair). The presumed commandment of cost-effectiveness often prevents further measures being taken. Moreover, a systematic approach (a forward-looking strategy) is often missing. Local authority decision-making processes require time and space for technical and political exchanges, especially in the case of major measures. Only if a local authority is committed to these topics and there is a political will in the city council or administration will there be integrated multidisciplinary action in local government.

Some local governments act as pioneers of the energy transition and have already defined their own objectives and standards in the past. ‘Guidelines on economic construction’ were developed in Frankfurt am Main, for example.

The greater share of construction activities in the local government stock is accounted for by the refurbishment of the local governments’ own portfolio. Setting a standard for existing buildings is therefore a particular lever. Without political pressure, both in new construction and in refurbishment, it is to be feared that only those local governments that already deal with the issue or have a sound financial situation will continue to set a good example.

2.2 Cost-effective approaches to energy-efficient refurbishments and trigger points

The following summary table presents an overview of all the instruments discussed in the following chapters and describes their impact in terms of their particular refurbishment impetus. The presentation shows that the various instruments at federal level address and interact with many issues. It also becomes clear that the instruments in the triad of support – demand – inform put the issues of long-term and strategic planning of the energy-efficient refurbishment of the national building stock into practice in a targeted manner.

Programme/initiative/project	Cost-effective concepts and trigger points	Policies and actions for cost-effective comprehensive energy-efficient refurbishments	Policies and actions for worst-performing buildings	Diverging incentives	Cases of market failure	Reduction of energy poverty	Policies and actions for public buildings	Incentives for the use of smart technologies	Initial and continuing training of experts	Wider benefits of refurbishment	Measures to support the mobilisation of investment
Tax support for energy-efficient refurbishment measures in	✓	✓	✓		✓			✓		✓	✓
CO_2 building refurbishment programme	✓	✓	✓	✓	✓		✓	✓		✓	✓
Market incentive programme to support renewable energy measures in the heating market (MAP)	✓	✓	✓	✓	✓		✓	✓			✓
Energy Efficiency Incentive Programme (APEE)	✓	✓			✓			✓			✓
Support programme for heating optimisation (HZO)	✓	✓	✓		✓		✓	✓			✓
Support strategy on energy efficiency and renewable heating	✓	✓	✓		✓		✓				✓
Energy-efficient urban redevelopment	✓	✓	✓		✓		✓	✓			✓
Meeting user requirements and effective interaction with the building: Social city			✓		✓						✓
National Climate Initiative (NCI)			✓			✓	✓				✓

Programme/initiative/project	Cost-effective concepts and trigger points	Policies and actions for cost-effective comprehensive energy-efficient refurbishments	Policies and actions for worst-performing buildings	Diverging incentives	Cases of market failure	Reduction of energy poverty	Policies and actions for public buildings	Incentives for the use of smart technologies	Initial and continuing training of experts	Wider benefits of refurbishment	Measures to support the mobilisation of investment
7th Energy Research Programme (ERP)								✓			✓
Energy transition construction programme								✓			
Future of Construction innovation programme								✓			✓
Support programme for Heating Network Systems 4.0	✓						✓	✓			✓
Federal funding for the Smart Meters pilot programme	✓				✓			✓			✓
Serial renovation	✓				✓	✓	✓	✓	✓		✓
Energy Efficiency Networks Initiative							✓				✓
EnEV		✓	✓		✓						✓
Right of tenancy				✓	✓						
Ordinance on Small and Medium-Sized Combustion Plants (1st Federal Emission Control Ordinance (1. BImSchV))			✓		✓						
Instruments and measures for inefficient buildings: National efficiency label for old heating systems			✓		✓					✓	✓

Programme/initiative/project	Cost-effective concepts and trigger points	Policies and actions for cost-effective comprehensive energy-efficient refurbishments	Policies and actions for worst-performing buildings	Diverging incentives	Cases of market failure	Reduction of energy poverty	Policies and actions for public buildings	Incentives for the use of smart technologies	Initial and continuing training of experts	Wider benefits of refurbishment	Measures to support the mobilisation of investment
One-stop shop and guide to energy efficiency support		✓			✓						✓
The 'Germany Does It Efficiently' campaign	✓	✓			✓						✓
The 'House Turnaround' campaign	✓	✓			✓						
Instruments and measures for inefficient buildings: Energy certification			✓		✓		✓				✓
Advice on energy-saving contracting	✓	✓	✓		✓						✓
Energy consultancy services for non-residential buildings of local authorities and non-profit organisations (EBK)	✓	✓	✓		✓		✓	✓	✓	✓	✓
Energy advice in small and medium-sized businesses	✓	✓			✓			✓	✓	✓	✓
Energy advice for residential buildings (on-site advice, building renovation passport)	✓	✓	✓		✓			✓	✓	✓	✓
Energy advice from consumer centres	✓	✓	✓		✓	✓		✓		✓	✓
Inspection tool for air-conditioning and ventilation systems	✓	✓	✓		✓		✓	✓		✓	✓

Programme/initiative/project	Cost-effective concepts and trigger points	Policies and actions for cost-effective comprehensive energy-efficient refurbishments	Policies and actions for worst-performing buildings	Diverging incentives	Cases of market failure	Reduction of energy poverty	Policies and actions for public buildings	Incentives for the use of smart technologies	Initial and continuing training of experts	Wider benefits of refurbishment	Measures to support the mobilisation of investment
Specialised portal for energy-efficient construction and refurbishment.					✓		✓		✓	✓	✓
Qualifications of energy consultants					✓		✓		✓		✓
Quality assurance in the funded energy advice									✓	✓	
Quality assurance of training									✓		
Qualification testing for energy consultants									✓	✓	
Inter-company vocational training in skilled trades									✓		
Continuing training to become master craftsperson									✓		
SME Initiative Energy Transition and Climate Protection – Support of Energy Scouts					✓				✓		
Assistance for energy advice in the local authority non-residential buildings area					✓		✓				

2.2.1 Climate zones

Because of the almost uniform climate in Germany, different approaches to energy-efficient refurbishment measures are dispensed with in relation to climate considerations. The approaches set out below apply irrespective of the location of the buildings.

2.2.2 Triggers for cost-effective refurbishment

The existing regulatory framework enshrines various trigger points that are targeted to implement cost-effective refurbishment measures.

Under Section 9 of the EnEV, the **replacement or first-time installation of exterior building units** in the area of residential and non-residential buildings must comply with the maximum values of the heat transfer coefficients (U-values) set out in Annex 3 to the EnEV, provided that the surface area of the modified building unit exceeds 10% of the total surface area of the building.

Under Section 9 of the EnEV, in the case of **complete refurbishments or where several individual measures are carried out**, the entire proof of the building unit may be based on the reference building procedure as an alternative to proof of the building unit. The limit values for primary energy demand and heat loss through the building envelope of the refurbished building are no more than 140% of the limit values for new construction.

Under Section 10 of the EnEV, **boilers** fired by liquid or gaseous fuels may no longer be operated after a period of 30 years. The obligation to replace does not apply to low-temperature boilers and condensing boilers. In the case of owner-occupied residential buildings with no more than two dwellings, the obligation to replace has to be fulfilled only in the event of a change of ownership (see trigger point of change of ownership).

Under Section 10 of the EnEV, in the case of residential buildings with no more than two dwellings, the following retrofitting obligations must be met in the event of a **change of ownership**: 1) Boilers fired by liquid or gaseous fuels must no longer be operated after a period of 30 years. 2) Previously uninsulated, accessible heat distribution and hot water pipes of heating systems and their fittings not located in heated rooms must be insulated in accordance with the requirements set out in Annex 5 to the EnEV. 3) Insulation of previously uninsulated accessible ceilings of heated spaces to the unheated roof space so that the heat transfer coefficient of the top storey ceiling does not exceed 0.24 W/(m²K).

Table 12 presents an overview of the trigger points and the related requirements.

Table 12 Overview Trigger points and requirements cost-effectiveness of the measure

Trigger points	Residential buildings and zones of non-residential buildings with internal temperatures of at least 19 °C	Owner-occupied residential buildings with no more than two housing units after change of ownership	Zones of non-residential buildings with internal temperatures from 12 °C to below 19 °C
Replacement/first installation of building units	Exterior walls: U_{max} = 0.24 W/(m²K) Windows: U_{max} = 1.3 W/(m²K) Roof surfaces: U_{max} = 0.24 W/(m²K) Basement ceiling: U_{max} = 0.30 W/(m²K)	Exterior walls: U_{max} = 0.24 W/(m²K) Windows: U_{max} = 1.3 W/(m²K) Roof surfaces: U_{max} = 0.24 W/(m²K) Basement ceiling: U_{max} = 0.30 W/(m²K)	Exterior walls: U_{max} = 0.35 W/(m²K) Windows: U_{max} = 1.9 W/(m²K) Roof surfaces: U_{max} = 0.35 W/(m²K)
At the appropriate time	Replacement of boilers over 30 years old		Replacement of boilers over 30 years old
Change of ownership		Replacement of boilers over 30 years old Insulation of heat distribution and hot water pipes Insulation of top floor ceiling	
Complete renovation	Requirements for new construction x 1.87	Requirements for new construction x 1.87	Requirements for new construction x 1.87

2.3 Policies and actions for cost-effective comprehensive energy-efficient refurbishments

2.3.1 Support programmes and initiatives at federal level

The following chapter presents federal support programmes and initiatives to encourage the necessary energy-efficient refurbishment measures in the buildings sector. This includes the provision of advisory services for all energy consumers (private households, small and medium-sized enterprises, local authorities and non-profit organisations) in advance of energy-efficiency measures to ensure that buildings are renovated efficiently and in accordance with objectives. The purpose of quality assurance measures and the random sample review of supported projects is to ensure high quality in the implementation of the structural and system-based refurbishment measures. Furthermore, the involvement of highly qualified and experienced experts in the application, planning and implementation processes minimises the risk of misuse of support and technical errors in planning and implementation. This is particularly important for the acceptance of energy refurbishment measures among future potential customers for support.

2.3.2 Investment support

2.3.2.1 Tax support for energy-efficient refurbishment measures in owner-occupied residential property

A key measure in the buildings sector is the tax support for energy renovation of buildings, which was introduced on 1 January 2020 as an attractive support instrument to supplement existing support schemes as a further pillar of support. Tax support can be used as an alternative to the existing loan and grant schemes for investment in the buildings sector. Support is given to individual measures on owner-occupied housing, which are also considered eligible under the existing buildings support programmes. This includes, in particular, the replacement of heating, but also, for example, the installation of new windows or the insulation of roofs and exterior walls. Support is also provided for the possibility of comprehensive renovation, if necessary on a step-by-step basis, through several individual measures. Eligible costs are 20% of the investment costs and of the costs of issuing the certificate to be submitted to the tax office in order to grant the tax relief, and 50% of the costs of an energy consultant charged with energy planning and supervision of the eligible measures. The support is provided through a deduction from tax liability spread over 3 years, for example in the replacement of old windows with modern thermally insulated windows. As a result of the non-progressive design of the support through deductibility from tax, as many owners of residential buildings as possible can benefit from the measure.

2.3.2.2 CO_2 building refurbishment programme

The CO_2 building refurbishment programme has been in place since 2006 and includes both systemic and entry-level support (individual measures) for energy-efficient refurbishment of existing residential buildings and energy-efficient new buildings. It consists of the KfW support programmes 'Energy-Efficient Construction' (Programme No 153) and 'Energy-Efficient Refurbishment' (Programme Nos 151, 152, 430) for private individuals, housing companies, housing cooperatives, developers and owners of residential homes. In addition, the 'Energy-Efficient Refurbishment – Monitoring of Construction' programme (No 431) supports the monitoring of energy-efficient refurbishment measures.

There are also two energy-efficient refurbishment programmes for local municipality buildings and buildings used for social purposes: 'IKK/IKU – Energy-Efficient Urban Regeneration – Energy-Efficient Refurbishment' (Nos 217, 218, 219, 220). The CO_2 building refurbishment programme consequently plays a key role in making homes and buildings more energy-efficient, far beyond the statutory requirements. There has also been an energy efficiency support programme for commercial buildings since 2015 (Nos 276, 277, 278).

The investment support programmes mentioned above are therefore targeted at private house/apartment owners and housing owners' associations, housing companies and housing cooperatives, developers and businesses (e.g. in contracting), private and local authority companies, as well as local authorities and non-profit organisations. Support is provided under the programmes through low-interest loans, partly in conjunction with repayment grants (Nos 151, 152, 153 for private individuals, etc.; Nos 217, 218, 219, 220 for local governments, municipal enterprises and non-profit organisations; No 276, 277, 278 for private companies), or direct grants (No 430, 431). Depending on the programme, up to a maximum of EUR 50 000 (individual measures) or EUR 120 000 (systemic refurbishments) up to 100% of the investment costs are eligible. The programmes have been allocated at least EUR 2 billion a year since 2015.

As part of the systemic support, energy-efficient and comprehensive refurbishments of existing buildings to create what are known as efficiency houses are supported. The requirements of the 2009 Energy Savings Ordinance for primary energy demand (QP) and the quality of the building envelope (transmission heat loss H'T) of the reference building are the benchmark against which the

amount of support is measured in the form of repayment grants in conjunction with low-interest loans or in the form of pure grants. The lower the primary energy demand and the better the quality of the building envelope, the higher the efficiency house level and therefore the support. The table below presents an overview of the individual efficiency house levels and support rates. The figures for the individual levels of efficiency class refer to the proportion of the primary energy demand of buildings in this class compared to the primary energy demand of an EnEV 2009 reference building.

Table 13: Support conditions for efficiency houses (residential buildings) since January 2020

Efficiency house[1)]	EH 55	EH 70	EH 85	EH 100	EH 115	EH Scheduled monument
Repayment grant (loan variant) [1)]	40% (max. EUR 48 000 per HU)	35% (max. EUR 42 000 per HU)	30% (max. EUR 36 000 per HU)	27.5% (max. EUR 33 000 per HU)	25% (max. EUR 30 000 per HU)	25% (max. EUR 30 000 per HU)
Grant (grant variant) [1)]	40% (max. EUR 48 000 per HU)	35% (max. EUR 42 000 per HU)	30% (max. EUR 36 000 per HU)	27.5% (max. EUR 33 000 per HU)	25% (max. EUR 30 000 per HU)	25% (max. EUR 30 000 per HU)

[1)] Efficiency House (EH) is an energy standard for residential buildings based on an EnEV reference building. The number after the abbreviation 'EH' describes the relative primary energy demand of an efficiency house level compared to the EnEV reference building. For example, an EH 55 may require only 55% of primary energy compared to an EnEV reference building.

[2)] Eligible investment costs max. EUR 120 000 per housing unit (HU)

The individual measures supported under KfW programmes Nos 152 and 430 are intended to encourage home owners to implement individual refurbishment measures of the highest energy quality possible. In the conditions for support, KfW has defined refurbishment measures and minimum technical requirements that need to be implemented in order to be able to benefit from repayment grants in conjunction with low-interest loans or pure grants, as is the case with systemic support. Since January 2020, all individual measures have received uniform funding of 20% of the costs in both the grant and loan variants. Support for heating replacement has been provided since 1 January 2020 in the market incentive programme for renewable energy (MAP) (see 2.3.2.3), where a new support scheme for hybrid gas heating has been introduced in particular. Here too, at least 20% of the costs are supported, while more demanding heating solutions based on renewable energy receive 35% but also significantly higher support rates. The oil heating replacement premium (ten percentage point increase in support rates) is also implemented here.

Table 14: Conditions for support of individual measures (residential buildings) since January 2020

Measures	Individual measures
Repayment grant (loan variant)	20% (maximum eligible investment costs of EUR 50 000 per HU)
Grant (grant variant)	20% (max. EUR 10 000 per HU)

In the **non-residential commercial, municipal and non-profit buildings sector**, the KfW energy efficiency programme 'Energy-efficient construction and refurbishment – non-residential buildings' has, since 2015, been subject to a system of support equivalent to the residential sector, with differentiated levels depending on the building efficiency assessed. The contents of the system and the way it functions are designed in the same way as the residential building programme, but commercial, local government and non-profit non-residential buildings can only benefit from loan support (not grants).

In contrast to 'efficiency houses' in the case of residential buildings, non-residential buildings are referred to as 'efficiency buildings' in terms of KfW support.

Table 15: Conditions of support for efficiency house (non-residential building) since January 2020

Efficiency building	EG 70	EG 100	EG historic building
Repayment grant (loan variant)	27.5%	20%	17.5%
Grant (grant variant)	max. EUR 275 per m² of useful floor area	max. EUR 200 per m² of useful floor area	max. EUR 175 per m² of useful floor area

Table 16: Conditions for support of individual measures (non-residential buildings) since January 2020

Measures	Individual measures
Repayment grant (loan variant)	20% (max. EUR 200 per m² of useable floor area)

The following instruments are included in the investment support programmes for quality assurance:

- **Planning and monitoring by qualified experts** includes the mandatory involvement of energy efficiency experts (www.energie-effizienz-experten.de) from the planning stage up to the implementation of the project. They have relevant experience and expertise. Practical experience and continuing training must be demonstrated on a regular basis. The verification of the supporting documents submitted at the time of the application and after the implementation of the project, in particular the calculation of the supported efficiency house level, ensures the quality and eligibility of the projects.
- **Sample checks are carried out on supported** objects to ensure that the supporting documents submitted correspond to the actual state of implementation. (Assessment of building systems, insulating materials, material thickness, etc.)

KfW's quality assurance for **non-residential buildings** is **analogous** to the requirements in the **residential building segment**. The sample checks carried out by KfW and the mandatory involvement of qualified experts have led to an increase in the quality of the applications for support.

Under the 'Energy-Efficient Refurbishment' part of the programme (residential buildings), in 2019 **more than 145 000 support commitments** were granted for **measures taken on around 280 000 dwellings** in 2019. The reduction in greenhouse gas emissions with the refurbishment measures supported in that year amounted to **around 500 000 tonnes of CO_2 equivalents**. The total investment costs of the energy-saving modernisation measures from the KfW application data were used to determine the **employment effects**. These investments, amounting to around EUR 11 billion (including VAT), produced employment effects amounting to 116 000 secured jobs.

In the 'non-residential' segment (municipal/social and commercial buildings), GHG savings amounting to approximately **145 000 tonnes of CO_2 equivalents** were achieved in 2019.

2.3.2.3 Market incentive programme to support renewable energy measures in the heating market (MAP)

The aim of the market incentive programme for renewable energy (MAP) is to increase the share of renewable energy in the heating sector. In addition to the CO_2 building renovation programme, this support programme specifically supports investments in various heat generators based on renewable energy sources. The MAP is implemented as a Federal Ministry for Economic Affairs and Energy (BMWi) programme in the field of grant support by the Federal Office for Economic Affairs and Export Control (BAFA) and in the field of loan support by KfW.

An amended Directive for the 'renewable energy heaters' part of the MAP implemented by BAFA, which includes an extension of the existing support schemes, entered into force on 1 January 2020. The support covers the technologies of solar thermal energy, biomass and efficient heat pumps, as well as the visualisation of renewable energy yields. New hybrid gas systems combining several heat generators and using renewable heat have also been newly added, even if the renewable heat generator is retrofitted within two years of the installation of the gas-based heating. In addition, the replacement of oil heating by a biomass, heat pump or hybrid installation is granted an additional premium of 10 percentage points on the support rate otherwise granted to the installation to be installed, because of the particularly positive climate effect.

In the BAFA part of the MAP, applications may be submitted by private individuals, housing owners' associations, municipalities, regional administrative bodies, associations of local authorities and non-profit organisations, but also by businesses, freelancers or cooperatives. The following conditions for support generally apply equally to residential and non-residential buildings:

Overview of support: Heating with renewable energy 2020

Nature of the heating installation	Building stock		New buildings
	Rate of support [1]	Rate of support with oil heating replacement premium [1]	Rate of support [1]
Biomass installation or heat pump installation	35%	45%	35%

Solar collector installation [2]		30%		30%
Renewable energy hybrid heating (RE hybrid) [3]		35%	45%	35%
Gas hybrid heating	With renewable heat generation	30% [5]	40% [5]	
	With later integration of renewable heat generation (renewable ready) [4]	20% [6]		

The provisions of the Guidelines of 31 December 2019 apply. The application must be made before the action starts to be taken.

With effect from 2 January 2020, applications may be made only on the electronic application form.

[1] The rates of support relate to the eligible costs of the action applied for.
[2] As a solar collector installation can never bear the entire heating burden of a building, no replacement premium is granted here.
[3] Combination of a biomass, heat pump and/or solar collector installation
[4] Renewable ready: A condensing boiler is installed with storage and control and regulation technology for later integration of a renewable heat generator
[5] Applies to the whole eligible installation, including renewable heat generators.
[6] Applies to the whole eligible installation, without the renewable heat generator to be installed later.

The level of support is to be calculated as a percentage of the eligible costs actually incurred for the replacement or extension of the heating system. The costs of the necessary environmental measures to install the new installation are also to be taken into account. The level of support is limited by a cap on chargeable eligible costs of a maximum of EUR 50 000 (gross) per housing unit for residential buildings and a maximum of EUR 3.5 million (gross) for non-residential buildings.

Under the name ‘Renewable Energy – Premium’ (Programme Nos 271/281 and 272/282), the KfW part of the MAP supports large-scale heat production plants with low-interest KfW loans, supplemented by repayment grants from the federal budget. Support can be requested for large biomass plants, deep geothermal plants, large efficient heat pumps, local heating networks, large solar collector installations in support of innovation, large heat storage facilities in support of innovation and biogas pipelines for untreated biogas in support of innovation. Minimum technical requirements are defined for each technology, which can be found in the support guidelines. The application must be submitted before the measures start being taken. For quality assurance, proof of use must be provided and random checks are also carried out.

The overall evaluation of the MAP for the support period 2015 to 2018 is based on the evaluation report of November 2019. A total of 49 341 installations received support in 2018. In the BAFA part, it was not possible for expansion, which was established in 2016 and 2017, to continue at the same level. In terms of technology, for the first time heat pumps represented the technology segment with the highest number of supported installations (38.4%). In the KfW part, the number of supported

installations remained broadly stable compared to 2017 (+ 0.8%). Support continued to focus on heating networks and biomass plants, including renewable heat storage.

The MAP supported a total capacity of 792 MW in 2018. Of these, the BAFA part accounted for just under 713 MW (90%) and the KfW part for about 79 MW (10%). The following table presents an overview of the identified final energy and useful energy volumes that were supported under the combined MAP (BAFA and KfW) in 2018. Altogether, the programme supported installations with annual quantities of energy of around 1 200 GWh (see Table 17).

Table 17 Energy provision MAP total

Energy sources/technology	Final energy in GWh/a	Useful energy in GWh/a
Biomass, total	797	613
Total solar thermal energy	53	53
Total heat pump	209	273
Total deep geothermal	23	20
Heating networks development of biogas cogeneration plants, total	107	107
MAP, total	1 188	1 065

The level of support for installations supported in 2018 was EUR 215 million. A total of EUR 901.2 million of investment was triggered by the MAP support. Total investment fell by around 19% compared to the previous year and the share of support fell by just under 15%.

Altogether, just under 303 000 tonnes of CO_2e emissions were avoided in 2018. Biomass accounts for by far the largest share in both programme pillars: around 86% in the BAFA part, followed by heat pumps and solar thermal energy at around 8% and 6% respectively. In the KfW part, biomass plants dominate with around 59%, followed by thermal heating networks/cogeneration plants with 31% and deep geothermal energy with 9%. Solar thermal energy and heat pumps do not play a significant role in this programme focused on large installations (see Table 18).

Table 18: Avoided CO_2e emissions of MAP-supported installations in 2018

	Energy source	Avoided CO_2e emissions in tonnes per year
BAFA	Biomass	203 525
	Solar thermal	13 482
	Heat pump	18 433
	Total	235 440
KfW	Biomass	39 821
	Solar thermal	480
	Deep geothermal	6 072
	Heating networks for the development of biogas cogeneration plants	21 224
	Heat pumps	21
	Total	67 619

Overall, the number of installations supported in the MAP in 2018 decreases from 2016 by almost 21%, and the negative effects on energy provision (also down 21%) and avoided CO2e emissions (down 23%) turn out similarly. (See Table 19).

Table 19: Overall results of the MAP from the 2018 evaluation

	MAP (total)
Number of installations	62 100
Installed capacity in MW	1 021.1
Energy provision (final energy) in GWh	1 498.8
Investments in EUR million	1 108.3
Support in EUR million	252.7
Avoided CO_2e emissions in tonnes per year	394 795

2.3.2.4 Energy Efficiency Incentive Programme (APEE)

As part of the amendment of the guidelines on support for renewable energy measures in the heating market, the Energy Efficiency Incentive Programme (APEE) in relation to the KfW programme line 'Energy-Efficient Renovation' (see comments on the CO_2 building renovation programme) and the BAFA part of the MAP expired at the end of 2019. In the KfW sub-programme 'Energy-Efficient Renovation – Investment Grant' (No 430), the APEE had financed a 'heating and ventilation package',

which specifically supported the renewal of inefficient heating systems and the installation of ventilation systems in conjunction with environmental measures through investment grants of 15%. Under the BAFA 'Heating with Renewable Energy' programme, an additional grant of 20% and a premium of a maximum of EUR 600 were granted from the additional bonus 'Heating Package', financed by the APEE, in order to support the installation of particularly efficient heating systems and measures to optimise the entire heating system (including radiators and piping). As a result of the switch of the support scheme to proportional financing of plant and associated costs in the BAFA part of the MAP and the increase in the repayment and investment grants for individual measures in 'Energy-Efficient Renovation', the APEE had become obsolete for these programmes.

The APEE will continue to finance the programme 'Energy-Efficient Construction and Renovation – Fuel Cell Grant' (No 433) implemented by KfW, which awards grants for innovative heating systems based on fuel cell technology, depending on the electrical output of the installed system. The level of the grant is up to EUR 28 200.

2.3.2.5 Support programme for heating optimisation (HZO)

The replacement of heating pumps and hot water circulation pumps by high-efficiency pumps and hydraulic balancing of the heating system have been supported since 1 August 2016. It is based on the guidelines on the support of heating optimisation through high-efficiency pumps and hydraulic balancing.

The purpose of the support is to replace inefficient heating and hot water circulation pumps. In addition, further optimisation measures on the heating system are supported. (Hydraulic balancing, thermostatic valves, optimisation of distribution and transfer, or measurement, control and regulation technology, MCR).

Applications may be submitted by private individuals, companies (provided that the conditions for *de minimis* aid are met), freelancers, municipalities, regional administrative bodies and associations of local authorities or other legal entities governed by private law (in particular associations, foundations, non-profit organisations or cooperatives).

The support is up to 30% of the net investment costs for services related both to the replacement of heating and hot water circulation pumps with high-efficiency pumps and to hydraulic balancing, however with a maximum of EUR 25 000. The measure must be carried out in an existing building or on an existing heating system (measures in new buildings are not eligible). Each eligible measure may be applied for once only per heating system. It is appropriate to combine measures, implement them together and apply for them once.

2.3.2.6 Support programme for Heating Network Systems 4.0

With the federal support for efficient heating networks (Heating Network Systems 4.0), systematic support has been introduced since 1 July 2017 in the area of heating infrastructure, supporting not only individual technologies and components, but complete systems. The heating networks to be supported are characterised by high proportions of renewable energy, efficient use of waste heat and significantly lower temperature levels than conventional heating networks.

The programme consists of several modules, covering both the planning phase and the investment phase. Feasibility studies covering up to 60% of the eligible costs (module I) and, in a second step, the implementation of a Heating Network System 4.0 covering up to 50% of the eligible project costs (module II) are supported. The level of support is up to EUR 600 000 for feasibility studies and up to EUR 15 million for the realisation of a Heating Network System 4.0.

In addition, customer information measures may also be supported in the area of the planned heating network system 4.0 to increase the connection rate to a pilot project, as well as project-

related scientific cooperation with universities, research and scientific institutions to support, plan, implement and optimise.

Applications may be submitted by undertakings, municipal enterprises, special-purpose local authority associations, registered associations and registered cooperatives and consortia if they are managed and represented by an authorised applicant from the above-mentioned groups. Contractors who carry out the projects referred to in this support notification under a contract with the authorised applicant mentioned above are also entitled to apply.

An additional scheme for the modernisation of existing heating networks is being planned. The new guidelines are due to enter into force at the beginning of 2021.

2.3.2.7 Energy-efficient urban redevelopment

The KfW programme for Energy-Efficient Urban Redevelopment supports the creation of integrated concepts for energy-efficient neighbourhood redevelopment and the initiation of renovation management with grants. Refurbishment management also monitors the implementation of the measures previously developed in the concepts. It will in future be supported for a period of generally three years, with an option to extend it to five years. In addition, energy-efficient supply of neighbourhoods (supply of heating and, in future, cooling, water and sanitation) will be supported with low-interest loans and, in future, grant repayment support (see section 2.5.5).

2.3.3 Support of energy advisory services

Energy advice is an essential tool in attaining the Federal Government's energy and climate protection objectives in the areas of buildings, industry and commerce.

Advice and information are at the strategically important interface with the consumer. At first sight and without relevant knowledge, it is often impossible for energy consumers, whether citizens, businesses, local authority stakeholders or non-profit organisations, to see what specific efficiency and savings potential there is in their households, businesses or buildings, what costs are associated with implementation and how these costs can be financed or supported. Energy advice offers support where recipients' own expertise is insufficient. At the same time, energy advisory services reinforce energy consumers' own ability to make decisions and help in avoiding wrong investments.

Expert energy advice is therefore of key importance in the energy efficiency chain. It is often a trigger for more ambitious efficiency measures, thus contributing significantly to achieving energy savings.

In recent years, the Federal Ministry for Economic Affairs and Energy has put in place several support programmes for high-quality energy advice. Advice covers the range from entry-level advice to in-depth advice, from power saving to renovation of buildings and restructuring of processes in companies. Trust in the expertise of the consultant and the trustworthiness of the recommendations are crucial to the acceptance and success of energy advice.

In order to safeguard the quality of the energy advice, minimum requirements are laid down for the content of the advisory reports. Compliance with these minimum requirements is verified by the administrative body (Federal Office for Economic Affairs and Export Control – BAFA) by making random sample checks.

2.3.3.1 Energy advice from consumer centres

Energy advice from the consumer centres (federation and the federal states) provides consumers with a first point of contact through a wide range of communications, from telephone advice to online advice and in-person advice at a single point of contact or advice in the owner's own building. There are more than 120 000 consultations per year. The provision of advice, in some cases free of charge (in particular for low-income households) and low-threshold, is essential to bring all sections

of the population into energy efficiency measures and thus makes a significant contribution to attaining the Federal Government's energy and climate policy objectives (see section 2.4.4.1).

2.3.3.2 Energy advice for residential buildings (on-site advice, building renovation passport)

The 'energy advice for residential buildings (on-site advice, building renovation passport)' addresses around 15.6 million single and two-family houses and around 3.1 million apartment multiple-family houses. Energy advice identifying options for energy-efficient refurbishment is eligible for support. To this end, a qualified energy consultant (Section 21 of the EnEV and mandatory further training) must prepare an energy advisory report, e.g. in the form of a building renovation passport showing the complete or step-by-step refurbishment with coordinated individual measures.

The Federal Ministry for Economic Affairs and Energy will meet 80% of the cost of the advice, up to a maximum of EUR 1 300 for advice concerning single and two-family houses and EUR 1 700 for advice on residential buildings with three or more housing units. As the coordination processes in housing owners' associations are more complex than in the case of an individual owner, the presentation of the refurbishment roadmap at a meeting of the housing owners' association can also be supported with a single payment of an additional EUR 500. The aim is to make decision-making process for energy-efficient refurbishment in a housing owners' association more transparent.

In order to present the complexity of a refurbishment roadmap in a simplified manner to the recipient of the advice, the individual building renovation passport (iSFP) was developed in 2017. This refurbishment roadmap applies to the residential building owner concerned.

The iSFP methodology standardises and gives a clear structure to the advisory reports. The initial energy-efficiency situation of the building is assessed on a component-by-component basis and provides the building owner with a clear overview of the parts of the building suitable for refurbishment. In setting out the renovation strategy, account is taken of individual needs, for example

- the real estate situation (location, sustainability of the building);
- The life situation of the owners (financial capacity, family situation);
- possible linking in time of repair and modernisation measures with efficiency measures; and
- individual interests and preferences of the owner, for example in terms of comfort and convenience.

In addition to a clear presentation of the renovation steps, the costs associated with renovation are clearly presented and explained. A comprehensible presentation should give the owner a clear incentive to follow the refurbishment plan with practical implementation steps.

According to the evaluation of energy advice for residential buildings, an average of around EUR 31 000 (net) additional investment per advice is triggered. On average, final energy savings of around 8000 kWh per consultation case are achieved per consultation case. Measures implemented in 2018 saved around 18 400 tonnes of CO_2 equivalents.

2.3.3.3 Energy advice in small and medium-sized businesses

The programme 'Energy Consultancy for SMEs' (EBM) targets small and medium-sized enterprises (SMEs), is equivalent to a high-quality energy audit and implements the requirements of the Energy Efficiency Directive (EED 2018). Applications may be submitted by SMEs in the commercial and other services sectors and by members of the liberal professions registered and operating in Germany, which employ fewer than 250 persons and have annual turnover not exceeding EUR 50 million or an annual balance sheet total not exceeding EUR 43 million. The points of departure for energy advice are buildings and installations, as well as user behaviour; the proposed measures should be cost-effective. If the use of renewable energy appears to be suitable, this should be highlighted in

particular and, where appropriate, a corresponding concept should be developed; this also applies to the use of waste heat.

For companies with annual energy costs above EUR 10 000, the grant is 80% of the eligible consultancy costs up to a maximum of EUR 6 000. For companies with maximum annual energy costs of EUR 10 000, the grant will be 80% of the eligible consultancy costs up to a maximum of EUR 1 200.

Around 3 500 energy consultations are carried out each year. As a result of the energy advice, companies on average save around 14% of energy, i.e. around 120 MWh per year. EUR 8.05 of investment was triggered per euro of support used. In total, the EBM programme contributes 502 GWh per year to the savings target.

2.3.3.4 Energy consultancy services for non-residential buildings of local authorities and non-profit organisations (EBK)

The 'Energy Consultancy for Non-residential Buildings of Local Authorities and Non-profit Organisations' (EBK) support guidelines, which entered into force in 2016, support the development of a refurbishment roadmap for the energy-efficient refurbishment of a non-residential building in the public sector. Energy advice on the preparation of an energy-efficient renovation plan for non-residential buildings is supported, either in the form of a refurbishment roadmap or in the form of extensive renovation. New construction consultancy for non-residential buildings is also promoted in order to help municipalities implement the example-setting role of public bodies (nearly zero energy buildings).

The Federal Ministry for Economic Affairs and Energy will cover 80% of the consultancy costs (maximum EUR 15 000). A total of around 2 600 applications for support were submitted by local governments and non-profit organisations between 2016 and the end in 2019. There are savings of 360 GWh per year in each municipality that are attributable to the advice provided. In addition, EUR 31.19 of investment was triggered per EUR of support.

2.3.3.5 Advice on energy-saving contracting

In the support programmes 'Energy advice for non-residential buildings of municipalities and non-profit organisations' and 'Energy advice in small and medium-sized enterprises', the Federal Ministry for Economic Affairs and Energy also promotes a 'contracting check'. This optional advisory element examines whether the planning and accomplishment of higher energy efficiency by an external service provider can be useful. In addition, contractors are entitled to apply under most of the federal support programmes.

The project **Contracting: Build the Future!'** supported by the Federal Ministry for Economic Affairs and Energy is aimed at initiating and implementing high-quality energy-saving contracting projects in public properties. As lighthouse projects, they are communicated widely and are thus intended to set an example for other potential implementers. They are also intended to contribute to building knowledge on energy-saving contracting in the public sector and among regional actors. The pilot projects support public properties by project development free of charge over a period of three years.

2.3.4 Communication measures

Communication with relevant target groups plays an important role in the successful implementation of the energy transition in the buildings sector. This focuses on information on possible measures for energy-efficient construction and refurbishment in order to increase the motivation to become active; acceptance can also be increased at the same time. Communication on support measures is of particular importance in this context. The institutions directly active in this field, such as KfW or BAFA, offer a wide range of communication services through various channels (print, online,

consultancy, etc.), and the relevant ministries and other institutions also work intensively on communication of the energy transition and related support and advice services. By way of example, two campaigns have been launched to support the implementation of the energy transition in the buildings sector: the ongoing BMWi campaign ‘Germany Does It Efficiently’ and the ‘House Turnaround’ campaign run by BMWi, dena, and other partners.

2.3.4.1 The ‘Germany Does It Efficiently’ campaign

Since 2016, BMWi has been providing extensive information to citizens, businesses and municipalities through the 'Germany Does It Efficiently’ campaign. The aim is to raise awareness and motivate people to use electricity and heating consciously and sparingly and to avoid unnecessary energy use.

The core of the information campaign is the website www.machts-effizient.de. Interested parties can find appropriate information on the efficient use of electricity and heating in their homes. Support programmes and advisory services, from initial advice from consumer centres to offers of grants or loans for major investments in an energy-efficient building, are set out there and explained in an easily understandable way. The website also contains practical examples of energy renovation from all parts of Germany.

In addition to the website, brochures and flyers are also available, as is an energy efficiency telephone hotline.

In addition, ‘Germany Does It Efficiently’ is in direct dialogue with consumers, businesses, etc. at trade fairs and events. The information offensive also covers businesses and municipalities, including an overview of relevant support programmes.

2.3.4.2 The ‘House Turnaround’ campaign

In the energy-efficient refurbishment of single and two-family homes, private house owners have to deal with numerous, sometimes contradictory, pieces of information and many stakeholders. They often encounter restrictions when trying to identify the refurbishment measures that are relevant to them and to implement complex projects of high quality. The aim was therefore to provide them with information in one place, to pool existing service provision and to facilitate contact with skilled energy efficiency experts in the regions.

In order to achieve this, the Alliance for Energy Efficiency in Buildings (geea) launched the ‘House Turnaround’ campaign from 2013 to the end of 2016 together with dena. The campaign directed by dena was supported by BMWi and by companies and associations from all relevant areas of energy efficiency in buildings. Close cooperation with regional energy agencies also ensures strong regional endorsement. The key element of the campaign was the web portal www.die-hauswende.de, which provided interdisciplinary information and a list of regional energy efficiency experts. Local information events for owners were also implemented locally. In addition, several action days were organised under the slogan ‘Open Due to Refurbishment’, during which renovators opened their doors to interested visitors. In addition, as part of the campaign the nationwide storytelling competition, ‘Refurbishment Heroes’ was developed and implemented. The campaign was accompanied by intensive press work and advertising.

2.3.5 Programmes of the federal states

Because of the federal structure, the support programmes of the federal states must also be taken into account for Germany. Since there are a large number of building-specific support programmes in the 16 federal states, it should be pointed out as a first step that an overview of the federal states’ programmes can be found in the BMWi support database here: www.foerderdatenbank.de. As part

of the work on the updating of the LTRS, it is planned that a summary of the Federal States' programmes will be integrated into the LTRS, in consultation with the federal states.

2.4 Policies and actions for the worst-performing buildings and to reduce energy poverty

2.4.1 Worst-performing segments of the national building stock

Article 2a(1)(d) of the EPBD 2018 requires Member States to compile an overview of policies and actions to target the worst-performing segments of the national building stock and market failures.

2.4.1.1 Description of 'worst-performing segment'

In order to assess whether a building with a certain energy demand is a 'worst-performing building', the present LTRS uses the existing efficiency classes of energy performance certificates. The building is classified in an efficiency class from A+ to H according to energy demand (see Table 20).

In the present LTRS, buildings from a demand-oriented efficiency class G, i.e. above 200 kWh/m², are defined as worst-performing buildings. A better classification to describe the worst performing buildings will be examined as part of the work to update the LTRS.

Efficiency class	A+	A	B	C	D	E	F	G	H
Final energy in kWh/m²/a	< 30	< 50	< 75	< 100	< 130	< 160	< 200	< 250	≥ 250

Table 20: Efficiency classes of the Energy Conservation Ordinance EnEV 2014/2016; (Source: EnEV 2014)

A breakdown of energy needs between the efficiency classes has been determined for each building class (type of building and age class). These were extrapolated to Germany's total building stock using area data from the census and Microcensus.

Residential buildings

The floor area-weighted frequency distribution of the efficiency classes for single and two-family houses and apartment blocks as well as for the total stock is presented in Figure 5. In the total building stock, about 30% of residential floor area belongs to efficiency classes G and H. About 26% of the residential floor area has a final energy demand of less than 100 kWh/m²a and thus falls into efficiency classes A+ to C. The figure shows that efficiency classes G and H are significantly more common in the area of single-family houses than for apartment blocks. 40% of the residential floor area in single-family houses is in classes G and H. In the case of apartment blocks, only 16% is in classes G and H. It is interesting to note that the particularly good efficiency classes A+ occur more commonly in single-family houses than in apartment blocks.

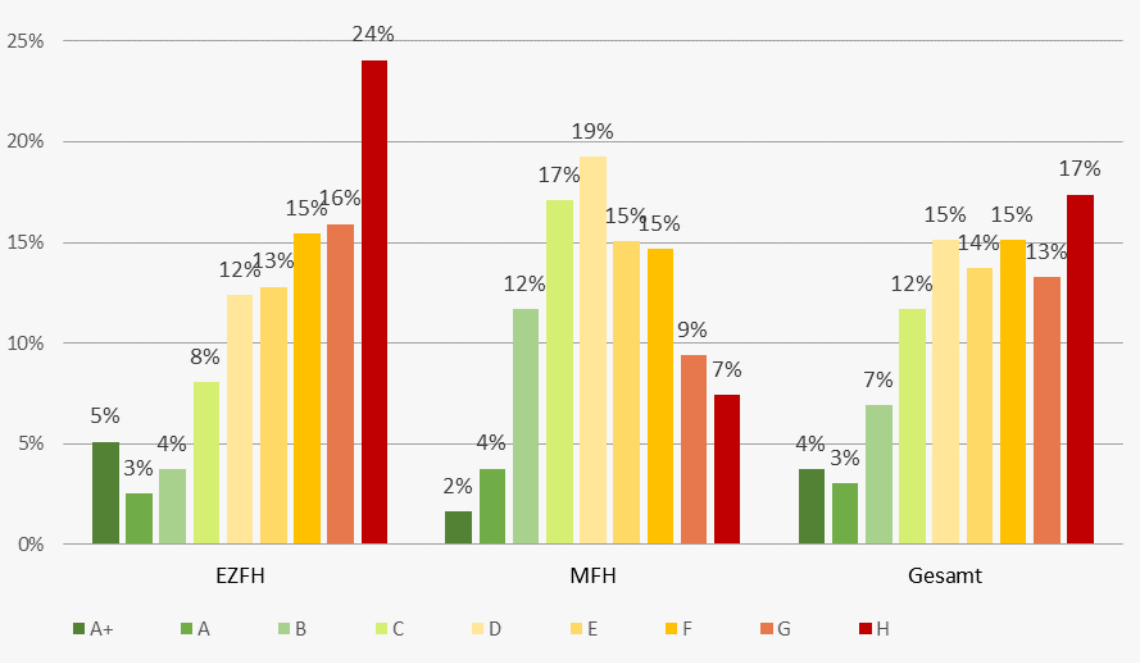

Figure 5: Frequency distribution of the efficiency classes according to the efficiency classes of the German housing stock; Source: dena/ifeu/prognos et al. 2019)

A detailed analysis of single and two-family houses by age class shows that almost all buildings (>98%) built after 2010 have a final energy demand of less than 100 kWh/m²a.

In the group of buildings constructed between 2001 and 2010, this is still the case for 65% of floor area. Efficiency classes D to F dominate in years of construction from 1979 to 1999. In the older age classes prior to the entry into force of the first Thermal Insulation Ordinance in 1978, more than 60% of all buildings are in efficiency classes G and H (see Figure 6).

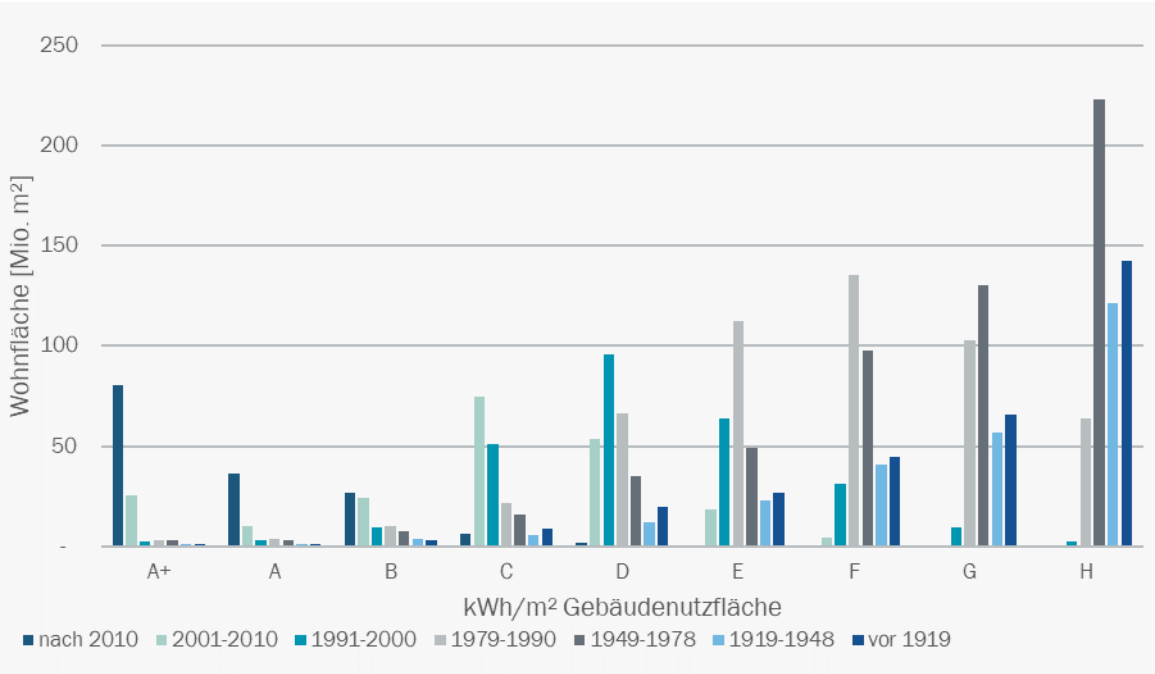

Figure 6: Principal energy sources in single and two-family houses; (Source: dena/ifeu/prognos et al. 2019)

Key:
Wohnfläche (Mio. m^2) = Residential floor area (million m^2)

kWh/m² Gebäudenutzfläche = kWh/m² building useable floor area
nach = after
vor = before

The picture for apartment blocks as expected is different. Here more than 98% of all buildings erected after 2010 and 79% of those erected between 2001 and 2010 have a final energy demand of less than 100 kWh/m²/a. Efficiency classes D to F are dominant in all classes of age of construction before 2000, with around 55 to 70%. However, in the age classes before 1978, only 10 to 15% are in the worst efficiency classes G and H (see Figure 7)

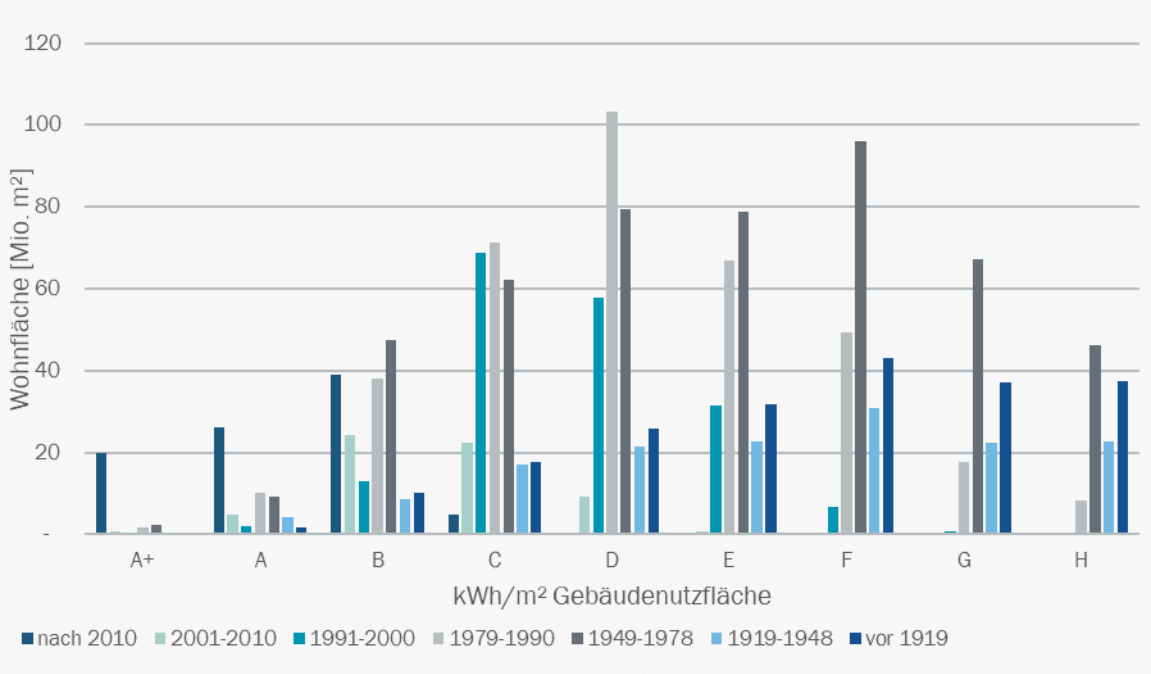

Figure 7: Principal energy sources in single and apartment blocks; (Source: dena/ifeu/prognos et al. 2019)

Key:
Wohnfläche (Mio. m² = Residential floor area (million m²)
kWh/m² Gebäudenutzfläche = kWh/m² building useful floor area
nach = after
vor = before

Non-residential buildings

The stock of non-residential buildings is far more heterogeneous than the stock of residential buildings, as energy consumption depends very strongly on the use and technical equipment of the building. The energy demand for non-residential buildings is therefore not an appropriate indicator for assessing the quality of the building. Owing to various difficulties, there is no division into efficiency classes.

The energy demand for heating of non-residential buildings is far more scattered than for residential buildings. 54% of heated non-residential buildings have a final energy demand of 200 kWh/m² or more. With total residential floor area of 1 732 million m² in 2018, this corresponds to around 935 million m² in terms of final energy demand. 18% of buildings even have an energy demand of more than 700 kWh/m² of energy. (See Figure 8)

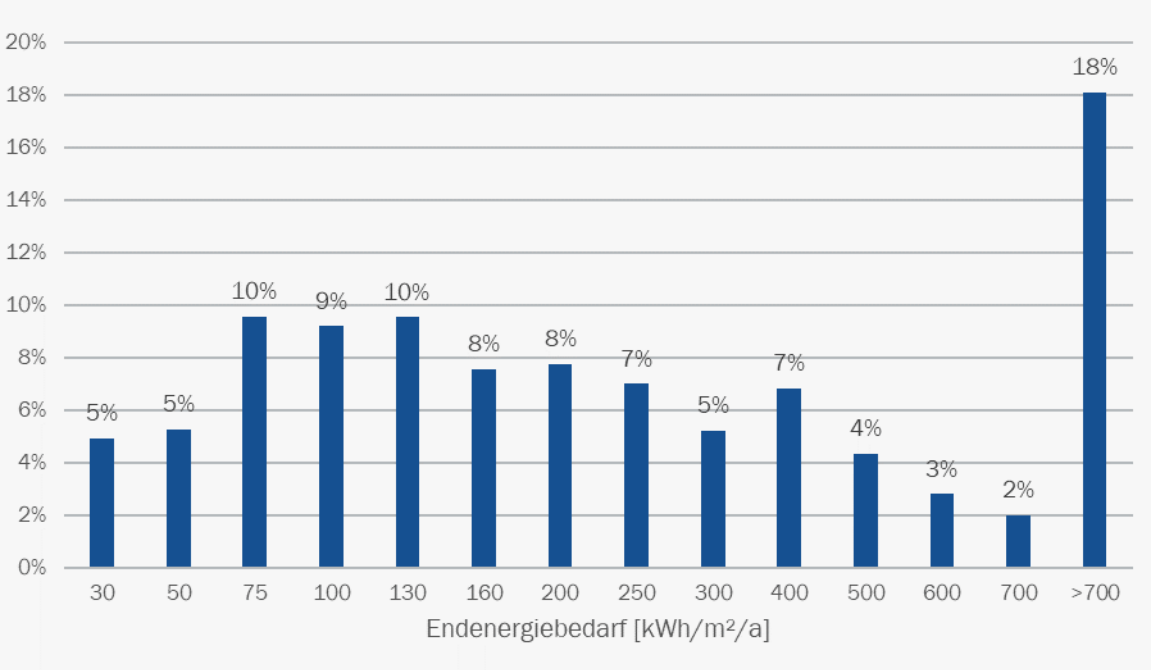

Figure 8: Final energy demand of the German non-residential building stock

Key:

Energiebedarf = energy need

2.4.1.2 Instruments and measures for inefficient buildings

There are a number of instruments that either specifically address building segments, often found in worst-performing buildings (WPBs), or highlight individual building characteristics with poor performance, such as (see Table 21):

- The retrofitting obligations in the EnEV require various refurbishment measures, sometimes independently of other triggers, such as insulation of the top storey ceiling or heating distribution pipes and replacement of older boilers. However, there are exceptions to these retrofitting obligations (e.g. timber joist ceiling).
- Some support schemes specifically target sub-segments of worst-performing buildings, such as support schemes for buildings with scheduled monument status.

Table 21: How policy instruments work for worst-performing buildings (ifeu)

Policy instruments that in the building stock...	
...specifically address WPBs	• KfW efficiency house building with scheduled monument status • EnEV retrofitting obligations • Ordinance to implement the Federal Emission Control Act (BImschV) • Heating system label
... work for all buildings but have a special incentive effect for WPBs	• KfW support for energy efficient construction and renovation • Optimisation of heating
...work for all buildings, but specifically address areas close to WPBs	• Social city • KfW Energetic Urban Renovation Programme
... work for all buildings	• EnEV requirements for certain changes • Energy performance certificate • Energy advice • NKI [National Climate Protection Initiative] Climate protection model projects • Research support

In the following, important building policy instruments are checked for their impact on worst-performing buildings.

In the area of investment support, the CO2 building renovation programme and the **KfW support for energy efficient construction and renovation** based on it are targeted at all buildings and is therefore also aimed at those with poor management. The KfW programme supports the refurbishment of residential and non-residential buildings to a high level of efficiency. Support is given to individual measures with strict requirements and refurbishments on the basis of efficiency-house standard. The support is not differentiated according to the baseline status and thus does not take account of WPBs separately, but rather differentiates the level of support according to the final energy status (efficiency house level) or technical minimum standard (individual measures support), as the differential costs for better efficiency status in the target are higher than for a lower standard.

One exception is support for the Efficiency House Scheduled Monument. In this case, the technical requirements for the stock of buildings with scheduled monument status are adjusted/weakened. This results in an implicit assessment of the historic building, which often also falls within the group of WPBs.

The support programmes provide a greater incentive to renovate in WPBs because consumption figures are higher and the refurbishment is therefore generally much more cost-effective as a result of the higher energy costs saved.

The need for repairs and for energy-efficient refurbishment on a building usually goes hand in hand. Eligible costs include repairs which would also become due in the event of non-energy-efficient refurbishment. For this reason too, renovation supported by KfW is more attractive/cost-effective the worse a building performs.

Support is not differentiated according to target group, for example low-income tenants or similar.

The **HZO programme** is aimed at heating in all buildings, and therefore also at the worst-performing ones. The replacement of heating pumps and hydraulic balancing is supported in heating pump support.

The **Social City** programme addresses economically and socially disadvantaged and structurally weak parts of towns and cities in urban planning. Investment in urban development in housing, infrastructure and quality of housing, including energy-efficient refurbishment in disadvantaged areas, is encouraged. Although WPBs are not an explicit eligibility criterion, such neighbourhoods are often WPBs in practice. 78% of the measures are in large and medium-sized towns and cities; 22% can be allocated to small towns and rural municipalities.

In **KfW's Energy-Efficient Urban Redevelopment programmes** there are grants for neighbourhood concepts and refurbishment managers. A steering effect is created by promoting neighbourhoods with particularly high energy saving and efficiency potential. WPBs do not automatically form part of the scheme. However, the programme also works particularly in neighbourhoods with high proportions of WPBs. For example, around a quarter of pilot project support was provided in residential areas in the 1950s to 1980s.

The National Climate Initiative (NCI) supports **local government climate protection model** projects. In principle, the programme applies to all buildings. One selection criterion is a high CO_2 saving in relation to the amount of support.

In the area of **regulative law**, the **EnEV** imposes retrofitting obligations for individual components of the building, in particular on house owners who refurbish or boiler owners with boilers more than 30 years old. However, a number of cases are excluded. WPBs are in principle also addressed if this includes buildings with old boilers or unrefurbished components of the building envelope. The retrofit obligations in the EnEV are particularly cost-effective in WPBs. If retrofitting obligations are not cost-effective, they are not to be applied. The retrofitting obligations therefore apply to WPBs in particular.

The Small and Medium-Sized Combustion Plants Ordinance (1st Federal Immissions Protection Regulation) also addresses combustion plants, including boilers, in WPBs. The Regulation sets limits for waste gas losses, leading to the decommissioning of particularly inefficient boilers.

With the **national efficiency label for old heating systems**, the installers and district chimney sweeps have awarded the efficiency label step by step since 2016, starting with the oldest boilers. The national efficiency label for old heating systems is intended to inform consumers about the efficiency status of their old heating devices and to encourage them to replace their inefficient heaters. The heating stock label issued to boilers in the stock more than 15 years old. It provides information on the energy efficiency status of the building. The stock label does not distinguish between WPBs and other buildings. However, the signalling effect is higher in WPBs, as they tend to have poorer heating. A total of around 13 million boilers are to be labelled over seven years.

The **energy performance certificate** is generally used to provide information on the energy efficiency quality of buildings. WPBs are not dealt with separately, but are visible through the energy performance certificate.

The **energy advisory programmes**, such as 'Energy advice for residential buildings (on-site advice, building renovation passport)', 'Energy advice for consumer centres', are in principle aimed at all buildings and therefore also at WPBs. Advisory reports/refurbishment roadmaps (individual building renovation passports - iSFP) corresponding to the buildings are to be offered to all customer groups. In the case of WPBs in particular, long-term refurbishment roadmaps are useful.

The social dimension must be taken into account when putting building objectives into practice. For example, all advisory services provided by consumer centres are available free of charge to low-income households. In addition, the NKI project 'Stromspar-Check Aktiv' [Electricity Saving Check

Active] of the Deutsches Caritasverband e.V. and the Bundesverband der Energie- und Klimaschutzagenturen Deutschland (EEAS) e.V. provides individual information and assistance on saving electricity for low-income households. This service is provided by long-term unemployed people who have received special training as 'energy-saving assistants'. Participating households receive simple energy-saving items that enable them to reduce their electricity demand immediately.

Although WPBs are not explicitly mentioned as a condition for eligibility, many of the households live in WPBs.

The **quick check for air conditioning and ventilation systems** allows for a rapid assessment of air conditioning and ventilation systems in non-residential buildings and is intended to help identify poorly set and inefficient systems and provide incentives for optimisation and/or renovation.

Energy advice to non-residential municipalities can also be used by municipalities for non-residential WPBs. In particular, support is given to 'economically appropriate investments in energy efficiency'.

2.4.2 Market failures and other barriers

Article 2a(1)(d) of the EPBD 2018 requires that Member States 'shall provide an overview of policies and measures addressing [...] market failures'. The concept of market failure describes a situation in the economy where deviations from a pareto-efficient allocation of resources occur, for example through information asymmetries, externalities or natural monopolies.

Under Section 9(2)(5) of the EDL-G, the Federal Energy Efficiency Agency (BfEE) is responsible for monitoring the market for energy services, energy audits and other energy efficiency measures and for drawing up proposals for their further development. The markets have been examined on an annual basis since 2016.[1] Particular emphasis is put on barriers for non-take-up of energy services (i.e. energy advisory services, energy contracting and energy management). These vary among households, businesses and the public sector.

About a quarter of tenant and a quarter of owner households surveyed have benefited from energy advice over the last five years. In addition, 8% of tenant households and 14% of owner households used energy advice more than five years ago. This means that around 60% of households have not yet been reached at all with energy advice. Owner households not wishing to use energy advice were asked why this was the case. The most common reasons in their estimation were the lack of action on the building (48%) or energy costs being low anyway (44%). It was also frequently mentioned that the added value of the advice was not identifiable (39%) or that questions on the subject should preferably be clarified without consultants (35%).

In the last five years, only a small proportion (21%) of the companies surveyed have used energy consultancy or energy audits according to DIN 16247 as an external service. When no energy services were used (not simply no advice), companies were most likely to cite the lack of need because they could implement the measures on their own and/or because the energy costs were not relevant.

Public authorities far more commonly use external energy advisory and planning services than companies or households. Just over 60% of respondents have benefited from such support in the last five years. Barriers to the use of external energy services often lie in the structure of public administration and are fundamentally different from those affecting businesses and households. The lack of an appropriate budget (38%), procurement and budget law (23%) or lack of responsibility for or access to the properties (22%) are often identified as barriers. The lack of own capacity may be not just a reason for using external parties, but may also be a barrier. This happens whenever it is feared that the effort associated with commissioning and care cannot be reduced. Other barriers, such as

[1] Study available at: www.bfee-online.de

self-implementation or generally low energy costs and doubts about economic viability, are in turn similar to those faced by businesses and households.

In principle, all the barriers summarised in **Error! Reference source not found.** in the overview are addressed by different instruments. The targeting, intensity and take-up of instruments can be increased further in some cases. For example, the provision of advice on renovation in Germany can be regarded as exceptionally good. However, the number of energy consultations that are taken up annually could be significantly increased.

This example also makes clear that it is not just the existence of individual instruments that matters, but also how they interact. In the further development of the support strategy, particular attention will therefore be paid, for example, to this chain of action: information campaigns, energy certificates and energy bills generate initial interest in renovation, which can then be deepened by energy advice, which in turn increases the likelihood of implementation of advisory recommendations by documenting the added value of renovation and references to investment support. This 'chain of beads' of decision-making mechanisms can be further reinforced in the future in the policy instruments.

It should also be borne in mind that not all barriers within the building instruments can be tackled. Social policy instruments and urban development support are also to be used for aspects of acceptance of refurbishments in strained housing markets.

With a view to support, the requirements of EU State aid law also constitute a barrier that imposes significant hurdles on energy-efficient building support (e.g. low intensities of support, increased expenditure due to providing proof of additional investment costs), although it is undeniable that this will help to achieve European climate objectives and will not lead to significant distortions of competition or damage to the European internal market.

Obstacles	**Addressing policy instruments**
Information deficits End-users	Energy advice, refurbishment roadmap
	Energy performance certificate
Information deficits Executing	Information campaign
Shortage of skilled labour	SME initiative
Inadequate motivation, reservations among end-users	Continuing training programmes
	Image campaigns
Availability of/access to funding	BAMF programmes
Incentives for property owners	Alliance for Vocational Education and Training
Lack of economic attractiveness/demand for sustainable technologies	Tools
Low perception of energy costs	KfW, MAP and other support
Lack of pricing of externalities	Special support programmes

Behavioural economic aspects Non-compliance with obligations in regulative law	Energy tax Rental law Energy bills Nudging Regulative law (EnEV, 1st Federal Immissions Control Regulation) Improvements to enforcement

Figure 9: Overview of elements of market failures/obstacles and examples of corresponding policy instruments addressing market failures/obstacles (based on: ifeu)

End-users have **information deficits** regarding knowledge of their own buildings, for example the need for renovation, other needs in the building or the opportunities and benefits of renovation. As a result, there is no meaningful renovation, especially at appropriate times.

In principle, a wide range of **advisory services** are available along the 'advisory chain'.

The **energy performance certificate** shows current energy consumption/needs and recommendations for renovation. It is mandatory in various situations, or submission of energy performance certificate may be required (new buildings, sale of property, new rental). Certain information must be documented in property advertisements. The energy performance certificate has become an important information tool.

Information campaigns, such as 'Germany Does It Efficiently', the joining-in campaign 'My Climate Protection', which shows the individual specific opportunities for action online, but also local and regional actions, help to highlight the issue of energy-efficient refurbishment and are intended trigger activities based on it.

Information deficits and lack of implementation experience on climate-friendly heating technologies and refurbishment measures among those who carry out and plan construction hamper the implementation of climate-friendly or energy-efficient measures.

The **Energy Transition and Climate Protection Initiative** supports companies in energy-saving measures through information events and training provisions and raises awareness of energy efficiency and climate protection. The **Digital Craft Competence Centre** has a thematic focus on 'digital construction' and aims to make demonstration and pilot projects visible and accessible. There is a lack of learning content on energy efficiency and renewable energy in the training and professional profiles of crafts in particular.

There is a major **shortage of skilled labour** in the extensions sector, which will be further exacerbated by the objective of a climate-neutral building stock. In particular, the good order intake situation in the craft sector means that refurbishment measures are often not carried out. Numerous image campaigns (for example ZVSHK [Central Association for Sanitation, Heating and Air Conditioning] advertising campaign 'Time to Start'), several support programmes to attract new target groups (e.g. EQ Plus), the 'Alliance for Vocational Education and Training) to strengthen in-company training or to promote the recruitment of a staff adviser per chamber district to tackle the local shortage of skilled workers on the ground addressed the shortage of skilled workers.

End customers face various barriers and blocks on action that discourage them from energy-efficient refurbishment – both objective barriers and **personal attitudes** can play a role here: for example requirements for the protection of buildings with scheduled monument status and technical/structural restrictions, especially in the case of older buildings, lack of time or simply no interest, aesthetic concerns, fear of stress, filth, damage to buildings, difficult planning and implementation or frivolous providers, uncertain profitability and, finally, the failure to tackle refurbishment measures due to the age of the building owners ('no longer worth it at my age'). **Information campaigns** aim at raising the awareness of end-users on various topics. **Energy consultancy** and **support programmes** (e.g. KfW, MAP) provide financial support to building owners. The **iSFP** in energy consultancy offers the opportunity to target the needs of the building owner and those of the occupants and to develop an appropriate and tailored renovation strategy together with the energy consultant. **Online building tools**, such as the 'ownership manager' or the 'renovation configurator', offer the opportunity to 'play out' refurbishment variants in advance without much effort. **A current project is exploring how the issue of energy advice can be better marketed. Events which represent refurbishment and thus a point of reference for energy consultancy play an important role in this context.**

Building owners lack the necessary **money** for efficiency measures in the building stock, particularly in the case of investment measures such as the thermal renovation of the building or the replacement of heating technology. The necessary capital cannot be provided even in the case of a positive cost-benefit assessment over the technical lifetime of the investment. Large-scale promotional activities and financial products, including the CO_2 building renovation programme and the resulting KfW programmes **'Energy efficient construction/renovation**' for private building owners, businesses, local governments and non-profit organisations, allow access to finance for efficiency measures in the building stock. The **MAP** supports the switch to renewable energy and thus reduces the financial hurdle for the investment.

Rebound effects lead to lower than expected actual savings from energy efficiency measures. Lower consumption-related costs lead to more intensive use (direct rebound) or the saved costs are invested elsewhere (indirect rebound). In the worst case scenario, total consumption even increases after the measure (backfire effect). In the case of the prebound effect, energy demand overestimates actual consumption, especially in older buildings with poor energy efficiency. This problem leads to savings from energy efficiency measures being overestimated. **Energy taxes and levies** in the buildings sector can partly counteract rebound effects with higher specific consumption-related costs. The **'Germany Does It Efficiently' information campaign** shows simple measures to reduce energy consumption, thus saving heating energy and counteracting rebound effects.

The **KfW support 'Smart Home'** can be used as an additional measure in the case of supported energy-efficient refurbishment. The installation of suitable smart home systems (e.g. consumption data collection and monitoring systems or electronic radiator room thermostats) can counteract direct rebound effects.

From the end-user's point of view, **energy-efficient technologies** are sometimes **uneconomic** compared to conventional solutions in the market. From an expert's point of view, economic viability in the case of energy-efficient refurbishments means that the savings resulting from the refurbishment measure implemented exceed the expenditure. However, end-users often have reservations about these profitability calculations and forecasts. In practice, this is often dominated by the impression of short-term investment costs, short payback periods to be taken into account (for example in the case of companies) and the motivation to insure against risks such as price risk ('how will energy prices develop in the future?'). Innovative products are often not taken into account by end-users (and intermediaries, for example craftsmen or architects) due to lack of experience, reservations and other barriers in the early stages of the product's maturity.

Support programmes provide financial support to end-users. There are several other lines of support specifically for innovative products, such as the market incentive programme and various other support, market introduction, research and pilot programmes (pilot project on energy saving meters, SINTEG, energy transition construction, etc.).

Import prices of coal, natural gas and crude oil decreased between 2013 and 2016, which also led to a fall in household energy prices for heating oil, natural gas and district heating. Lower energy costs lead to increased energy consumption or prevent necessary efficiency measures due to a lack of financial incentives. Energy taxes produce a partial internalisation of external costs, e.g. costs of damage to the climate, and contribute to ensuring that energy costs remain in the 'memories' of end-users.

The **costs** of negative impacts on climate protection, health and labour productivity and other **externalities** from buildings with low energy efficiency are often not borne by the owner but by society as a whole. The added value of refurbishment (co-benefits) is increasingly reflected in the instruments, for example in the building renovation passport. The current **energy tax** includes an environmental tax and thus partly internalises costs of climate damage.

2.4.3 Split incentives

Under Article 2a(1)(d) of the 2018, each LTRS must 'encompass an overview of policies and actions to target (...) split-incentive dilemmas'. This is a new component which was not yet included in the Directive in this form.[2] The Commission's recommendations on the Directive state that 'a "split incentive" arises between the owner and the tenant of a building or among owners where the party who pays for energy retrofits or efficiency upgrades cannot recover the full benefits and savings (COM(2019) 3352)'.

In Germany, these 'split incentives' play a key role in renovation activity due to the fact that a majority of households rent their housing.[3]

In Germany there are therefore already a number of rental law instruments targeting 'split incentives' (see BBSR 2016).

In the first place, mention must be made of the possibility provided for in rental law of increasing rent after modernisation (Section 559 of the Civil Code), referred to in abbreviated form as the **modernisation levy**. Since 1 January 2019, the permissible increase in annual rent has been 8% of pure modernisation costs. The rent increase after modernisation takes place for an unlimited period of time. The property owner is not bound by the limitation of the rent increase to the standard local comparison rent that otherwise applies. Under Section 559(2) of the Civil Code, pure repair costs are not recoverable and, like State funding and financing costs, have to be deducted from the modernisation costs.

[2]However, Article 19 of the EED already provides that 'Member States must 'evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States, in particular as regards the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency-improving investments that they would otherwise have made by the fact that they will not individually obtain the full benefits or by the absence of rules for dividing the costs and benefits between them; this also applies to national rules and measures regulating decision-making processes in multi-owner properties' (C(2019) 3352).

[3]According to the microcensus, the proportion of rental housing in residential buildings in 2014 was 54.4%. This is equivalent to 22.8 million rental housing units.

With the aim of providing effective incentives for energy-efficient refurbishment of the rental housing stock, current rental law allows the property owner to pass on the cost of energy-efficient refurbishment to the tenant. This legal provision is therefore considered to be a crucial economic condition for the implementation of energy modernisation measures in the rental housing stock (ESG 2015). The level of the modernisation charge is intended to repay the pre-financed investment costs for the property owner. In turn, the tenant benefits from modernisation through lower warm operating costs and improved housing comfort. Ideally, the increase in cold rent and reduced operating costs are in balance, making it possible to achieve warm rent neutrality.

The Act to amend the Rental Law Act, which entered into force on 1 May 2013, further improved the underlying conditions in rental law for energy-efficient refurbishments, e.g. by requiring tenants to tolerate energy-efficient refurbishments and by creating a uniform legal framework for the transition to commercial heating supply (contracting) in the current tenancy.

With a view to social compensation, on 1 January 2019 the levy rate was reduced from 11% to 8% and, in addition to the existing hardship rules, a cap of EUR 3 per square metre within 6 years was introduced (Section 559(3)a of the Civil Code). If the rent is less than EUR 7 per square metre, the rent may increase only by EUR 2 over 6 years as a result of a modernisation. Increases under Section 558 of the Civil Code (increase up to the standard local comparison rent) or Section 560 of the Civil Code (changes in operating costs) are not taken into account. However, these recent statutory improvements to the position of tenants must be seen in the context of housing policy tensions, as there is a risk of incentives for renovation being reduced as a result. On the tenant's side, it contributes to the acceptance of energy-efficient refurbishment.

A further incentive is provided by the simplified procedure for calculating the modernisation charge or rent increase for minor measures in force since 1 January 2019 (Section 559c of the Civil Code). If the total cost does not exceed EUR 10 000 per dwelling, property owners may deduct 30% for maintenance costs and charge the remainder as modernisation costs at the levy rate of 8%. In addition, funding received is not taken into account.

Depending on the rate of increase in comparable rents in the local housing markets, the economic benefit of the modernisation rent increase can only be temporarily felt by the property owner and the market situation is the dominant factor for rent levels in the long term (BBSR 2010).

By integrating energy differentiation features in the rent level ('environmental/energy efficiency rent level', in detail: BBSR 2010), however, there is a further possibility of incentives for energy-efficient refurbishments. Account was taken of the significance of energy characteristics in determining the standard local rent through an addition to Section 558(2) of the Civil Code. At local government level, market transparency and the acceptance and sustainability of energy investments can be strengthened in the future by the establishment of qualified energy rent levels.

An analysis of existing rent levels in Germany shows that just over half of all rent levels already contain energy differentiation features, which are taken into account in varying degrees of detail (BBSR 2010). For some time, there has been an increased interest in many local governments in taking energy differentiation features into account to an even greater extent in rent levels (BBSR 2010). Owners who carry out energy-efficient refurbishment with the aim of increasing the value of their property, improving their market position, limiting the burden of heating costs on tenants and, where appropriate, avoiding vacancy may receive market-oriented support through energy-based rent levels.

2.4.3.1 Lack of information on support programmes

Potential beneficiaries are often not sufficiently informed about existing support schemes to increase energy efficiency and use of renewable energy for heating in buildings, industrial processes and

installations, and existing information and the application process are perceived to be too complex from the customer's point of view.

As a consequence of this finding, in cooperation with the programme implementers BAFA and KfW, the online tool entitled 'Guide to Energy Efficiency Support' was designed, guiding potential beneficiaries from all target groups (private individuals, businesses, local government and non-profit organisations) through a compressed question and answer scheme along a simple path to the correct support programme from the customer's point of view. Since 24 January 2020, the 'Guide to Energy Efficiency Support' has been available at https://www.machts-effizient.de/foerderwegweiser, as well as at KfW.de and BAFA.de.

2.4.3.2 Support strategy on energy efficiency and renewable heating

Since 2017, all support programmes have been fundamentally revised by the BMWi's 'Energy Efficiency and Renewable Heat Support Strategy', expanded and better aligned: the focus is on increasing the efficiency, targeting and clarity of existing support programmes and exploiting and pooling synergies between individual support programmes. The aim is to strengthen the combination of efficiency and renewable energy in the energy-efficient refurbishment of buildings through closer meshing of existing support instruments, for example by paying special attention to package solutions that combine efficiency measures with the new installation of renewable heat generators.

In the area of buildings, the strategy merges the two major support programmes 'CO_2 Building Renovation Programme' and 'Market Incentive Programme' (MAP) into the **new programme 'Federal Support for Efficient Buildings' (BEG)**, in order to be able to promote energy efficiency and renewable energy in one scheme at the same time. The aim is to make funding much more targeted and attractive, to focus even more on more ambitious measures and to substantially simplify application procedures. In addition, support will be given to digitisation measures to optimise operation and consumption and sustainability aspects, as well as to improving the interfaces with energy advice.

2.4.3.3 Specialised portal for energy-efficient construction and refurbishment.

Since the beginning of 2019, the Federal Government has commissioned the Specialist Portal for Energy-Efficient Construction and Refurbishment (FEBS). The FEBS provides matched technical information for experts working in the field of energy-efficient construction and refurbishment. This includes energy saving legislation, energy advice, funding opportunities, and planning and implementation. The specialist portal serves as a reference point for the energy-related construction and refurbishment process and as a source for various tools.

In addition, a contact point is offered with the FEBS service centre at which to provide reliable, quality-assured answers to technical questions by telephone and in writing. In order to continuously optimise the scheme, there is an additional exchange with practitioners. The overall package – online provision, service centres, publications and dialogue – aims, together with experts, to improve the quality of energy construction and refurbishment.

2.4.4 Reducing energy poverty

It is important for Germany that energy remains affordable as part of the energy transition. The Federal Government therefore aims to ensure affordability for all citizens. Energy saving can make an important contribution to this. Affordability is not least an element of the target triangle of the German energy transition, to which the current coalition agreement again makes explicit reference.

The German Government does not use the term 'energy poverty' as a separate term. Instead, it takes a comprehensive approach to fighting poverty in social legislation, which does not focus on individual elements of need, such as energy. If financial support is needed to ensure subsistence, benefits

under the minimum social security schemes are provided under the Second and Twelfth Social Code (Basic Insurance for Jobseekers – Social Code II and Social Assistance – Social Code XII). This includes the 'normal requirement', which also includes, for example, the needs for expenditure on general household electricity. Expenditure on heating energy is included in accommodation and heating needs to the extent of the appropriate actual expenditure. In addition, energy debt can normally also be taken over on a loan basis.

2.4.4.1 Federal support for energy advice from consumer centres and StromsparCheck Aktiv

Energy advice from consumer centres for private individuals is provided by the Federal Ministry for Economic Affairs and Energy with a subsidy to the consumer centres and is therefore available free of charge or for a small contribution. All services offered by consumer centres are free of charge for low-income households. In addition to **online advice** and **telephone helplines**, other formats of personal advice are available.

These include, first of all, the **energy checks**, which address differentiated priorities around the (private) home in different ways. These are the basic check, the building check, the heating and solar thermal check, the detailed check and the fitness check for the use of solar thermal or photovoltaic technology. In addition, the consumer centres offer 'stationary consultations', where more than 500 architects and engineers throughout Germany can be appointed as energy consultants by the consumer centre.

The support of the Federal Ministry for Economic Affairs and Energy is intended to guarantee the independence and neutrality of advice.

- Stationary free of charge
- Basic check free of charge
- Building check EUR 30
- Heating check EUR 30 (free of charge for low-income households)
- Solar heat check EUR 30
- Detailed check EUR 30
- Fitness check (ST/PV) EUR 30
- Telephone advice free of charge
- Online advice free of charge

The evaluation (PWC 2017) of the VZBV (Federation of German Consumer Organisations advisory services is based on the objectives set by the VZBV itself on the basis of the funding objectives (2015) defined for the projects on energy savings advice and energy checks, which set target indicators and target values.

- Target 1: VZBV energy advice contributes to **improving energy efficiency** in private households by raising awareness and motivating
- Target 2: Every consumer receives **independent energy advice** suited to their needs, if necessary.
- Target 3: **Energy and CO_2 savings** through the implementation of efficiency measures

In addition, the 'Stromspar-Check Aktiv' ('Electricity Saving Check Active') supported by the National Climate Protection Initiative' of the Deutsches Caritasverband e.V. and the Federal Association of Energy and Climate Protection Agencies in Germany (eaD) provides individual information and assistance on saving electricity for low-income households. This service is provided by long-term unemployed people who have received special training as 'energy-saving assistants'. Participating

households receive simple energy-saving items that enable them to reduce their electricity demand immediately. .

Table 22: General overview of the net effects of the energy savings advice and energy checks

	Advice on energy savings	Energy checks	Total
1. Final energy saved (in GWh), over the lifetimes of the measures			
Implemented	1 225	578	1 803
Planned	857	484	1 341
total	2 082	1 062	3 144
2. Reduced CO_2 emissions (tonnes) over the lifetimes of the measures			
Implemented	457 990	225 280	683 270
Planned	307 620	176 960	484 580
Total	765 610	402 240	1 167 850
3. Investments initiated (EUR million)			
Implemented	84.3	29.6	113.9
Planned	58.4	34.2	92.6
Total	142.7	63.8	206.5

2.4.4.2 Housing benefit

The tenant structure in Germany is highly heterogeneous. There are about 18 million tenant households. Particular attention needs to be paid to the group of recipients of housing benefit and social security benefits, because in 2017 the public authorities relieved the burden of around 4.4 million households with a sum of EUR 17.5 billion through housing benefits and consideration of the needs for expenditure on accommodation and heating in minimum social security schemes. As a result, 11% of all households benefited from full or partial relief of housing costs.

The Housing Benefit Increase Act increased housing benefit as of 1 January 2020 and brought it into line with the general trend in rent and income since the 2016 housing benefit reform. As a result, the number of households receiving housing benefit will increase from 480 000 households without the reform to approximately 660 000 in 2020.

Furthermore, as agreed in the Climate Action Programme 2030, in the context of the anticipated CO_2 pricing, a separate law will extend the housing benefit to include a CO_2 component by 1 January 2021 in order to relieve the burden of heating costs on households in receipt of housing benefit.

2.4.4.3 Demographics and age structure of building owners

The **age structure of the owners** of property (owner-occupiers or small property owners) is another material aspect that has an impact on the motivation and economic opportunities due to the time horizon: Almost half of this population are over the age of 60 in Germany. Due to demographic trends, a significant change of ownership of the property stock can therefore be expected in coming years. Such a change opens up possible investment windows, as the transfer of ownership always raises the question of possible modernisation and therefore energy-efficient refurbishment of the building. Overall, the analysis of the structure of the building stock and the ownership situation shows that it is easier to implement measures in the building stock in particular if the investor at the same time is a beneficiary of reduced energy costs and the investor does not have to coordinate their decisions with others. This owner-occupier of a single-family house faces other barriers, such as creditworthiness or borrowing capacity. Implementation of such measures is more difficult in the case of homeowners' associations: this raises a number of questions, ranging from majority voting to unanimous decisions to invest in energy-efficient refurbishments. The challenge in the rented building stock is to provide the owner with sufficient incentives to invest (economic viability of actions) and at the same time not to overburden the user. In this case, the system of levies through the modernisation rent increase has proved its worth in principle. Further models need to be discussed. As in the case of the classification of buildings, it is important, in view of the ownership, investor and user structure, to identify in future different ways of resolving the situation according to user and owner groups.

2.5 Policies and actions for public buildings

2.5.1 Central government buildings

In recent years, the Federal Properties Energy Conservation Programme (120 Million Programme) has made efforts to reduce final energy consumption for space heating in the Federal Government. The 'EnEV Decree' introduced requirements to meet the applicable EnEV requirements in federal construction in 2011. According to these requirements, all new buildings and the modification, extension and extension of existing buildings had to be below the permissible primary energy requirement by at least 20%. Independently, the energy quality of the building envelope (thermal insulation, windows) must be 30% better than permitted.

In addition, the guidelines for the implementation of federal construction tasks and the operational monitoring rules contained in them provide a tool with which to also influence the energy consumption of federal buildings in operation. Since 1990, the civil and military service facilities of the Federal Administration have shown a reduction in heating consumption of almost 70% and a reduction in electricity consumption of around 30%. The reduction is based both on the relinquishing of land (mainly in the Federal Armed Forces) and on increasing efficiency in the form of reduced area-specific heating consumption.

Federal Government buildings must set an example in terms of energy efficiency, climate protection and sustainable construction for the entire building stock and demonstrate that climate policy objectives can be achieved in harmony with the cost-effectiveness and functionality of construction measures. They will attain at an early stage a standard that is commensurate with the climate policy objectives and integrate innovative technologies. Budgetary acknowledgement is based on the principle of economy with the fewest possible resources. New federal buildings are expected to meet at least EH 40 standard from 2022. At least EH 55 standard should be used as a basis in refurbishing existing federal buildings (see section 1.4.1.8).

2.5.2 State Secretary Committee for Sustainable Development

Sustainability policy is coordinated by the Federal Chancellery. At the same time, all the federal ministries formulate sustainability policies in their areas of competence. In the State Secretary Committee for Sustainable Development, the ministries work on the joint implementation of many policy areas that address sustainability.

One state secretary per ministry, together with the Head of the Chancellery, form the State Secretary Committee for Sustainable Development. Sustainability policy up to 2020 exists at federal level in the German Sustainability Strategy.

The committee has the following specific tasks:

- continue to develop the sustainable development strategy;
- regularly review how these indicators develop;
- act as a point of contact for the Parliamentary Committee for Sustainable Development, for the federal states and for the umbrella associations of local governments;
- advise the Federal Government on current issues of sustainability.

2.5.3 Sustainable construction

The Sustainable Construction Guide describes procedures, sets out objectives and makes recommendations for federal construction in order to direct the planning and implementation of new construction and extension projects, including the design of external installations, the planning and implementation of modernisation, conversion and change-of-use projects for existing buildings as well as use and operation and maintenance buildings and properties in accordance with the sustainability requirements in the construction sector.

In terms of DIN EN 15643-2 'Sustainability of construction works. Assessment of buildings. Framework for the assessment of environmental performance', the guide looks at the whole life cycle of a building. The calculations use the first 50 years of a building for the specific life cycle considerations.

2.5.4 National Climate Initiative (NCI)

With the NCI, the Federal Ministry for the Environment aims to tap the existing potential for emission reductions in a cost-effective way. The International Climate Initiative (ICI) also supports actions to adapt to climate change and protect climate-relevant biodiversity in developing and newly industrialising countries. Approximately EUR 270 million is available for the national part.

The Federal Ministry for the Environment has launched seven support programmes and calls under the NCI.

2.5.4.1 Local government guidelines

On the basis of the local government guidelines, the NCI supports the preparation and implementation of ‘climate protection concepts’ by climate protection managers. Integrated climate protection concepts cover all areas of a municipality with climate relevance and, in particular, its own properties. In addition, the establishment and operation of an energy management system is promoted. Eligible beneficiaries of funding include local government (cities, municipalities and rural districts), associations in which only local authorities are involved, and businesses, enterprises and other organisations with at least 25% local government participation.

The local government guidelines also focus support on the establishment and operation of **local government networks** in the fields of climate protection, energy efficiency, resource efficiency and climate-friendly mobility. In the establishment phase, the recruitment of network participants is supported by a network manager and during the project period by the management of the network.

2.5.5 Energy-efficient urban redevelopment – KfW 432

The KfW programme 'Energy-efficient urban redevelopment – KfW 432' supports integrated neighbourhood concepts and refurbishment management. The programme is designed as an 'investment preparing' programme that solely promotes concepts and their implementation. No investment in the building stock is supported, for which there are other KfW support programmes (such as the CO_2 building refurbishment programme). Integrated neighbourhood concepts show the technical and economic potential in the neighbourhood for energy savings taking account of urban planning, care of scheduled monuments, building culture, housing economics and demographic and social aspects. The concepts may also include statements on the extent to which 'smart' technologies can contribute to climate protection in the neighbourhood. However, this is not a condition for eligibility. BMI has developed the KfW 436 programme for model projects in the area of 'Smart City'.

Applications may be submitted by local authorities and local government enterprises. They apply to KfW for grants of up to 65% for an action.

Since 2011, the Federal Government has supported Energy-Efficient Urban Redevelopment with a total of around 1 300 commitments for concepts and renovation management. The volume of funding is around EUR 82 million.

The following federal support programmes are aimed in part at the public sector. They are described in detail elsewhere:

- 2.3.3.4 Energy consultancy services for non-residential buildings of local government
- 2.3.3.5 Support of consultations on energy-saving contracting
- 2.3.2.3 MAP
- 2.3.2.4 HZO
- 2.3.2.2 CO_2 Building Renovation Programme IKK/IKU
- 2.6.3.7. Heating Networks 4.0.

2.6 Incentives for the use of smart technologies

National initiatives in the field of smart technologies relate to the areas of energy research, funding and standardisation. Digitisation plays a key role in this process, leading to a new approach to building planning and management, including renovation. This leads to increased efforts in the training of planners and performers to develop the necessary expertise in the various professional groups.

2.6.1 Smart technologies

Digitisation is significant in the buildings sector in two ways:

Firstly in the planning, construction, operation and maintenance phase of buildings, through the digital modelling of buildings and related processes, i.e. building information modelling (BIM). The second impact of digitisation relates in particular to the operation of buildings. Advances in measurement, control and regulation technology make completely new applications possible in this area. Smart sensors can report consumption and equipment performance, allowing for transparency of consumption for the user, automatic optimisation of systems, and ancillary services such as prospective maintenance and remote diagnostics. The Federal Energy Efficiency Centre (BfEE) market survey for 2017 asked energy management service providers for their typical sales figures for the core products in energy and environmental management. The certification of energy management (EnM) systems according to ISO 50001 accounts for most of the business with EnM. 1 177 German organisations at a total of 2 243 sites offer EnM systems. In addition, the introduction of energy auditing and load management, as well as the installation of sensors and metering technology, also play a major role for suppliers. This will allow for efficiency-enhancing applications and new business

models in the individual building, but also in the combination of different buildings on a property or in a neighbourhood. It is important to provide for the recording of key parameters over time and appropriate universal interfaces in machine-readable format for data exchange and to encourage their dissemination. Only then can a targeted evaluation be made on a voluntary basis, where appropriate by third parties, in accordance with the provisions on data protection. Digitisation is primarily associated with additional energy consumption, and the secondary efficiency potential that can also be expected to be realised must also be raised in practice.

2.6.1.1 Building Information Modelling

The aim of BIM is to improve planning, construction and operation, while at the same time ensuring greater compliance with time limits and costs. This can indirectly reduce construction costs. In addition, BIM enables resources and materials to be optimised and documented. This documentation of built-in material in the long term will make effective recycling possible. The first German standards have already been published in draft or even in finalised versions. Special mention should be made here of the VDI guidelines from the VDI 2552 series 'Building Information Modelling (BIM)', which enable order to be brought to the complexity of the issue.

The recognised codes of practice on data management, volumes and auditing, and above all the much-needed skills, are now available and support both enterprises and the German construction industry in taking the digital step towards working with BIM in the future.

2.6.2 Energy and construction research in the buildings sector

2.6.2.1 7th Energy Research Programme (ERP)

Since 1977, the Federal Government has been continuously promoting research into energy technologies across all sectors. The programmatic basis for this is seven consecutive energy research programmes, of which the 7th Energy research programme 'Innovations for the Energy Transition' was adopted in September 2018 as the current programme at that time. (See Figure 10)

The 7th ERP focuses on technology and innovation issues related to energy efficiency, renewable energy and system integration. The focus of support is increasingly macroeconomic and systemic. Accordingly, research on transformation of the energy system is also focused on the topic of buildings and neighbourhoods.

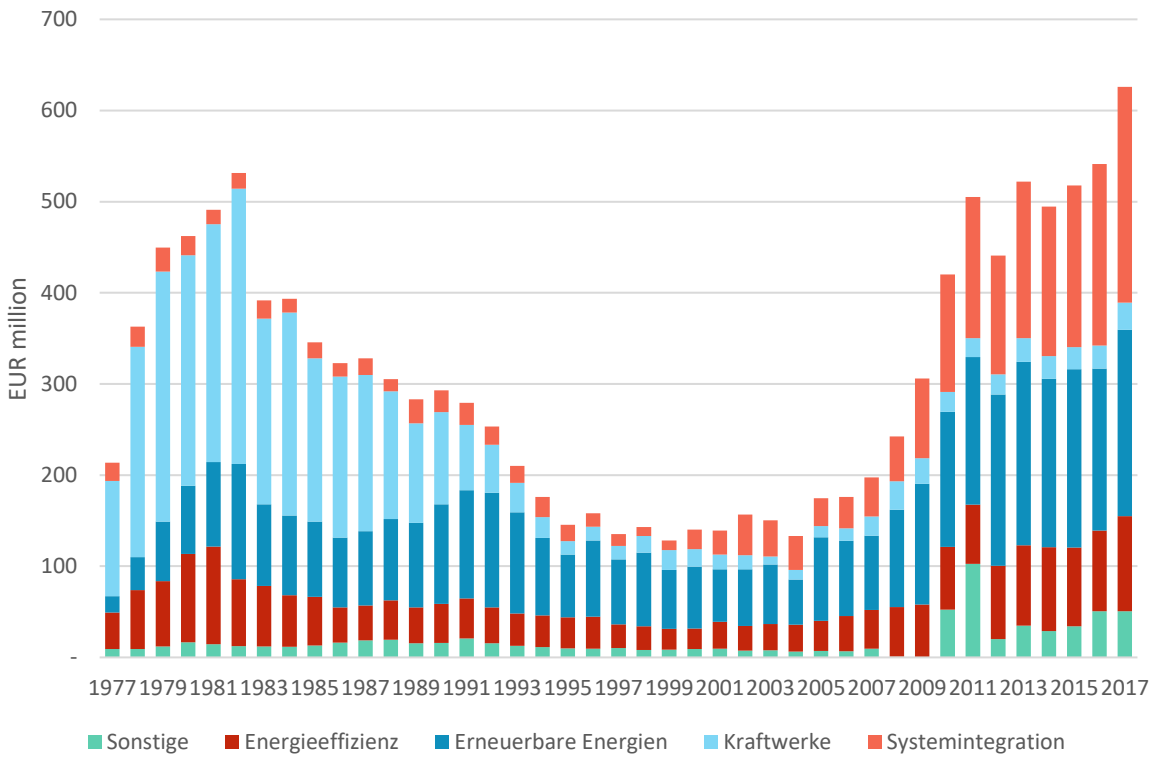

Figure 10 Project funding for non-nuclear research in Germany from 1977 to 2017 (base year 2010)

Key (left to right): Other Energy efficiency Renewable energy Power plants System integration

Cross-cutting issues such as energy efficiency, reduction of consumption and operational optimisation, sector coupling and digitisation are promoted through specific materials, components and technologies. This should help to ensure that support is as integrated as possible.

- The 7th ERP established the 'real laboratories' of the energy transition as a new pillar of research funding. The February 2019 ideas competition focused on the neighbourhoods. In real laboratories, both innovative technologies and integrated energy concepts are to be tested in time- and space-limited experimentation rooms under real-life market-related conditions and in systemic interaction. The aim is to further develop innovative technologies for the transformation of the energy system in a market-related manner, consider appropriate adjustments to the regulatory framework and keep in mind the societal consequences of innovation. 'Real laboratories' are larger and thematically more extensive than previous demonstration projects and aim to open pathways to 'regulatory learning'.
- In addition to the real laboratories, the role of **start-ups** as new players in the energy transition and the importance of new **exchange and networking platforms** for research and innovation as well as research networks are addressed in particular.
- In addition to the traditional themes of support for materials and component research, the focus of the funding is on digitisation (e.g. BIM) and network-based building operation.
    - **Building-integrated photovoltaics** and solar thermal as well as coupled photovoltaic-thermal solutions will have to play a more important role in the future, as the energy needs of buildings cannot be met by the use of roof surfaces alone.
    - Innovative low-energy integrated approaches should, where possible, interact with an increasingly flexible electricity system and enable renewable, network-based, decentralised heating and cooling through increased efficiency. In addition,

integrated storage in buildings, neighbourhoods and industry can harness fluctuating yields from renewable or locally available sources.
    - The use of fuel cell heating (FCH) as a decentralised combined heat and power technology (CHP) can also be a promising complement to the heating and power supply in the building and in a neighbourhood and can be used as an additional element of the supply strategy.
- The technology-specific support priority of **neighbourhoods** focuses on **decentralised supply structures**. With the interconnection of the electricity, heating and mobility sectors, buildings and neighbourhoods will in future increasingly have to interact with the electricity system; an increasingly integrated, flexibilised and network-based energy supply is therefore necessary.
    - In addition to the technical challenges (energy, sustainability and resources), **public acceptance** is becoming increasingly important in many research activities, especially with regard to possible barriers to implementation. In addition, planning and construction processes should also integrate social factors such as the housing environment, new forms of housing and work, demographics and sustainable mobility. In the area of buildings and neighbourhoods, demonstration projects are an important part of research work, as this is the only way to test the complexity of networking from energy and heat supply, system integration and the provision of mobility to societal processes and needs.
    - The extensive use of **digital options** in the planning of renovation, new construction and management of buildings is becoming increasingly important. The digitisation of planning also requires increased effort on the part of practical research.
    - In its 7th ERP in the period 2018-2022, the Federal Government is making a total budget of around EUR 6.4 billion available for research, development, demonstration and testing of future-capable technologies and concepts. Compared to the comparison period 2013-2017, this represents an increase of around 45%. At federal level, state support for energy research is made up of **resources from the federal budget** and the **special fund 'Energy and Climate Fund' (EKF)**.

2.6.2.2 Energy transition construction programme

The objective of the Energy Transition Construction research initiative is to bring together the broad range of **research funding topics in the buildings sector** and to improve the perception of energy innovation through targeted public relations for federal research activities. The Energy Transition Construction research initiative is a key element of energy research funding under the Federal Government's 7th energy research programme and is **not a stand-alone support programme**.

The buildings sector has a key role to play in the energy transition process with a view to unlocking efficiency potential and integrating renewable energy into the heating sector. Buildings and cities are increasingly taking over a growing share of near-demand decentralised provision of heating, cooling and electricity. The systemic interaction of buildings, neighbourhoods and energy infrastructure is becoming more important. Against this background, the Federal Ministry for Economic Affairs and Energy summarises the funding priorities for energy-optimised buildings and neighbourhoods in the Energy Transition Construction research initiative.

The Ministry allocated some EUR 117 million in 2019 for 207 newly approved projects under the Energy Transition Construction research initiative. Around EUR 83 million was spent in 2019 on 854 ongoing projects.

Eligible (under the 7th ERP), in addition to research institutions, are undertakings in the commercial economy with a permanent establishment or branch in Germany, as well as regional corporations and public administration bodies. In particular, start-ups and other small and medium-sized enterprises (SMEs) are encouraged to apply. Combination projects involving enterprise and science

are particularly encouraged. Research organisations which receive basic funding from the Federal Government and/or the federal states may, in addition to their institutional funding, be granted project support for their additional costs on a case-by-case basis. The grants are awarded as project support in the form of outright grants, usually in the form of part-financing. Applied research, development and demonstration of energy technologies in one or more of the above research areas are supported. Accompanying studies on societal issues of the energy transition and on the social acceptance of technological developments, as well as scientific cross-evaluations and analyses, are in principle eligible in major research projects. In the context of this strategy, the (consumption) sector of **buildings and neighbourhoods** has a key role to play, with further differentiations in the areas of **energy-optimised and climate-neutral buildings, energy transition in the neighbourhood, heating and cooling supply, thermal energy storage** and **climate-neutral building stock in 2050**.

Extensive research in the area of energy transition is currently being cross-evaluated by two alliances: on the one hand, the 'Energy Transition Construction' team, which deals with the topics from the 6th Energy research programme and, on the other hand, the 'EnEff.Gebäude.2050' ('Energy Efficiency of Buildings') team, which evaluates and manages the projects under the same funding guidelines.

The funding measure Innovative Projects for the Nearly Climate-Neutral Building Stock in 2050 (notification of the support initiative **'EnEff.Gebäude.2050 – Innovative Projects for the Nearly Climate-Neutral Building Stock in 2050'** of 14 March 2016 and 20 October 2017) will be continued as part of the 7th ERP.

The funding measure complements, as a further format, the research and development (R&D) and demonstration projects in the Energy Transition Construction research initiative. The objective of the action is to achieve a significant reduction in non-renewable primary energy demand by speeding up the deployment of available but novel technologies and processes. It will take on board innovations and results from long-standing research and the focus on removing barriers to enable the exemplary implementation of ambitious projects on the path to a climate-neutral building stock.

Support is given to model innovation projects that make a qualitative contribution to ambitious energy efficiency improvements in combination with the integration of renewable energy in the building sector (indicative value: 80% saving on non-renewable primary energy as compared with 2008).

2.6.2.3 Future of Construction innovation programme

The Federal Ministry of the Interior, Building and Community (BMI) is actively supporting climate protection, energy and resource efficiency, affordable construction, quality of design in the construction (urban planning) context and the management of demographic change through the Future of Building innovation programme. Emphasis is put on knowledge building and knowledge transfer of technological, cultural and organisational innovations. The innovation programme continues the Future of Construction research initiative launched in 2006. Since 2006, the Future of Construction research initiative has generated more than 1 200 research projects and around 70 pilot projects, supported by EUR 140 million from the Federal Government.

The Future of Construction innovation programme consists of the parts Future of Construction Research Funding, Future of Construction Departmental Research and Future of Construction Model Projects. All the actions of the Innovation Programme are aimed at promoting the sustainable development of the buildings sector as a whole. The Future of Construction innovation programme is implemented behalf of BMI by the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) at the Federal Office for Building and Regional Planning (BBR).

As part of Future of Construction research funding, researchers can formulate individual research topics relating to construction. The funding of these projects is intended to cover an existing research

need of particular public interest. The research focus ‘establishment of climate-friendly and environmentally friendly construction methods’ in Future of Construction calls for research funding to cover a wide range of topics relating to the environmental dimension of sustainable construction. Research topics range from regional, climate-neutral construction and conservation of land to construction with renewable raw materials and building concepts that avoid fossil fuels and instead exclusively use renewable sources of energy. Promoting the development and improvement of environmentally friendly and resource-efficient building materials and products based on renewable and secondary raw materials is an important contribution to climate protection. Construction is understood as a circular system from component creation to dismantling and recycling, which also takes account of GHG emissions from the production of building materials, components, plant technology, etc. Another aspect is strengthening the robustness and resilience of buildings, both to adapt to climate change impact and to reduce the complexity of construction.

Another research focus is ‘management of the building stock’. Relevant research topics here are tools for recording and determination of condition, historical analyses, innovative approaches to issues concerning buildings with scheduled monument status, new construction techniques and materials, and adequate strategies for identifying and implementing future-capable uses with the aim of preserving, maintaining, modernising and extending existing buildings.

2.6.3 Optimal building operation

2.6.3.1 Federal funding for the Smart Meters pilot programme

As part of the pilot programme on smart meters, the BMWi promotes the development and testing of measurement systems to quantify energy savings in electricity, gas, oil, biomass, heating and cooling. It is left open for which customer groups (industry, households, public bodies, etc.) and using which technology the smart meter is developed. The aim of the pilot programme is to drive forward the development of measurement systems that allow customers to continuously monitor their energy consumption and make decisions to reduce it. Actual savings are then to be presented. Applications may be submitted by companies and consortia. Beneficiaries receive funding for a period of five years. Due to the fact that research and development projects are supported by smart meter products, these require a longer development and measurement period before initial savings can be achieved and demonstrated. As all the projects are still in their first two years, no significant savings can yet be reported.

The allocated budget is EUR 162 million. In principle, all undertakings with a sound accounting system are eligible to apply.

The second period of funding, based on an amendment to the guidelines, has been running since 21 February 2019.

2.6.3.2 Support programmes for plant optimisation, MCR and energy management systems

As part of the support product ‘Energy-efficient construction and renovation’ (see 2.4.2.1. above), which is widely applied at national level, KfW grants loans and investment grants in sub-programme No 152/430, among other things for individual measures for example in the following areas which contribute to the optimisation of operations:

- optimisation of heat distribution (e.g. hydraulic balancing);
- installation or optimisation of measurement, control and regulation and building automation (e.g. ENMs);
- Replacement of existing pumps by high-efficiency pumps;
- Smart metering systems and heat meters.

Under the ‘heating package’, these sub-programmes also subsidise the replacement of particularly inefficient heating in conjunction with measures to optimise installations with higher rates of funding; in addition, the installation of ventilation systems in existing buildings in conjunction with additional refurbishment measures is also eligible in particular.

2.6.3.3 Inspection tool for air-conditioning and ventilation systems

The air conditioning and ventilation efficiency calculator is a calculation tool for the assessment of complex ventilation and cooling systems in non-residential buildings. This makes it possible, for example, to examine installations in hospitals, shopping centres or large office buildings. The efficiency calculator supplements the energy inspection of these installations and summarises the results in such a way that the evaluation can be seen at a glance. The tool takes into account both the sizing and operation of the installation and goes far beyond the energy efficiency of the components used. In addition, up to three other important aspects are assessed, thermal protection of the building in summer, equipping with meters and sensors (‘smartness’) and the ecology of the refrigerant (in particular the global warming potential of the refrigerant). The tool results in an energy label containing six colour classes from A (green) to F (red) in line with EU energy labelling. An accompanying text tailored to the installation explains the results to the customer.

The air-conditioning efficiency calculator is aimed at experts in air-conditioning and ventilation, such as energy inspectors, technical building equipment engineers, planners, technical managers of larger installations, experienced energy consultants and auditors of non-residential buildings. In the present form, the label is intended for existing installations. Transfer to new installations is planned in a second stage.

No time limit has yet been laid down. The tool will be available free of charge on the website of the Federal Energy Efficiency Agency at BAFA. In addition, the algorithm has been shared with industry software providers who will integrate the tool into their own software products. A revision of the energy label is still pending.

2.6.3.4 Support programme for ‘Renewable energy heating’; Combined bonus

BAFA promotes the establishment or extension of:

- solar thermal systems with heating support;
- heat pumps;
- biomass installations.

In addition to the basic support, the BMWi grants additional funding for example for the combination of biomass and solar thermal installations, load management capability of heat pumps, etc. BAFA also provides a one-off grant for the optimisation of heating systems already supported (e.g. optimisation of the heating curve, adjustment of the end temperature and pump capacity, use of individual room controls) or a heat pump check. The optimisation grant for the heat pump check is awarded if a comparison has been made between the seasonal performance coefficient calculated in the support application and the seasonal performance coefficient actually achieved in operation. Depending on the outcome, measures for optimisation are proposed or implemented.

2.6.3.5 Meeting user requirements and effective interaction with the building

The **Smart Living** business initiative, launched on 14 March 2017, aims to speed up the transfer of innovation to the market, remove existing barriers and develop sustainable market strategies through joint action by leading German companies and associations. An independent office of the Federal Ministry of Economic Affairs and Energy (BMWi), as a guarantor of neutrality, helps to mediate between the various sectors and to better coordinate policies and initiatives between

politics and economics in the field of smart living. In particular, the office brings political interests into the bodies of the Smart Living business initiative, carries out coordinating tasks, supports implementation measures in coordination with the BMWi and acts as a central point of contact in the topic area of Smart Home/Smart Living at national and international level.

2.6.3.6 Energy-Efficient Urban Redevelopment Programme

With the integrated neighbourhood concepts supported by the KfW programme under the **Energy-Efficient Urban Renovation Programme**, requirements for energy-efficient refurbishment, efficient energy supply systems and the development of renewable energy can be linked to demographic, economic, urban and housing-related issues. The processes initiated on the ground are intended to help to reconcile the interests of the actors involved, in addition to the technical requirements. This will allow the development of integrated, energy-efficient solutions.

2.6.3.7 Heating Networks 4.0 pilot project.

Under the 'Heating Systems 4.0' support programme, the BMWi, through BAFA, is supporting the construction of highly innovative 4th generation heating network systems for the sustainable supply of residential and non-residential buildings, as well as commercial processes with low-temperature heat up to max. 95 °C. Before the construction of a heating network system can be supported, attainability must be demonstrated by means of a feasibility study which is also eligible for funding. Fourth-generation heating networks are characterised by high proportions of renewable energy, the cost-effective provision of this renewable heating, the integration of innovative elements such as seasonal large heat stores and the creation of a flexibility option for the electricity market. Applications may be submitted by all companies, including engineering firms and project developers, municipalities/cities/rural districts, local authority enterprises, municipal associations, registered associations and registered cooperatives. An application may also be submitted by a consortium of different stakeholders. (For further details, see above).

An additional provision for the modernisation of existing heating networks is also being planned. A future basic programme will support the gradual transformation of existing networks from fossil-fired heating infrastructure towards heating supply based on renewable energy sources and the use of unavoidable waste heat.

2.6.4 Initial and continuing training of experts

Responsibility for vocational education and training in Germany is held by the Federal Government and the federal states. The training takes place regularly in a company and is supplemented by the vocational school. The Federal Government sets uniform federal standards for each profession by issuing training regulations for individual professions, which are supplemented by the regional curricula for teaching in vocational schools. The trades which are relevant here, such as heating, ventilation and air conditioning, chimney sweeps, electronics specialists in energy and building engineering or the professions in the construction industry, are subject to the obligation to obtain a master craftsperson's certificate. As a rule, only those who have passed a master craftsperson's examination or have equivalent skills in addition to vocational training can become self-employed.

In the 2018/2019 winter semester, German universities offered 19 559 courses with 8 832 bachelor's and 9 113 master's courses. Engineering accounted for 3 637 courses, broken down into 1 914 bachelors and 1 650 masters.

In the 2017 examination year (winter semester 2016/2017 and summer semester 2017) 473 330 graduates obtained degrees (excluding doctorates) from German universities. Of these, 26.4% (124 935) obtained their degree in engineering. Of these, 2 664 were university degrees, 668 for

teaching examinations, 1 785 for technical university degrees, 72 694 for bachelor's degrees and 47 124 for master's degrees.

Energy efficiency experts come from both the trade in the area of execution and from engineering studies in the area of planning and construction supervision. A special role is played by energy advice, which can be provided by representatives of both groups (see Energy advice). A distinction should be made here between initial and continuing training.

Energy efficiency is already firmly established in the curriculum in the field of **engineering studies** (construction engineering with 10 720 graduates in 2017) and in technical building studies. In study programmes, such as urban planning and architecture, energy-efficiency aspects of buildings are also regularly integrated into study schemes. There are also new courses dedicated to energy efficiency, such as 'Smart Building Structures' (West Saxon University of Zwickau), Building Systems Engineering: Energy-efficient housing and building technology' (Darmstadt University). Further training is facilitated by different structures, such as regional chambers and associations (such as the DEN Academy) or Dena.

2.6.4.1 Qualifications of energy consultants

In order to be admitted to continuing training as an energy consultant, there must be an authorisation to issue in accordance with Section 21 of the EnEV. This includes engineers, architects, craftspeople and technicians with clear qualifications. The conditions to be met have been and will continue to be amended in order to pave the way for the largest possible number of people to obtain qualified energy advice.

Since 2017, qualified experts from other sectors (e.g. craftspeople, energy companies, chimney sweeps) have also been able to provide advice in federal support for energy advice for residential buildings, provided they meet the high qualification requirements. Advice is provided according to the same quality standards as in the past, i.e. the requirements for the qualification of the consultants (initial and continuing training) and the quality of the advice (advisory reports, sample checks) remain unchanged. This will provide consumers with a wider range of qualified energy consultants.

Information on the professional activities of energy consultants is presented in the Energy Efficiency Expert List for federal funding programmes. This helps consumers in searching for suitable experts.

2.6.4.2 Quality assurance in the funded energy advice

Confidence in the consultant's expertise and the trustworthiness of its recommendations are crucial for the acceptance and success of energy advice. In the funded energy advice, quality assurance is provided through the Federal Energy Efficiency Expert List. Only energy efficiency experts who have sufficient professional qualifications (Section 21 of the EnEV and corresponding additional qualifications) and who regularly undergo continuing training may be included in the list.

In addition to quality assurance, the Energy Efficiency Expert List is used by private consumers to find a qualified energy consultant in their region.

2.6.4.3 Qualification testing for energy consultants

In order to meet the widely differing and complex requirements for energy advice, energy consultants need a high level of technical qualification. This is generally regulated in the advisory support programmes through definitively stipulated training professions or courses of study and continuing training, and does not always cover the various ways to qualify as energy consultants. The aim is therefore to extend the existing conditions for admission through a uniform qualification test to include an alternative route of access.

The project ‘Qualification requirements in energy advisory services’ was launched in 2017 with the aim of enabling qualified energy consultants who do not currently meet the conditions of section 21 of the EnEV to participate in federal advisory programmes

As a final result, a uniform examination concept for energy consultants in the residential and non-residential areas is being developed throughout Germany, which forms the basis for the alternative access route. The alternative access route is to be trialled alongside the existing system. The ability to apply relevant expertise in practice and to provide high-quality energy advice can be demonstrated, in particular, by means of a practical test involving both the preparation of an advisory report and a technical interview, which closely approximates a consultation for the recipient of consultancy.

This standard of quality could then also be applied to the non-funded advice. This would be an important step towards a nationwide standard of quality for energy advice and greater transparency for energy consumers.

2.6.4.4 Quality assurance of training

Continuous monitoring of quality development is necessary as the area of energy-efficient construction and renovation is subject to constant change. Training regulations need to be revised for example for roofers. The new training code, which entered into force in 2016, provides that those training as roofers learn to take account of trade-transcending aspects, such as the preparation of attachments and terminations for cable penetrations for solar power units. Trainees also learn to inform customers about major energy-saving measures. In this way, the German Confederation of Skilled Crafts (ZDH) gives education and training providers a tool to identify, in a multi-stage process, at regional and supra-regional level, which skills and training opportunities need to be adapted in a reliable and timely manner. The vocational training centres in the construction and energy network also provide support in identifying the necessary adaptations to the training opportunities with their specific construction and energy expertise. It is particularly important to provide training on a case-by-case basis. Finally, craftspeople already bring with them diverse and very specific knowledge and skills that can only be optimally supported through tailored training. The ZDH has therefore advocated improving the provision of appropriate initial and continuing training opportunities in each company and made a continuing training database available online on 17 March 2017. The continuing training database provides a nationwide overview of the continuing training opportunities offered by the skilled crafts. The available provision being presented in a transparent way means that interested businesses can easily find the training they need. The continuing training database lists more than 5 000 continuing training opportunities in skilled trades across Germany, of which more than 320 in the area of energy-efficient construction. New providers are regularly added with their continuing training courses. The database makes it easier to find suitable continuing training.

In addition, information on career opportunities for crafts and regional contact points for personal career guidance are available.

The chambers of skilled trades of individual federal states offer special continuing training and qualification programmes; Saxony, for example, has developed continuing training as an HVAC efficiency craftsperson.

2.6.4.5 Inter-company vocational training in skilled trades

Since the early 1950s, the Federal Government has promoted the provision of inter-company apprenticeship training in skilled trades (ÜLU). In particular, with the support of the Federal Government, guilds and chambers have set up inter-company training centres as specialised teaching content cannot be taught in all companies. This means that apprentices can take part in profession-specific courses outside their training centre. Grants of around EUR 49 million per year are intended to contribute to the training and accommodation costs to be borne by the training companies. The objectives of this action include:

- securing skilled workers by strengthening and/or maintaining the willingness and capacity of skilled trade businesses to provide training and
- securing technical know-how through high take-up of ÜLU in order to:
    - achieve uniformly high quality of training in each skilled craft profession, irrespective of the specialisation of the individual companies;
    - adapting the level of human resources to technical and economic progress; and
    - reducing the burden on businesses when providing training content that is difficult and time-consuming.

Electronics engineers in energy and building technology will be trained, for example. Teaching content includes, for example, the creation and testing of building communication systems, information technology systems or measurement and analysis. For chimney sweeps, for example, content is provided on coordination and planning to improve the ability of existing buildings and installations to be used in an energy-efficient manner and in particular measures to improve efficiency.

2.6.4.6 Continuing training to become master craftsperson

The most important continuing in the skilled trades is the master craftsperson's examination. Anyone wishing to become self-employed in a skilled trade subject to authorisation under Annex A to the Skilled Trades Code must normally pass the master craftsperson's examination. Hardly any other qualification prepares for self-employment as well as master craftsperson certification. This is based on modern master craftsperson examination regulations drawn up by the BMWi in cooperation with the social partners. Training as chimney sweep, for example, requires that the usability of types of design can be assessed and documented, taking into account ecology, energy efficiency, operational and fire safety, and that their use can be determined and justified. In addition, graduates must be able to review and assess buildings and their structural and technical installations, in particular with regard to operational and fire safety, energy efficiency, environmental and climate protection, and to develop, initiate and monitor optimisation measures. This and other content can be found in numerous other master craftspersons' examination regulations for building-related training professions, which the BMWi is involved in shaping.

2.6.4.7 SME Initiative Energy Transition and Climate Protection – Support of Energy Scouts

The SME initiative Energy Transition and Climate Protection is supported by the four partners the Federal Ministry of the Environment, the Federal Ministry of Economic Affairs, the German Chamber of Commerce and Industry, and the German Federation of Skilled Crafts. Funded by the Federal Ministry of the Environment's National Climate Change Initiative and the Federal Ministry of Economic Affairs and Energy's Energy Efficiency Fund, it initiates projects and events throughout Germany to raise awareness on energy efficiency and climate protection among small and medium-sized industrial, commercial and craft enterprises and to disseminate new impetus and ideas to promote energy efficiency in businesses.

One of these initiatives is the creation of energy scouts. These are trainees who acquire know-how on energy efficiency from the chambers of commerce and industry. They help their training companies to manage energy wisely and take responsibility for their own projects.

In addition to the advantages energy optimisation offers to training companies, qualification in times of shortage of applicants for training increases the attractiveness of the training company. The chambers of industry and commerce offer several workshop modules to participating companies. All training professions are welcome, and specialisation is not required.

The first module 'Introduction to Energy Efficiency' provides a basic understanding of the topic of energy from production to consumption and knowledge of energy efficiency. The following modules cover communication, project work and work with measuring instruments. Two further modules on

company mobility management and material and resource efficiency have been added to the contents of the qualification measure since 2017.

An essential part of the qualification is a practical energy efficiency project which the trainees design and implement together with their training management or an energy officer in the company.

Altogether more than 2 000 trainees from around 700 companies across Germany have qualified as energy scouts since the start of 2014.

2.6.4.8 SME Initiative Energy Transition and Climate Protection – Guide to Energy Efficiency in Crafts

As part of the SME initiative Energy Transition and Climate Protection, the trade environmental centres have developed and tested materials and advisory tools that have proved their worth in providing energy advice in seven skilled trades. They can be used by experienced consultants to provide 'their businesses' with systematic guidance on energy efficiency, and provide a safe guide to colleagues who are new to the topic when it comes to initiating energy efficiency measures in companies. (www.energieeffizienz-handwerk.de)

2.7 Wider benefits of refurbishment

2.7.1 Wider benefits

Under Article 2a(1) of the EPBD 2018, the 'long-term renovation strategy', should encompass, in addition to an evidence-based estimate of expected energy savings, wider benefits, such as those related to health, safety and air quality.

In principle, energy-efficient refurbishment aims to reduce energy demand. However, it also brings other benefits, such as improved housing health for building users and, in the long term, for society, as labour productivity increases when fewer people are ill. This micro- and macro-economic added value should be taken into account in the cost-effectiveness analysis and communication with target groups. The assessment of the benefits of energy-efficient modernisation is often reduced to comparing the saved energy costs with the cost of the saving measures. This approach ignores other relevant benefits and underestimates the overall benefits that modernisation measures can bring.

Investments in energy-efficient refurbishment of buildings between 2010 and 2016 total around EUR 40 billion per year (at manufacturing prices) and are provisionally estimated at EUR 42 billion in 2016. Of this, around EUR 2 billion is imported from abroad. The gross product associated with these investments is significantly higher than the investment itself, as it also includes the outlay (indirect production effects) needed to produce the investments. The gross product in 2016 totals EUR 73 billion. Residential construction accounts for about two thirds of total production impacts, while non-residential construction accounts for one third. A total of 544 000 people are needed to provide the goods and services for energy efficiency measures in the building stock. This includes, in addition to direct employment, indirect employment in upstream production, which accounts for around 40% of total employment generated. After a noticeable increase in the production volume of potential energy efficiency products in Germany between 2009 and 2011, it has remained relatively stable since at between EUR 20 and 21 billion (2016: EUR 20.6 billion). By far the greater part of production is in the sub-segment of the rational use of energy (production, repair and installation of thermal insulation and heat exchange products) with EUR 18 billion, predominantly heat insulation products (EUR 16.7 billion).

2.7.2 Instruments

The individual **building renovation passport (iSFP)** takes into account the added value of energy renovation of residential buildings in the energy advice for residential buildings. iSFP assists the energy consultant in drafting the advisory report. At the end of the consultation, the client will

receive a iSFP tailored to them and their building. iSFP is financially supported through the energy advice for residential buildings (on-site advice, building renovation passport) with up to 80% of the consultancy costs incurred through a grant (see 2.3.3.2).

In the accounting software with a iSFP module, under the heading 'Your house in the future – these are your benefits', the energy consultant can choose from eight icons representing different added value. In addition, these icons appear on the overview pages of the packages of measures. This will allow building owners to recognise what additional benefits will be achieved through which package of measures. The assessment of installation technology is carried out in the BRP in the same way as the assessment of components using a colour chart. The presentation of the indicators in the form of numbers or letters was deliberately omitted in order to avoid further classification and thus avoid any confusion. The building components are assessed on the basis of the requirements of the EnEV and KfW for individual building parts. Individual parts are grouped into components, e.g. roof and top storey ceiling both belong to the roof component. The energy efficiency condition is presented using mean U-values. Depending on the component, different characteristics are used as limit values for the different colour classes. The type of ventilation is classified into efficiency classes according to the heat delivery rate and the specific power consumption of the ventilator. A modern ventilation system with high heat recovery (≥ 85%) is classified in the best efficiency class, while window-only ventilation is classified in the worst efficiency class. (See **Alongside savings in energy, greenhouse gases and heating costs, the energy-efficient refurbishment of your house automatically brings other benefits. The improvements the refurbishment roadmap envisages for your house are summarised here:**

Thermal comfort: free from unpleasant draughts, radiation of heat and cold
Unpleasant draughts are prevented by leaktight doors and windows. The insulation of walls and roof also substantially improves comfort.

Protection from summer heat; protection against overheating in the summer
Shading for roof and façade windows are the most important protection against overheating. The insulation of roof and façade also improves protection against heat.

Acoustic protection: free from noise and sound from the surroundings
Leaktight doors and windows substantially improve acoustic protection. The insulating materials also contribute to better acoustic protection.

Residential health: free from damp, mould and toxins in interior rooms
Insulated, warm building units and guaranteed ventilation reliability ensure a healthy indoor climate without mould and toxins.

Property value: increase in the market value of the building
The useful value of a refurbished building can match that of newly erected buildings. At the same time, it increases the market value of the building.

Security: protection against burglary and theft
If new doors and windows are installed, a higher class of resistance can be chosen and protection against burglary can therefore be increased.

Architectural quality: design of the external appearance of your building
Refurbishment enables you to design your house as you wish, for example the colours of the roof or façade or the door and window design.

Freedom from barriers: simple usability of the building for everyone
When the building is refurbished, barriers in and to the house can be removed and access for everyone can be made easier, from prams to elderly people.

Figure 11)

Alongside savings in energy, greenhouse gases and heating costs, the energy-efficient refurbishment of your house automatically brings other benefits. The improvements the refurbishment roadmap envisages for your house are summarised here:

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If new doors and windows are installed, a higher class of resistance can be chosen and protection against burglary can therefore be increased.

Architectural quality: design of the external appearance of your building
Refurbishment enables you to design your house as you wish, for example the colours of the roof or façade or the door and window design.

Freedom from barriers: simple usability of the building for everyone
When the building is refurbished, barriers in and to the house can be removed and access for everyone can be made easier, from prams to elderly people.

Figure 11: Presentation of the added values of refurbishment in the iSFP

Uncomfortable draughts are prevented by more leaktight doors and windows. Insulation of walls and roofs also significantly increases comfort. Shades for roof and façade windows are the most important **protection against overheating**. The insulation of the roof and façade also improves heat protection. It is therefore of great importance for **thermal comfort** and the prevention or saving of cooling energy. In the light of climate change and more frequent heat waves, the issue is also becoming increasingly important in climate adaptation strategies. Proof of summer thermal insulation has already been an integral part of the proof procedure in new construction since the EnEV 2009. According to the EnEV, new construction requirements must be met for summer thermal insulation for residential and non-residential buildings in accordance with DIN 4108-2. The proof may be provided through a simplified procedure, using insolation indicators, or through a thermal building simulation.

In addition, the **Workplaces Regulations (ArbStättV)** lay down protection objectives for the establishment and operation of buildings intended to be **used for workplaces**. These also affect the indoor climate and protection. The corresponding requirements of the ArbStättV are specified in the **Technical Rule for Workplaces 3.4 'Indoor temperature' (ASR 3.4)** of the Federal Ministry of Labour and Social Affairs. It must be ensured that a maximum summer temperature of +26 °C is not exceeded in work rooms and that excessive sunlight is avoided. Building insulation and sun protection devices contribute to meeting these requirements.

In addition, when planning major energy refurbishment measures for older buildings which are intended to be used for jobs, it must be examined whether, because of the **expiry of the transitional provisions of Section 8 of the Workplaces Regulations on 31 December 2020**, there may still be a need to make structural adjustments to adapt to the current construction requirements in accordance with ArbStättV.

The **assessment parameters of thermal comfort** are defined in DIN ISO 7730 on the basis of two indicators: the (mean) indoor climate assessment by users – the Predicted Mean Vote (PMV) and the resulting (expected) percentage of dissatisfied users (PPD) – the Predicted Percentage of Dissatisfied (PD).

Requirements for **moisture protection** are laid down in the building regulations of each federal state. Minimum requirements are set out in DIN 4108-3. There are three ways in which the moisture protection of thermally insulated building units can be ensured. Standard moisture protection ensures that damp patches are not formed with mould or fungal attack, that thermal insulation is not compromised and that the structure is not damaged.

An **airtight building envelope** prevents unintentional exchange between indoor and outdoor air and thereby avoids building damage, ventilation heat losses, increases thermal comfort, improves noise protection and fire safety and preserves air quality. Under Section 6 of the EnEV 2014, buildings to be erected must be constructed in such a way that the heat-transferring surface, including the joints, is permanently airtight in accordance with the generally recognised state of the art. Buildings to be erected must be constructed in such a way as to ensure the **minimum air replacement** required for health and heating purposes. KfW also sets out requirements for the airtightness of a building during refurbishment in its technical fact sheets

The useful value of a renovated building can easily match that of newly erected buildings. This also increases the **market value** of the building. A green energy class on the energy certificate can increase the value of the property. Energy-efficient renovation prior to the sale of the property thus leads to an increase in value.

If new doors and windows are installed, a higher resistance class may be chosen, thus increasing **protection against burglary**. In the 'Energy-Efficient Renovation' support programme, the Federal Government, through KfW, promotes the renewal of **windows and external doors**. Leaktight doors and windows significantly increase **noise protection**. Insulating materials also contribute to better noise protection. The 'Age-Appropriate Conversion' programme supports anti-burglary measures. In parallel, the programme can also be used for **barrier-reducing** measures. In order to protect people from unacceptable nuisance in their homes, minimum noise protection requirements were laid down in DIN 4109 'Sound insulation in buildings'. VDI 4100 'Sound insulation between rooms in buildings - Dwellings - Assessment and proposals for enhanced sound insulation between rooms' can also be used to assess and improve noise protection. The increased noise protection should already be taken into account by developers and planners when constructing a building and contractually agreed.

The **fire safety measures** to prevent and control fires are determined by building regulations, implementing regulations and administrative provisions. In addition, there are special regulations for places of assembly, business premises, garages, schools and other special buildings. To demonstrate that the general requirements of building regulations are met, the national standard DIN 4102 specifies terminology for classifying fire behaviour.

The fireplace inspection (Section 14 of the Chimney Sweeping Trades Act - SchfHwG) is a visual inspection/check of the whole plant in order to certify operational and **fire safety**, as thermal loads, chemical effects, etc. lead to wear and tear in all combustion plants.

It is therefore determined whether the combustion plant is still safe in terms of operation and fires or whether there are deficiencies. The chimney sweep has to check, among other things:

- condition of fireplaces, e.g. stability;
- fire safety distances from components made of combustible materials;
- condition of the exhaust systems, e.g. tightness of flues;
- additional devices such as non-combustible aprons in front of combustion chamber openings;
- installation room and fuel supply;
- safety equipment for chimney sweeping;
- data from the official sweeping book and, if necessary, updating (reconciliation of master data).

In addition to ensuring fire safety, other risks to physical health have been addressed for some time. Asbestos, for example, started to be removed at an early stage in Germany. Sprayed asbestos was banned in the Federal Republic in 1979, and as early as 1969 in the GDR. However, the management of asbestos already installed in existing buildings remains an issue. In 1983, the Building Standardisation Commission of the Conference of Ministers of Construction in the federal states (ARGEBAU) set up a project group on asbestos removal. The **guideline on the evaluation of loosely bound asbestos products in buildings (Asbestos Guideline)** has been included in the model list of Technical Construction Specifications. An amended version was published in 1996. The Guideline was editorially revised in 2019 following amendments to TRGS 519 and VDI Guideline 3492. The draft was included as Annex 16 in MVV TB 2020/1. Once the notification procedure of the Model Administrative Provisions – Technical Building Rules (MVV TB) has been completed, the Directive will be transposed into regional law.

Further asbestos-containing building products that to date have received little attention have recently come into the spotlight. These are the subject of the **National Asbestos Dialogue**, which is conducted jointly by the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (BMU), the Federal Ministry of the Interior, Building and Home Affairs (BMI) and the Federal Ministry of Labour and Social Affairs (BMAS) and experts from the umbrella organisations of those involved in construction.

Until the entry into force of the **general ban on the production and use of asbestos in Germany on 31 October 1993**, asbestos fibres were present in many construction products. This applies not only to asbestos-cement roofing and façade panels, but also to **plasters, adhesives, jointing compounds, paints, screeds and floor coverings**. All buildings that were erected before the above effective date or erection of which began before this effective date are in principle affected. This concerns about 80% of all existing buildings in Germany, which are also particularly in focus for energy-efficient refurbishment. Work on construction products containing asbestos is subject to strict restrictions in the field of health and safety at work and environmental/waste legislation. Particular mention should be made of the **Hazardous Substances Regulation**, which is specified in the Federal Ministry of Labour and Social Affairs **Technical Rule for Hazardous Substances 519 'Asbestos – demolition, remediation or maintenance works' (TRGS 519)**.

With regard to the proper disposal of construction waste containing asbestos, account should be taken of the **communication from the Federal Government/federal states Working Group on Waste 23 (LAGA M 23) entitled 'Enforcement assistance for the disposal of waste containing asbestos**', which is currently undergoing revision.

Information on the safe handling of asbestos-containing construction products in existing buildings will shortly (as of 1 March 2020) be available as an important result of the National Asbestos Dialogue with www.asbestratgeber.de, in particular for **non-specialists**.

In addition to asbestos-containing construction products, **other building pollutants** must also be taken into account when building refurbishment measures are taken. These include old mineral wool insulation materials, tar-containing building materials (PAHs), wood preservatives (PCBPCP, lindane,

DDT), PCP, polychlorinated biphenyls (PCBs, e.g. in permanent elastic joint sealants on external façades) and coatings containing heavy metals. These substances also have specific requirements for industrial safety and disposal.

As a general rule, **dust minimisation measures** must be taken into account in all activities in order to ensure the protection of humans and the environment. For further information, reference is made to the ecological **building materials information system WECOBIS** (www.wecobis.de) of the Federal Ministry of the Interior, Building and Home Affairs (BMI) and the Federal Ministry of Labour and Social Affairs (BMAS) **'Dust minimisation in construction' action programme** (www.staub-war-gestern.de)

The sustainability of buildings is also playing an increasingly important role. The aim of rating systems is to describe and assess the quality of the **sustainability of buildings** and structures in their complexity. This process covers the whole life cycle of the building, from planning to construction, use, maintenance, maintenance to demolition/recycling of buildings and structures, and is expected to lead to higher quality of construction. Modernisation approaches can also be assessed. The evaluation systems should take due account of the importance of socially recognised objectives and content and allow for a balanced assessment of environmental, economic, social, functional and technical aspects, while considering the quality of planning, implementation and management processes.

The Federal Ministry of the Interior, Building and Home Affairs (BMI) has developed and published an evaluation system in cooperation with the German Society for Sustainable Building (DGNB), primarily for the interests of federal construction, The BMI applies the BNB usage profiles (office and administrative buildings, educational buildings, laboratory buildings, outdoor facilities) for construction works under its own responsibility and issues certificates. The use of systems to describe and assess the sustainability quality of buildings and structures is voluntary. In addition to the BNB for public buildings, the BMI provides the 'Sustainable Housing Assessment System' (BNK) for use in single and two-family houses and in small apartment blocks (with up to five housing units).

The nominal **building volume** in the building stock in 2017 stands at a value of EUR 206 billion. Compared to 2012, this represents an increase of 11%. In the housing sector, the increase was 14%. In the case of non-residential construction, the stock measures increased by only 6%. Energy refurbishment measures represent a significant part of the high importance of construction work on existing buildings. Integrated into the calculation scheme for the construction volume, more than EUR 62 billion was accounted for by such measures in the existing stock in 2017. Some EUR 41 billion of this was spent on energy-efficient refurbishment of residential buildings and some EUR 21 billion on non-residential buildings. The development dynamics in the field of energy-efficient refurbishment was relatively weak between 2012 and 2015. However, investment in energy-efficient refurbishment in residential and non-residential buildings has increased significantly in the last two years. The level of renovation in 2017 was about 20% higher than in 2015. *(BBSR – Structural data on production and employment in construction)*

Between 2012 and 2017, building sector statistics show an increase in employment of more than 12% in the construction sector as a whole. In 2016, the German construction trade employed some 2.3 million people.

3 Public consultation and monitoring

3.1 Energy Transition Platform on Buildings

The Energy Transition Platform on Buildings, launched on 3 July 2014, discusses the multiple potential of the buildings sector for the energy transition with stakeholders from real estate, the trades, industry, consumers and the public sector.

The Energy Transition Platform Buildings Plenary brings together relevant stakeholders from industry, civil society, the scientific community and relevant departments. Due to the many substantive interfaces with the Ministry of Construction, there is co-chairmanship by the Federal Ministry of Economic Affairs and Energy (BMWi) and the Federal Ministry of the Interior (BMI). There is discussion here of the building-related results and intermediate statuses of the working groups of the two energy transition platforms, efficiency and buildings. Parallel discussions take place with the federal states.

Since 2014, regular meetings have taken place which have influenced many of the energy transition issues, including the National Energy Efficiency Action Plan (NAPE), the Energy Efficiency Strategy for Buildings (ESG), the Green Paper on Energy Efficiency and the individual building renovation passport (iSFP), as well as implementation of the BMWi support strategy.

The tenth meeting was held on 12 November 2019. At that meeting, the draft 'long-term renovation strategy' under Article 2a of Directive (EU) 2018/844 was announced to approximately 100 participants. The participants in the Energy Transition Platform on Buildings have received the LTRS draft and have been asked to comment in writing. Germany has therefore chosen a format of discussions and the possibility of written comments for the LTRS consultation process. The results of the public consultation are summarised in the report on the public consultation on the long-term renovation strategy.

3.2 Roadmap Energy Efficiency 2050 dialogue process

In addition, as of 2020 there is the new dialogue process **'Roadmap Energy Efficiency 2050'.** The Federal Government has set itself the objective of halving primary energy consumption (PEC) by 2050 compared to the base year 2008. New solutions are need to achieve this long-term objective. The Federal Government will therefore launch the 'Roadmap Energy Efficiency 2020' dialogue process in 2050 with the broad participation of the sectors concerned, consumers, civil society representatives and scientific experts. This roadmap process is intended for discussion of cross-sectoral pathways to achieve the 2050 reduction target and to develop proposals for their implementation. Particular attention is to be paid to the impact of the identified pathways on different groups of stakeholders (e.g. consumers, suppliers, policy makers). As a result of this process, a final document will be produced that identifies political, economic and legal challenges as well as practical options for action and solutions to achieve the 2050 target. The aim of the dialogue process is also to develop practical energy efficiency measures in a conceptual manner and to draw up proposals for the operationalisation of the efficiency-first principle. The new measures can support both the achievement of the 2030 targets as well as achievement of the 2050 targets. The substantive priorities of the roadmap process are defined taking into account the further technical dialogues needed to implement the climate package or for specific aspects such as the development of a hydrogen strategy.

3.3 Monitoring

The development of the energy transition is continuously tracked by the Federal Government's 'Energy of the Future' monitoring process.

The task of the monitoring process is to make available energy statistical information more condensed and understandable. Measures already taken are included in the analysis, as are the areas in which efforts will be needed in the future.

The centrepiece of the process is the annual monitoring report, which provides, for the preceding year, an evidence-based overview of progress in the implementation of the energy transition.

It thus also serves to fulfil the Federal Government's reporting obligations under the provisions of the Energy Industry Act and the Renewable Energy Act.

The key source of the monitoring report is official energy statistics, which are supplemented by further data and statistics from the Federal Network Agency, the Federal Environment Agency and the Working Group on Energy Balances.

The monitoring report is adopted by the Federal Cabinet and forwarded to the German Bundestag and the Bundesrat.

An independent Commission tracks the process and provides scientific advice on the monitoring reports concerned. The opinions of the Commission of Experts are published together with the Federal Government's report.

In the monitoring report 'The future of energy', the chapter on buildings shows the energy performance indicator – illustrated numerically through non-renewable primary energy consumption ($PEV_{n.E.}$) according to the BMWi calculation (see Sections 1.1.1) – on an annual basis.

3.3.1 Progress report on the energy transition

The more detailed progress report on the energy transition is presented every three years instead of the monitoring report. The Federal Government published the second progress report on 6 June 2019.

The progress report provides more comprehensive observation of the energy transition and allows more in-depth analysis over a longer period of time, identifying reliable trends. It also looks to the future, with an assessment of whether and to what extent the objectives of the energy concept will be achieved in the medium to long term and what new measures need to be taken.

4 Actions and mechanisms to support the mobilisation of investments in the buildings sector

4.1 CO_2 Building Refurbishment Programme and MAP of the Federal Government'; 'Green Bonds' of Kreditanstalt für Wiederaufbau (KfW)

In the established support programmes 'CO_2 Building Renovation Programme' and MAP (see 2.3.2.2 and 2.3.2.3) the Federal Ministry of Economic Affairs and Energy mobilises private capital for investments in energy efficiency and renewable energy in the building sector through the granting of low-interest loans in conjunction with repayment grants and investment grants. The CO_2 building renovation programme has generated a total of around EUR 385 billion of private investment since 2006 and the MAP has generated more than EUR 20 billion since 2000. Existing market barriers and profitability gaps in the area of energy-efficient refurbishment and highly energy-efficient new buildings can therefore be effectively overcome; at the same time, jobs will be safeguarded, particularly in small and medium-sized enterprises. The transfer of the existing programmes to the new 'Federal Support for Efficient Buildings' (BEG) as part of the support strategy 'Energy Efficiency and Heat from Renewable Energy' (2.3.2.4) is intended to channel private investment even more specifically towards measures to improve building efficiency and the use of renewable energy in heating and cooling supply.

In order to refinance the loans granted to the beneficiaries under the CO2 building renovation programme, KfW issued 'green bonds' for the first time in 2019 for sectors of the programme ('energy-efficient construction').

4.2 Energy Efficiency Networks Initiative

In December 2014, the Federal Government, together with 22 business associations, launched the Energy Efficiency Networks Initiative (IEEN). The goal of the IEEN is to initiate a total of 500 new

energy efficiency networks by 2020. The initiative aims to make a tangible contribution to meeting the climate protection objectives by saving 5 million tonnes of CO_2. The initiative helps companies to set objectives to use energy more efficiently under their own responsibility. In the IEEN, at least five companies form a network over a defined period of time, set a common energy saving target and exchange views on how to implement efficiency measures. Mutual motivation and moderated exchange of experience between companies contribute to the success of networking. This enables companies in the networks to acquire the necessary technical and organisational knowledge to make significant progress in efficiency. Since the launch of the initiative, more than 270 networks of over 2 400 participating companies have been registered. A continuation of the initiative beyond 2020 is aimed for.

4.3 The 'Germany Does It Efficiently' campaign

The Federal Ministry of Economic Affairs and Energy launched the nationwide information offensive 'Germany Does It Efficiently' in May 2016. The campaign informs, creates awareness and motivates involvement because the message that energy efficiency does not mean going without but adds value in many areas needs to be more strongly endorsed among the target groups. The campaign provides comprehensive and clear information on advice and support programmes offered by the Federal Government and the federal states on energy efficiency measures for home owners, private households, businesses and local authorities. The offensive is supported by a number of high-profile actions. These are flyers and brochures, a website with wide-ranting information and advice, advertisements and posters. In addition, multipliers are taken on board: Experts from associations, craft businesses and trade unions, who have a great deal of experience and who directly address households, businesses and local authorities as 'energy-efficiency ambassadors'. They can also use the logo of the information campaign in their outreach activities and use flyers, posters and other material.

4.4 Support of advice on energy-saving contracting in the framework of the EBK

As part of the advisory programme 'Energy advice for non-residential buildings of local authorities/non-profit organisations', a 'contracting cheque' (up to 80% of the net consultancy fee, with a maximum of EUR 2 000) is provided for local authorities and non-profit organisations. A qualified energy consultant examines whether and how the measures proposed in a previous energy audit (also supported) or consultation (refurbishment roadmap) can be implemented using an appropriate contracting model. The aim is to draw the attention of local authorities to the often unfamiliar possibilities of different contracting models, encouraging greater use of energy-saving contracting in particular. Further development of contracting support is currently being considered.

4.5 Information on existing contracting model contracts

The website of the Federal Energy Efficiency Agency provides information on contracting model contracts and guidelines on energy-saving contracting available free of charge. This includes offers specifically aimed at public properties or local authorities.

Federal Government/federal state dialogue on energy-saving contracting

The project will provide a platform for intensive exchanges on energy-saving contracting between representatives of the Federal Government and the federal states. The project aims to remove barriers to the implementation of energy-saving contracting and to build up regional expertise in this area. This will be done through annual plenary meetings and workshops, as well as a mentoring programme and the exchange of examples of best practice. The development of regional centres of excellence is also supported.

Model project contracting

The dialogue between the Federal Government and the federal states mentioned above (ESC) also promotes the practical implementation of around 10-15 ambitious energy-saving contracting model projects in representative properties in local authorities and at federal state level, with the aim of providing a model for the potential of contracting and thus prompting the establishment of a functioning ESC market in Germany. The model projects will also be used to train key players and develop standards and guidelines for similar projects and, where appropriate, future support programmes.

4.6 Mandatory energy audits for non-SMEs

Under Article 8 of the European Energy Efficiency Directive, Germany requires non-SMEs to carry out energy audits in accordance with DIN 16247-1. Alternatively, companies may introduce an energy management system or an environmental management system. The amendment, which entered into force in November 2019, implements mandatory online notification and a continuing training requirement for energy auditors and further measures to improve the quality of energy audits. The online notification will provide businesses in future with guidance on appropriate support schemes, campaigns such as energy efficiency networks and sector-specific examples of best practice. This is intended to help increase the acceptance and effectiveness of the energy audit obligation.

4.7 Refurbishment configurator

With the 'Refurbishment Configurator' service launched in 2012 (https://www.sanierungskonfigurator.de/start.php), building owners and tenants can learn about possible refurbishment measures on their building, their cost and savings potential and state support programmes on a dedicated website of the Federal Ministry of Economic Affairs and Energy . The technical facts are prepared in a user-friendly manner and are visualised and presented in a modern, appealing and motivational way. The building to be renovated is freely configurable in terms of its parameters (size, ground plan, year of construction, etc.). Around 24 000 calculations are carried out each year with the renovation configuration.

4.8 Serial renovation

Energy-efficient renovation has so far been based on a very high proportion of skilled trade work at the construction site. Cost certainty at the start of the measures is very limited due to the complexity of the established construction process, even for small buildings. Overall, these aspects pose a significant barrier to faster energy-efficient refurbishment of the building stock.

In order to resolve these issues, to prepare the market for high-efficiency, innovative complete renovations together with the relevant stakeholders, and thus to continue to drive renovation towards a climate-neutral building stock, the German Energy Agency (dena), together with the construction industry and the real estate sector, is launching the project 'Serial refurbishment of apartment blocks' with funding from the BMWi and with the involvement of the Dutch initiative 'Energiesprong'.

Industrial production is in principle conceivable for many types of buildings. For the next three years, however, the focus will be on the stock of housing companies (mostly apartment blocks) as there may be only a relatively small number of decision-makers on the refurbishment of a very large number of buildings among them. A large number of renovations are necessary to generate sufficient demand for industrially prefabricated façade and roof modules and necessary technology, which in turn makes serial refurbishment competitive with conventional energy-efficient refurbishment in terms of price.

The buildings refurbished in a serial process differ fundamentally from previous refurbishment schemes due to lower prospective costs, a short refurbishment period (a few weeks), attractive design and a guarantee of function and savings.

The objective of the project is to connect innovative housing companies with smart construction companies, transform neighbourhoods and improve the quality of life of residents.

During the 2017-2019 project period, market barriers are being removed in close exchange with the housing sector and the building industry and confidence is being built between the stakeholders. The aim is to jointly develop prototypes to show which serial refurbishment solutions can be implemented in Germany.

First prototypes are currently being implemented in Germany. The project 'Serial refurbishment of apartment blocks' will continue beyond 2019 and include further types of buildings.

4.9 One-stop shop and guide to energy efficiency support

Potential beneficiaries are often not sufficiently informed about existing support schemes to improve energy efficiency and use of renewable energy for heating in buildings, industrial processes and installations, and existing information and the application process are regarded as too complex from the point of view of customers.

As a consequence of this finding, in cooperation with the programme implementers BAFA and KfW, the online tool entitled 'Guide to Energy Efficiency Support' was designed, guiding potential beneficiaries from all target groups (private individuals, businesses, local government and non-profit organisations) through a compressed question and answer scheme along a simple path to the correct support programme from the customer's point of view. Since 24 January 2020, the 'Energy Efficiency Support Guide' has been available at www.machts-effizient.de/foerderwegweiser, as well as at KfW.de and BAFA.de.

The Energy Efficiency Support Guide is also an important building block of the planned digital one-stop-shop scheme, which is intended not only to draw the attention of recipients to the appropriate support programme, but also to guide them directly through the complete application process in a prospective manner.

4.10 Asset Class Energy Efficiency (ACE) project

Since the beginning of September 2017, the Baden-Württemberg Climate Protection and Energy Agency (KEA) together with the Institute for Energy Efficiency in Production (EEP) of the University of Stuttgart and the German Enterprise Initiative for Energy Efficiency (DENEFF) have been developing standardisation and pooling approaches for energy efficiency measures. The Federal Ministry of Economic Affairs and Energy (BMWi) is supporting the project for a period of 18 months (September 2017 to February 2019).

Alongside the difficulty of correctly assessing and minimising risk, the main challenge lies in the small share of energy efficiency projects and the associated small project volumes (high risk and transaction costs). Together with stakeholders, innovative solutions have been developed in the form of three products tailored to the needs of funders.

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Residential floor areas from the building model Prognos 2018, based on the census data.

Annex: Report on the public consultation on the Federal Government's long-term renovation strategy

Pursuant to Article 2a of Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings (EPBD 2018)

Introduction

The national consultation on the draft long-term renovation strategy (LRTS) of the Federal Government pursuant to Directive (EU) 2018/844 amending Directive 2010/31/EU on the energy performance of buildings (Energy Performance of Buildings Directive, EPBD 2018) took place in writing between 7 May and 20 May 2020 on the basis of the draft LTRS of 7 May 2020 and a consultation sheet broken down into the chapters of the LTRS.

The results of the public consultation are presented in the following report in accordance with Article 2a of the EPBD (2018). The summary of the responses is reproduced in the report without comment. It can be established from the LRTS to what extent they have been taken into account.

A total of 53 opinions on the consultation were received.

Of these, 42 opinions were received from associations, 2 from companies, 2 from research bodies and 7 from federal states.

The language conventions and abbreviations used to make the analysis of the online consultation easier to understand are as follows:

Table 1 – Language conventions used for the number of responses

Number of responses	**Language convention**
1	one stakeholder
2 to 4	some stakeholders
5 to 14	many stakeholders
from 15	very many stakeholders

Table 2 – Participating institutions

The following stakeholders, institutions and organisations took part in the consultation[4]:

Institution	Abbreviation	Group of participants
Building Performance Institute Europe	BPIE	Research
Bundesindustrieverband Technische Gebäudegeräte e.V. [Federal Association for Technical Building Equipment]	BTGA	Association
Bundesverband der Deutschen Heizungsindustrie e. V. [Federal Association of German Heating Industry]	BDH	Association
Bundesverband der Deutschen Industrie e. V. [Federation of German Industries] [5]	BDI	Association
Bundesverband der Deutschen Ziegelindustrie e.V. [Federal Association of the German Brick Industry]	ZIEGEL	Association
Bundesverband der Energie- und Wasserwirtschaft e.V. [Federal Association of Energy and Water Industries]	BDEW	Association
Bundesverband deutscher Wohnungs- und Immobilienunternehmen e.V. [Federal Association of German Housing and Real Estate Companies]	GdW	Association

[4]Three associations did not agree to the publication of their opinion and are not listed by name.

[5] Joint opinion with ZVEI

Bundesverband energieeffiziente Gebäudehülle e.V. [Federal Association of Energy-Efficient Building Envelopes][6]	BuVEG	Association
Bundesverband Erneuerbare Energie e.V. [Federal Renewable Energy Association]	BEE	Association
Bundesverband Freier Immobilien- und Wohnungunternehmen e.V. [German Association for Private Housing and Real Estate Companies]	BFW	Association
Bundesverband Kalksandsteinindustrie e.V. [Federal Association of Sand-Lime Brick Industry]	BVKSI	Association
Bundesverband Mitteltändischer Ölunternehmen e.V. [Federal Association of Small and Medium-Sized Oil Companies]	UNITI	Association
Bundesverband Neue Energiewirtschaft e.V. [Federal Association of Energy Market Innovators]	bne	Association
Bundesverband Wärmepumpe e.V. [Federal Heat Pump Association]	BWP	Association
Daikin Airconditioning GmbH	DAIKIN	Company

[6] Joint opinion with FMI

Deutsche Gesellschaft für Mauerwerk und Wohnungsbau e.V. [German Society for Masonry and Housebuilding]	DGFM	Association
Deutsche Säge- und Holzindustrie Bundesverband e.V. [Federal Association of Sawmilling and Wood Industries]	DeSH	Association
Deutsche Umwelthilfe e.V. [Environmental Action Germany]	DUH	Association
Deutsche UnternehmenInitiative Energieeffizienz e.V. [German Industry Initiative for Energy Efficiency]	DENEFF	Association
Deutscher Verein des Gas- und Wasserfaches e.V. [German Technical and Scientific Association for Gas and Water]	DVGW	Association
Deutsches Energieberater-Netz e.V. [German Network of Energy Consultants]	DEN	Association
Energieberaterverband GIH [Association of Energy Consultants GIH]	GIH	Association
Fachverband Mineralwolleindustrie e.V. [Trade Association of the Mineral Wool Industry]	FMI	Association
geea – Allianz für Gebäude-Energieeffizienz [geea – Alliance for Building Energy Efficiency]	geea	Association

Hauptverband der Deutschen Bauindustrie [Federation of the German Construction Industry]	Bauindustrie	Association
Haus & Grund Deutschland [House & Land Germany]	H&G	Association
Industriegewerkschaft Bauen-Agrar-Umwelt [Trade Union for Building, Forestry, Agriculture and the Environment]	IGBau	Association
Institut Wohnen und Umwelt GmbH [Institute for Housing and Environment]	IWU	Research
NABU Bundesgeschäftsstelle [NABU Federal Office]	NABU	Association
re!source Stiftung e.V. [relsource Foundation]	re!source	Association
Repräsentanz Transparente Gebäudehülle [Representative Office Transparent Building Envelope]	RTG	Association
Vaillant GmbH	Vaillant	Company
VDMA – Forum Gebäudetechnik [Building Engineering Forum]	VDMA	Association
Verband für Wärmelieferung e.V. [Association for Heating Supply]	VfW	Association
Verband kommunaler Unternehmen e.V. [Association of Local Public Utilities]	VKU	Association

Verband Privater Bauherren e.V. [Association of Private Developers]	VPB	Association
Verbraucherzentrale Bundesverband [Federation of German Consumer Organisations]	vzbv	Association
Zentraler Immobilien Ausschuss e.V. [German Property Federation]	ZIA	Association
Zentralverband der Deutschen Elektro- und Informationstechnischen Handwerke [Central Association of the German Electrical and Information Technology Trades]	ZVEH	Association
Zentralverband des Deutschen Baugewerbes [Central Association of the German Construction Industry]	ZDB	Association
Zentralverband des Deutschen Handwerks {German Confederation of Skilled Crafts]	ZDH	Association
Zentralverband Elektrotechnik- und Elektronikindustrie e. V. [German Electrical and Electronic Manufacturers' Association]	ZVEI	Association
Zentralverband Sanitär Heizung Klima [Central Association for Plumbing, Heating and Air Conditioning]	ZVSHK	Association

Bavarian State Ministry for Economic Affairs, Regional Development and Energy	Bavaria	Federal state
Baden-Württemberg Ministry for the Environment, Climate and Energy	Baden-Württemberg	Federal state
Free and Hanseatic City of Hamburg, Urban Development and Housing Authority	Hamburg	Federal state
Hessen Ministry for Economic Affairs, Energy, Transport and Housing	Hessen	Federal state
Ministry for Economic Affairs, Innovation, Digitisation and Energy of North Rhine-Westphalia	North Rhine-Westphalia	Federal state
Saxony State Ministry for Finance	Saxony	Federal state
Construction and Housing Department of the Ministry for the Interior, Rural Areas, Integration and Equality of the Federal State of Schleswig-Holstein	Schleswig-Holstein	Federal state

The following is a summary of the main points raised in the responses to the public consultation on the LTRS of the Federal Government. Because of the summary nature of this report, individual opinions are not regularly reproduced. Please refer to the consultation reports submitted by the various stakeholders, which are published online, subject to the agreement of the stakeholders.

General

1. ***How do you rate the contribution of the German long-term renovation strategy (LTRS) to the EU 'wave of renovation' announced as part of the European Green Deal?***

Number and distribution of opinions	
Associations, companies and research institutes	40
Federal states	6
Total	**46**

Many stakeholders consider the draft LTRS and its contribution to be inadequate (DAIKIN, FMI, BUVEG, BPIE, DENEFF, RTG, BEE, ZIA, DUH, NABU, DVGW, vzbv). The LTRS draft is recognised as a fundamentally welcome approach, but is considered largely to represent the status quo and thus not to exploit fully the existing potential (FMI, BUVEG, VKU, ZVEH, DAIKIN, RTG, BEE, DUH, DESH, NABU, ZIEGEL, DGFM). A number of suggestions for amendments were identified. In particular, a long-term strategy accompanied by practical measures, indicators and milestones is needed to achieve the net zero greenhouse gas target by 2050 (VfW, BPIE, BDI, ZVEI, DAIKIN, DENEFF, RTG, BEE, DUH, NABU, vzbv). Monitoring of the measures is also considered to be necessary in order to fully evaluate their effectiveness (DAIKIN, RTG, NABU). The measures currently described are considered to be for the most part inadequate, especially in the light of possible tightening of the EU Green Deal (BPIE, FMI, Bauindustrie, VDMA, BuVEG, VfW, N.N., BDI, ZVEI, DENEFF, ZIA, DUH, NABU).

The federal states rate the contribution of the LTRS to the objective differently. Bavaria and Schleswig-Holstein, for example, consider the objective to be compatible with the EU objectives. North Rhine-Westphalia in principle welcomes the mix of measures, but notes that there is no long-term perspective. Bavaria also warns that achievement of the target is uncertain, as the measures for the period after 2030 are not yet known. Hessen criticises the fact that the target of 55% reflects only the European average. By 2030, 70% of Germany's GHG emissions would have to be saved in terms of Germany's GDP per capita (Hessen). Baden-Württemberg also criticises the fact that the description given solely reflects current measures which would lead to a failure to meet the 2030 objectives. Finally, Hamburg states that the LTRS is in principle in line with the federal state's previous planning. However, there was a desire for further clarification of substantive development (Hamburg).

2. How do you rate the choice of indicators?

Number and distribution of opinions	
Associations, companies and research institutes	43
Federal states	6
Total	**49**

The overall choice of indicators, as well as the main indicator of energy performance, are rated as tending to be the correct approach (Bauindustrie, BTGA, BPIE, ZVEH, BDI, ZVEI, RTG, UNITI, NABU, BDH, ZIEGEL, VKU, GEEA, ZDH, ZIA, GIH, ZDB, BDEW, ZVSHK). However, there are requests for changes in the further shaping of the choice of indicators. For example, the level of refurbishment and the rate/depth of renovation could be included, but also indicators of GHG emissions from buildings, the share of renewable energy, sector coupling, etc. (Vaillant, IWU, VDMA, BTGA, N.N., BDI, ZVEI, DAIKIN, BEE, ZIA, DEN, DGVW, BWP). The general database for the buildings sector should be swiftly optimised (IWU, BDEW, geea). In some cases, a critical view is taken of energy performance certificates as a basis for information. The solution proposed is to focus, for example, on demand certificates alone or to bring about other standardisation (Vaillant, BEWS, BPIE, GDW, RTG, GIH).

Bavaria, Hessen and North Rhine-Westphalia consider the energy performance indicator to be appropriate in principle. Schleswig-Holstein agrees, provided that the database is valid and the data collection is coordinated with the federal states. Baden-Württemberg considers the energy performance indicator to be questionable. Along with Baden-Württemberg, North Rhine-Westphalia and Hamburg, Hessen wishes in principle to have further indicators included in order to better reflect the climatic effect in the future. An indicator for GHG emissions is proposed, for example (Baden-Württemberg, Hamburg). North Rhine-Westphalia points out that the rectification at source principle is not appropriate to fully assess greenhouse gas emissions attributable to the buildings sector. Finally, indicators of the rate and depth of refurbishment (Baden-Württemberg, Hessen) are essential.

3. How do you rate the indicative milestones?

Number and distribution of opinions	
Associations, companies and research institutes	38
Federal states	6
Total	**44**

The indicative milestone for 2030 is assessed in very different ways, in some cases being perceived as appropriate, but in other cases as (very) ambitious or else not sufficiently ambitious. However, the milestones for 2040 and 2050 are criticised by many stakeholders as being inadequate. There is a desire for more precise criteria and practical benchmarks rather than a qualitative description (FMI, BTGA, BuVEG, N.N., BPIE, BDI, ZVEI, DAIKIN, DENEFF, BEE, Bauindustrie, ZIA, DUH, NABU, BWP, BWF). It is proposed to link the indicative milestones, based on the responses to Question 2, to various quantitative indicators (BPIE, DENEFF, RTG, BWP, BFW).

North Rhine-Westphalia welcomes the indicative milestone for 2030. Schleswig-Holstein also considers it appropriate to indicate the measurable milestones initially only until 2030. Baden-Württemberg, on the other hand, criticises the missing milestones for 2040 and 2050. Hamburg would like to see the indicative milestones – based on Question 2 – also taking GHG emissions into account. Hessen suggests that the 'efficiency first' principle be made measurable by the milestones and thus verifiable. Bavaria points out that the significance of non-renewable primary energy consumption is weakened by the fact that a significant part of the apparent improvement results from the decommissioning of the nuclear power plants (with a high primary energy factor) and the impact on the electricity consumption indicator.

4. How do you rate the presentation of the potential and restrictions for... 4a)...energy efficiency?

Number and distribution of opinions	
Associations, companies and research institutes	40
Federal states	5
Total	**45**

Many stakeholders rate the presentations positively; the 'efficiency first' approach is welcomed, although some stakeholders consider it not to be followed. Many stakeholders note that there is no satisfactory description of either the breadth or depth of the barriers listed (VPB, VDMA, VfW, GdP, BDI, ZIA, DVGW). There is also a need to focus more on the principle of cost-effectiveness (ZDB, BFW, DUH, FMI). Many stakeholders consider the volume of support and the support incentives to be inadequate (FMI, BuVEG, N.N., DEN). Nor is the property owner-tenant dilemma fully taken into account (Vaillant, BTGA, BDI, DAKIN, H&G). Some stakeholders criticise the fact that the necessary conditions are not exhaustively described (BDI, DENEFF, DUH). There is criticism of issues of sustainability, life cycle analysis and energy balance of building materials being ignored (NABU, N.N., ZIA). For some stakeholders, additional attention should be paid to standardised construction methods and their potential (N.N., DEN). There should be a clearer distinction between new construction and existing stock, and more attention should be paid to neighbourhood solutions (BDEW, ZIA). No account is taken of the influence of future changes in efficiency gains and the trend in electricity prices (ZDH, Vaillant). Technologies such as synthetic (green) gaseous and liquid energy sources or heating networks should be integrated, as well as aspects of hot water use (BDEW, GdW). In addition to economic issues, more attention should be paid to technical and social aspects (BDEW, GdW). Some stakeholders consider the presentation not to be consistent with the 'efficiency first' approach or to be incomplete; many stakeholders call for a detailed and differentiated description of the strategy, which also expresses the objectives more clearly (FMI, construction industry, VDMA, BuVEG, VfW, RTG, BEE, DUH).

North Rhine-Westphalia welcomes the efficiency measures. Bavaria considers the technical potential described to be too conservative. Hessen objects that the limits and potential are not sufficiently differentiated; there is also a need to take greater account of the economic benefits. In addition, the property owner-tenant dilemma leads to further restrictions (Hessen). Baden-Württemberg considers that the measures taken by the Federal Government do not comply with the 'efficiency first' approach. Shortcomings in the regulatory raising of the level of requirements for new construction and existing buildings are also seen (Baden-Württemberg). As carbon pricing is not taken into account, the Building Energy Act (GEG) does not comply with the concept of cost-effectiveness; this concept should be interpreted in economic terms (Baden-Württemberg). Due to the potential mentioned, only a reduction of 80% in GHG emissions is possible (Baden-Württemberg). Schleswig-Holstein criticises the lack of coordination between the federal states and prioritisation. It is also objected that regional

circumstances should be taken into account and that greater emphasis should be placed on technological openness (Schleswig-Holstein).

4b)...renewable energy?

Number and distribution of opinions	
Associations, companies and research institutes	37
Federal states	5
Total	**42**

Many stakeholders agree and (generally) rate the presentations positively. The description of barriers and restrictions to renewable energy is assessed by many stakeholders as insufficiently detailed in both qualitative and quantitative terms (Vaillant, BuVEG, VKU, GdW, DENEFF, DUH, BWP). Some stakeholders consider the presentations to be insufficiently detailed or inconsistent; further additions and a revision of the strategy are requested (DAKIN, VDMA, SDO). For some stakeholders, the comments do not show sufficient alternatives; there are also calls for different assessments of individual energy carriers/types or for other energy carriers/types to be taken into account (DeSH, DEN, N.N.). In order to unlock further potential, the renewable energy approach needs to be broadened, also taking into account other sectors (GdW, BTGA, FMI). Furthermore, some stakeholders consider the area of synthetic (green) gaseous and liquid energy sources to be insufficiently described (BDEW, BPIE, UNITI). Some stakeholders point to the imperative need to consider efficiency and renewable energy in combination (DUH, DENEFF). Some stakeholders point to the need to take energy imports into account (UNITI, DVGW, BDH). Some stakeholders would like to see aspects of upgrading installations in connection with renewable energy (ZDH, ZVEH). It is also suggested that the volume of support be increased (H&G, GIH). The hydrogen strategy should be adapted and the legislative conditions simplified (NABU, GIH).

Bavaria considers the presentation to be factually correct, but recommends that account be taken of conflicts of aims between efficiency and economic viability in the area of heating networks. Hessen draws attention to economic restrictions arising from the property owner-tenant dilemma. Furthermore, issues that clarify the future updating of the LTRS should be addressed at an early stage (Hessen). Baden-Württemberg welcomes the statements on networks, but at the same time criticises the fact that the other aspects do not shed any new insight, that a strategic approach is lacking and that key questions regarding the role of gas are not clarified. Schleswig-Holstein views the prioritisation and lack of coordination with the federal states as problematic. In addition to the need to take account of regional specifics, a commitment to technological openness must also be taken more seriously (Schleswig-Holstein). North Rhine-Westphalia stresses the need for near-building heating production in the future and for further efforts to increase the potential of renewable heat sources.

4c)...decarbonised energy sources and energy infrastructure?

Number and distribution of opinions	
Associations, companies and research institutes	35
Federal states	5
Total	**40**

Some stakeholders in principle agree with the presentation (VPB, GdW, NABU). Many stakeholders see shortcomings in general with regard to heating networks, the description of their planning and future structure and their impact on decarbonisation and wish to see them clarified (BuVEG, BPIE, BDI, ZIA, DEN). In addition, many stakeholders point out that the presentations on (synthetic and/or green) liquid or gaseous energy sources are inadequate; additional potentials are not sufficiently taken into account (SDO, DVGW, UNITI, geea, N.N.). Questions and guidance on the statements concerning security of supply and (network) infrastructure are also not available to many stakeholders in sufficient quality and quantity (NABU, BDEW, FMI). Some stakeholders see the involvement of citizens in the energy transition as being too low and see other barriers that are not further identified (BWP, GdW). The aspects of gradual building renovation are insufficiently addressed (VPB, BPIE). The price level of electricity is cited by some stakeholders as a barrier (BDEW, Vaillant). The presentations on general economic viability and energy stores are not adequate for some stakeholders (BPIE, GdW). In addition, some stakeholders call for technological openness (ZIA, BTGA).

Bavaria objects that, in view of the costs of decarbonised energy sources, consideration must always be given to other efficiency measures. Hessen criticises the potential and restrictions not being clearly identified. North Rhine-Westphalia agrees in principle with the presentation of potential and restrictions and points out that barriers and restrictions to innovative heating networks need to be removed. On the one hand, Baden-Württemberg does not see sufficient recognition of the role of electricity and heating networks; heating networks and their expansion need to be boosted massively. Moreover, no reduction in electricity demand in the building sector is expected in the long term. Against this backdrop, conflicts arising from self-generation of electricity are not adequately addressed. There are also no strategic statements on the future development of gas networks (Baden-Württemberg). Schleswig-Holstein considers there to be insufficient consideration of the potential of heating networks.

5. ***How do you rate the measures and instruments for making an adequate contribution to the long-term climate protection target?***

Number and distribution of opinions	
Associations, companies and research institutes	41
Federal states	5
Total	**46**

Some stakeholders noted that the presentation was limited to existing measures and that there were no new instruments in the LTRS (VDMA, IGBAU, DUH). Some stakeholders have noted that the 'efficiency first' approach is not sufficiently taken into account in the measures. (FMI, BuVEG, NABU). In addition, some stakeholders welcome carbon pricing (FMI, BDEW, BPIE, VKU). Some stakeholders point to the need for effective carbon pricing to have a steering effect (SDO, BPIE). For example, some stakeholders consider the current carbon price to be too low (NABU, DUH, ZVEH) and one stakeholder sees no steering effect in the current formulation (ZDH). Two stakeholders consider that carbon pricing should be rethought and adapted in a climate-effective and socially acceptable manner (ZIEGEL, DGfM). Some stakeholders have noted a lack of measures to reduce electricity prices in the LTRS (BDH, BWP, DAIKIN, Vaillant). Many stakeholders consider the measures in the Climate Action Programme 2030 to be inadequate to achieve the objectives (FMI, N.N., GdW, N.N., DENEFF, RTG, BEE, geea, ZIA, NABU). Many stakeholders welcome the tax support (FMI, VPB, BDEW, BPIE, ZDH). Some stakeholders have pointed out that more differentiated tax support is needed or should be extended to other ownership and use structures (ZIA, BTGA, H&G, NABU). It was also noted that there is a lack of quality assurance in tax support (DUH) and that professional advice/implementation and supervision should be required (DEN, GIH). Some stakeholders also point out that grey energy is still not taken into account (N.N., DUH, DeSH).

Hessen points out that the LTRS refers only to the Climate Action Programme 2030, the Energy Efficiency Strategy and the Building Energy Act (GEG). Bavaria criticises the fact that prevention of lock-in effects is not addressed. Schleswig-Holstein criticises the lack of prioritisation. North Rhine-Westphalia welcomes the measures in principle. Baden-Württemberg welcomes the further development of the support, in particular 'serial refurbishment' and the merging of the support programmes. Schleswig-Holstein in principle assesses the Climate Action Programme 2030 and the Federal Support for Efficient Buildings (BEG) favourably. Baden-Württemberg criticises the limitation of the carbon price corridor to EUR 65 per tonne and the lowering of the building envelope requirements in the BEG. The draft GEG is criticised as being unsuitable for achieving the long-term objectives (Hessen) or not representing an adequate contribution to climate protection (Baden-Württemberg). Bavaria stresses that all measures must be checked for economic compatibility with the long-term objectives. It is pointed out that there is no commitment to technological openness (Schleswig-Holstein) and that this and the economic viability requirement must be respected

(Bavaria). Attention is also drawn to the need for continuous updating and further development of the measures in coordination with the federal states (North Rhine-Westphalia).

6. How do you rate the prospects for the LTRS update?

Number and distribution of opinions	
Associations, companies and research institutes	37
Federal states	4
Total	**41**

Many stakeholders call for further development of the energy performance assessment indicator (FMI, Bauindustrie, BuVEG, BDEW, BDI, ZVEI, DAIKIN, ZVSHK, BEE, ZIA, BDH, BWP), either as a broadening of the definition of the indicator or by introducing additional indicators. Some stakeholders are critical of the inclusion of other indicators (ZDH, ZDB), while others welcome the indicator mentioned without excluding other/further indicators (ZIEGEL, DGFM). Many stakeholders consider final energy consumption to be a suitable (partial) balance parameter (FMI, Bauindustrie, BuVEG, BDI, ZVEI, ZVSHK, ZIA, GIH, ZIEGEL, DGfM). Many stakeholders in principle welcome the future consideration of sustainability and resource efficiency announced in the LTRS (N.N., DeSH, BPIE, DUH, NABU, re!source, ZIEGEL, DGfM). The announced consideration of these issues does not go far enough for some stakeholders (BPIE, DUH, NABU). Some other stakeholders explicitly stress the need to take sustainability and resource efficiency into account when formulating steering instruments (re!source, ZIEGEL, DGfM). Many stakeholders are in favour of improving the consultation process, an early start on updating and/or greater involvement of market players, experts and research in the process (DAIKIN, DENEFF, RTG, BEE, DUH, DEN, NABU). Many stakeholders emphasise the need for further development in the form of prompt review and development of promotion and information measures (Bauindustrie, BDI, ZVEI, ZIA, BDH) or continuous development of policies and measures (VPB, VKU). Many stakeholders call for planning certainty (BTGA, BDEW, geea, ZIA, DVGW). Some stakeholders consider the statements to be too vague or unspecific (VDNA, DEN, BPIE), while others stress that important opportunities for setting the course have been missed (DUH, NABU). Some stakeholders are committed to the principle of 'efficiency first' (Bauindustrie, BDI, ZVEI, DENEFF, ZDB), with one stakeholder stressing that the principle at present is sufficiently and effectively taken into account (ZDB). Some stakeholders wish to see a target pathway with quantifiable measures (RTG, BEE). Some other stakeholders criticise the lack of a forward-looking approach to climate objectives (DUH, NABU). Some stakeholders are in favour of an area-wide switch to warm rents (FMI, BuVEG). Some stakeholders also suggest a revision of the complete assessment system (ZIEGEL, DGFM). Some other stakeholders propose that the balance limit in energy accounting of buildings be extended to include household electricity in residential buildings (N.N.) or the storage effect of renewable raw materials (DeSH). Individual stakeholders call for the following aspects to be taken into account in the future: security of supply (BDEW), affordability/housing cost development (BDEW, IGBau), environmental compatibility (BDEW), hydrogen technology (DVGW), electrical and information technology (ZVEH).

Baden-Württemberg would like the LTRS to be updated as soon as possible in the form of a fundamental recast with the intensive involvement of the federal states and associations. North Rhine-

Westphalia welcomes the measure in particular with regard to planning and investment security. Bavaria suggests that the seasonal availability of renewable energy sources should be taken into account through variable primary energy factors, where appropriate, and that the implementation burden for citizens and planners should be kept to a minimum. Baden-Württemberg suggests establishing a life-cycle approach to buildings, including an indicator on final energy consumption and complementing a CO2 indicator. Baden-Württemberg criticises 2023 being too late as the date for the next review of the standards and that the Building Energy Act should be reviewed immediately so that a fundamental amendment can be put into effect at an early date. North Rhine-Westphalia suggests that the LTRS update should create incentives for the use of smart technologies. Schleswig-Holstein points out that the perspectives presented will depend in particular on the acceptance of the database and how it is rated.

Chapter 2: Mandatory components of the long-term renovation strategy

7. How do you rate the overview of the national building stock?

Number and distribution of opinions	
Associations, companies and research institutes	40
Federal states	6
Total	46

Very many stakeholders consider the data situation for residential buildings to tend to be positive, while there are large gaps in the data for non-residential buildings (FMI, Bauindustrie, VBP, VDMA, BTGA, BuVEG, BDI, ZVEI, DAIKIN, DENEFF, RTG, BEE, geea, ZIA, DUH, UNITI, NABU, BDH, BWP, IG Bau). Early publication of the results of the 'Research Database on Non-residential Buildings' project on the stock of non-residential buildings in Germany and an altogether more robust database are requested. Additional data is requested on different areas, such as the explicit energy efficiency status of buildings, such as the explicit energy efficiency status of buildings (for example type of insulation, type of window), type of building, the economic situation of the owners, smart home installations, etc. (BEE, RTG, ZIA, ZIEGEL, BWP, N.N., BDEW, BPIE).

Bavaria considers the overview of the national building stock to be well apportioned, and Baden-Württemberg also considers the presentation of the data to be helpful. Efforts to improve the database are welcomed (Baden-Württemberg, North Rhine-Westphalia). Hessen considers the body of data to be inconsistent and incomplete and wishes to see significant improvements. Hamburg and Schleswig-Holstein take a critical view of the national consolidation of the database on the building stock with centrally collected data and would like to see a bottom-up rather than a top-down approach at this point in the data collection process. North Rhine-Westphalia notes that data collection should be carried out in consultation with the federal states.

8. How do you rate the cost-effective concepts for renovations and trigger points?

Number and distribution of opinions	
Associations, companies and research institutes	34
Federal states	5
Total	**39**

According to some stakeholders, the table provides a good overview and shows that the number of existing programmes is large and that the trigger points set are in principle appropriate (FMI, Vaillant, BuVEG, BPIE, ZVHSK, RTG, ZDH, ZDB). There was criticism that there is a need for more transparency, the measures sometimes appear to be very small-scale, the snags are not always understandable and that there is a need for optimised integration (Bauindustrie, VDMA, BTGA, BDI, DAIKIN, ZVSHK, DENEFF, ZIA, DVGW, BDH). An overview of the interaction between the instruments is also requested (DENEFF, NABU, BDH). A particularly important trigger point is change of ownership, the potential of which should be further exploited (DEN, BDI, BPIE, BuVEG, FMI).

Bavaria sees the cost-effectiveness factor as a critical point in achieving the objectives. Hessen fears that the measures mentioned will not be adequate to achieve the objectives in the long term. The derogations in building energy legislation or the Building Energy Act are considered by Baden-Württemberg to be too wide-ranging, so that they might result in the concepts for renovations and trigger points becoming meaningless. The ban on oil-fired heating is also not as far advanced as it could be (Baden-Württemberg). North Rhine-Westphalia and Schleswig-Holstein point out that the measures should be developed further with the involvement of the federal states and that the strategies of the federal states for energy-efficient and cost-saving housing should be taken into account. Furthermore, the regulatory environment should be further developed to bolster digitisation (North Rhine-Westphalia).

9. How do you rate the policies and actions for cost-effective extensive renovations?

Number and distribution of opinions	
Associations, companies and research institutes	37
Federal states	4
Total number	**41**

Many stakeholders express general support, but sometimes with reservations (DeSH, BDI, ZVEI, VfW, DENEFF, RTG, NABU, BDH). Many stakeholders emphasise a fundamentally positive assessment of the support options, including the recent adjustments and the planned federal support of efficient buildings (BPIE, N.N., ZVEH, VKU, geea, GIH, BEE, BWP, ZIEGEL, DGFM). Some stakeholders support more simplification of measures (ZIA, Bauindustrie, VBP, ZVSHK, geea). On the other hand, many stakeholders also consider the measures not to be consistent with the objective, effective or sufficient (Vaillant, BDI, ZVEI, VfW, DENEFF, RTG, NABU, BDH, FMI, BuVEG). Many stakeholders also criticise the current support in the buildings sector (DUH, BTGA, BDI, ZVEI, H&G, DEN, GIH). Some stakeholders consider there to be no strategy or regard the draft LTRS as unclear (NABU, DENEFF, DAIKIN, DEN, VDMA, vzbv). In addition, individual suggestions and requests are put forward by many stakeholders.

Bavaria, Baden-Württemberg and North Rhine-Westphalia welcome the federal support in principle and consider the CO_2 building refurbishment programme to be appropriate. However, the current support does not automatically lead to comprehensive refurbishment measures embedded in an overall concept and therefore carries a risk of lock-in effects and consequential harm (Bavaria, Hessen). Baden-Württemberg also points out that disincentives due to inappropriate general conditions (for example in the case of heating networks or efficient electricity applications) must be avoided. The definition of 'cost-effective major renovations' should be revised, as many LTRS measures 'do not fit this and a distorted picture might arise due to the large impact of primary energy factors' (Bavaria, Hessen). Baden-Württemberg also points out that a higher level of regulatory requirements would make it possible to focus support more closely and could free up funding for more ambitious measures. In addition, independent energy advice should be more firmly established as a mandatory requirement in support (Baden-Württemberg). Support measures in the field of heating networks are welcomed, and attention is drawn to the need to focus on heating networks and neighbourhood solutions and to the need to encourage 'heating planning' (Schleswig-Holstein, Baden-Württemberg). The continuous development of the instruments should take place with the involvement of the federal states in order to take greater account of the strategies of the federal states (e.g. support programmes) and to allow early coordination between the Federal Government and the federal states for support programmes (North Rhine-Westphalia).

10. How do you rate the policies and actions...

10a)...for the worst performing buildings?

Number and distribution of opinions	
Associations, companies and research institutes	40
Federal states	5
Total number	**45**

In principle, the overview of 'worst performing buildings' is regarded as positive and its approaches as comprehensible (BPIE, ZVEH, ZVSHK, ZDH, NABU, ZDB). However, it is also stressed that the actions described in some cases do not directly address the issue (FMI, VDMA, BuVEG, BPIE, DENEFF, BEE, DUH, NABU) and worst performing buildings should be focused more on energy renovation (Vaillant, geea). There is criticism that the efficiency house standard EH-115 is to be dropped, as this is an attractive entry point to renovation for buildings that are poor in terms of energy efficiency (Bauindustrie, BDI/ZVEI, RTG, ZIA, BDH). Measures specifically targeting worst performing buildings are needed. Numerous proposals are made in this regard, for example regarding energy certificates, individual building renovation passport (iSFP) and rental law (Vaillant, Bauindustrie, VPB, N.N., VfW, BDEW, BPIE, GdW, DENEFF, BEE, geea, H&G, DEN, GIH, BFW).

Bavaria emphasises that refurbishment is particularly suitable for worst performing buildings' Hessen and Baden-Württemberg regret the absence of new measures for 'worst performing buildings' in the draft LTRS; these should be developed as a matter of urgency (Baden-Württemberg). North Rhine-Westphalia rates the measures described positively; however, further information deficits and market barriers should be reduced. Furthermore, additional incentives should promote competition and improve cost-effectiveness (North Rhine-Westphalia).

10b)...for reducing energy poverty?

Number and distribution of opinions	
Associations, companies and research institutes	32
Federal states	6
Total number	**38**

Many stakeholders welcome the energy advisory measures described (FMI, Vaillant, Bauindustrie, BTGA, BuVEG, VKU, BDI/ZVEI, DENEFF, ZIA, GIH, NABU, BDH, BWP). In addition, many stakeholders see a useful measure in housing benefit and taking account of a climate component (FMI, VKU, BDEW, DUH). Numerous proposals are made for resolution of the tenant-property owner dilemma (FMI, BuVEG, BPIE, ZIA, DEN, BWP). Furthermore, some stakeholders consider it necessary to launch further measures to combat energy poverty (BEE, DUH, SDO, DEN).

Hessen and North Rhine-Westphalia rate the measures described positively. Hamburg welcomes the climate component in housing benefit. Schleswig-Holstein proposes focusing support on buildings with poor performance in order to implement economic measures. North Rhine-Westphalia has long been pursuing its own approaches to combating energy poverty, but the high energy costs in this context necessitate legislative action.

11. How do you rate the policies and actions for public buildings?

Number and distribution of opinions	
Associations, companies and research institutes	22
Federal states	6
Total number	**28**

Very many stakeholders see shortcomings in fulfilment of the example-setting role of the public sector (FMI, Bauindustrie, VDMA, BuVEG, N.N., VfW, BDEW, BPIE, BDI, ZVEI, ZVSHK, RTG, BEE, geea, DUH, DEN). Some stakeholders point out that the planned energy efficiency decree should be adopted and the refurbishment roadmap for the federal building stock completed as quickly as possible (Bauindustrie, BDI, ZVEI, DUH, BDH). Many stakeholders consider it important to raise the rate of refurbishment of public buildings (FMI, BuVEG, ZVSHK, RTG, BEE, geea, BDH). Energy standards for public buildings range from 'inadequate' (N.N., DUH) to 'adequate' (BEE) and 'too ambitious' (ZDH). More use should be made of the instrument of contracting in the opinion of some stakeholders (construction industry, VfW, BDI, ZVEI). More attention should be paid to sustainability issues such as life-cycle considerations according to some stakeholders (N.N., DUH, DeSH, GIH). There should also be greater exchange of information between the Federal Government, the federal states and local authorities (Bauindustrie, BDI, ZVEI, BDEW).

Some federal states consider the measures to be appropriate, although area-wide implementation is criticised in some cases and energy standards are rated differently (Baden-Württemberg, Saxony, North Rhine-Westphalia). Hessen argues that the minimum standards for federal buildings could be more ambitious in view of the 2050 objectives. Hamburg considers the implementation of the EH-55 standard to be critical for buildings of scheduled monument status of relevance to town planning. Saxony suggests reviewing the assessment of ecological criteria. North Rhine-Westphalia sees implementation of the envisaged measures as making an important contribution to achieving the Federal Republic's climate protection objectives, provided that the appropriate capacities at federal state level are made available by the Federal Government.

Chapter 4: Actions and mechanisms to support the mobilisation of investments in the buildings sector

12. How do you rate the incentives for the use of smart technologies?

Number and distribution of opinions	
Associations, companies and research institutes	32
Federal states	3
Total number	**35**

Many stakeholders regard Building Information Modelling (BIM) as an important tool (FMI, BTGA, BDEW, BPIE, ZDH, DUH, DeSH, DEN, NABU), with some highlighting the link to the operational phase (FMI, BTGA, BuVEG, BDEW, NABU) and others highlighting the link to sustainability (BPIE, DUH, DeSH, NABU). However, some stakeholders consider the incentives to use BIM still to be inadequate (ZDH, DeSH). In addition, some stakeholders expect that BIM will only be available in the medium term (ZIEGEL, DGFM). Many stakeholders consider the requirements of the Energy Performance of Buildings Directive (EPBD) appropriate and regard enhanced implementation as important (Bauindustrie, BTGA, BuVEG, BDI, DENEFF, ZIA). Digitisation, in the opinion of many stakeholders, needs to be backed by data protection and IT security measures (VPB, GdW, BDI, DENEFF, ZIA, DEN, GIH, NABU). Research funding is considered important by many stakeholders (BTGA, BDEW, GdW, RTG, geea, DEN). The special role of smart meters is highlighted by some stakeholders (BDWE, ZVEH, VfW). Some stakeholders are of the opinion that smart technologies should be better reflected in initial and continuing training (BPIE, DEN, GIH) and end-user information (RTG, ZDH, ZDB).

Bavaria comments that the potential of smart home solutions is often overestimated, although there are important individual solutions. There is a need for qualifications among skilled traders and planners (Bavaria). Support should focus more on high-efficiency products and thus strengthen system-compatible sector coupling (Bavaria). Saxony comments that higher technology input only leads to savings when combined with optimised building operation. Qualification, staffing and adequate incentives for non-residential buildings play an important role in this (Saxony). North Rhine-Westphalia calls for further promotion and driving of digitisation in the construction sector. Digital, smart building technology needs to be developed and applied, while barriers need to be removed (North Rhine-Westphalia).

13. How do you rate the wider benefits of refurbishment?

Number and distribution of opinions	
Associations, companies and research institutes	31
Federal states	4
Total number	**35**

Many stakeholders confirm the positive added value and importance of the wider benefits (BTGA, BuVEG, geea, ZDH, ZIA, DUH, DeSH, BEE, NABU, ZDB, GdW). However, many stakeholders criticise the wider benefits being communicated too little or not with the target group in mind (FMI, Vaillant, BTGA, BuVEG, ZVSHK, DENEFF, ZDH, GIH, DVGW, ZDB, DAIKIN). The treatment of wider benefits in the iSFP is highlighted as positive by many stakeholders (FMI, BuVEG, DAIKIN, DENEFF, geea, DEN, NABU). Many stakeholders stress that added value is an important driver of renovation decisions and for business and skilled crafts, thus making an important contribution to energy efficiency in the building (BDEW, VBP, VKU, DAIKIN, ZVSHK). Some stakeholders criticise the fact that the economic benefits (e.g. cost savings for the public health service) are not sufficiently highlighted or quantified (DENEFF, DUH, NABU, BEE). Some stakeholders take the view that resource conservation and sustainability should be more widely taken into account or embedded in the instruments (ZDH, ZDB, DUH, NABU). The importance of neutral and independent energy advice is stressed by some stakeholders (Vaillant, ZVHE, DEN). Some stakeholders suggest that the wider benefits should be more strongly embedded in energy advice (BDI, ZVEI, VKU). Some stakeholders consider that consideration of the wider benefits should also include the disposal of harmful building materials and their effects on health (ZDH, ZDB, DeSH). Some stakeholders stress that increasing the rate of refurbishment is crucial if the climate objectives are to be met (ZIEGEL, DGFM).

Baden-Württemberg criticises the fact that the LTRS merely lists the advantages. Bavaria points out that the wider benefits are often overlooked and that there should be greater focus on them in the public debate. Baden-Württemberg suggests that the economic benefits should also be included in the economic perspective and that the wider benefits should be quantified. Saxony takes a partly differing view of the wider benefits, pointing out that energy savings in some cases are at odds with increasing comfort demands, partly also induced by legislation, and that this conflict needs to be better presented and solutions identified. North Rhine-Westphalia considers buildings to be important elements in sector coupling; there are strong synergies between energy-efficient buildings, decentralised energy production and the use of renewable energy.

14. How do you rate the actions and mechanisms to support the mobilisation of investments in the buildings sector?

Number and distribution of opinions	
Associations, companies and research institutes	34
Federal states	5
Total number	**39**

The measures described are in principle considered appropriate by many stakeholders (FMI, VPB, BTGA, BuVEG, BDEW, BPIE, DAIKIN, ZVSHK, DENEFF, RTG, BEE, DeSH, DEN, NABU). At the same time, many stakeholders criticise the measures not yet being adequate to mobilise investment in the buildings sector (VDMA, Vaillant, BDEW, BPIE, ZDH, NABU, ZDB). The one-stop shop approach is considered necessary and appropriate (FMI, BTGA, BuVEG, BPIE, ZVEH, DENEFF, BEE, ZIA, NABU, BDH). Many stakeholders would like more work to be done in the field of outreach and communication (ZVSHK, BPIE, ZDH, H&G, NABU, ZDB). Many stakeholders welcome the fact that the Federal Government is implementing the topic of 'serial refurbishment' (FMI, BuVEG, BDI/ZVEI, DENEFF, BEE, geea, DeSH, DEN).

Baden-Württemberg regrets the absence of a detailed description of the possibility of contracting. Saxony comments that too little of the investment is devoted to measures relating to the existing stock and energy-efficient refurbishment, so that there is a need for action. Bavaria comments that targeted thinking should go beyond purely monetary approaches. North Rhine-Westphalia points to the important role of AI use in the area of building renovation and the need to exploit the opportunities presented by 'serial refurbishment'.

Consultation sheet on the draft long-term renovation strategy (LTRS) under Article 2a of the EU Energy Performance of Buildings Directive (EPBD 2018; Directive 2018/844/EU)

Personal information		
Please specify your type of organisation (please tick)	☐ Federal state ministry ☐ Association/interest grouping ☐ Research institution ☐ Other Institution: _____	
Please provide the name and address of your organisation		
Please indicate your contact details (for enquiries only, not published)	Name:	
	Tel.:	
	E-mail:	
Can we make your opinion public? (please tick)	☐ Yes	☐ No
General		
1. How do you rate the contribution of the German long-term renovation strategy (LTRS) to the EU 'wave of renovation' announced as part of the European Green Deal?		
Chapter 1: Development of the roadmap		
2. How do you rate the choice of indicators?		
3. How do you rate the indicative milestones?		

4. How do you rate the presentation of the potential and restrictions for...	
4a)...energy efficiency?	
4b)...renewable energy?	
4c)...decarbonised energy sources and energy infrastructure?	
5. How do you rate the measures and instruments for making an adequate contribution to the long-term climate protection target?	
6. How do you rate the prospects for the LTRS update?	
Chapter 2: Mandatory components of the long-term renovation strategy	
7. How do you rate the overview of the national building stock?	

8. How do you rate the cost-effective concepts for renovations and trigger points?	
9. How do you rate the policies and actions for cost-effective extensive renovations?	
10. How do you rate the policies and actions...	
10a)...for the worst performing buildings?	
10b)...for reducing energy poverty?	
11. How do you rate the policies and actions for public buildings?	
Chapter 4: Actions and mechanisms to support the mobilisation of investments in the buildings sector	

12. How do you rate the incentives for the use of smart technologies?	
13. How do you rate the wider benefits of refurbishment?	
14. How do you rate the actions and mechanisms to support the mobilisation of investments in the buildings sector?	
Conclusion	
15. Do you have any further comments?	