CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

Implementation of the EPBD Germany

Status in 2020

AUTHORS
Ann-Cathrin Horward, Jonas Rosenberger, *Federal Energy Efficiency Center, Federal Office for Economic Affairs and Export Control, Eschborn;*

with contributions by Unit IIC2, Federal Ministry for Economic Affairs and Energy,* Isabel Ahlke, *Federal Ministry of the Interior, Building and Community, Berlin;* and Dirk Markfort, *KfW Funding Bank, Berlin

NATIONAL WEBSITES
https://www.bfee-online.de/BfEE/DE/Home/home_node.html
http://www.bmwi.de/Redaktion/EN/Dossier/enhancing-energy-efficiency-in-buildings.html
http://www.kfw.de/inlandsfoerderung/Privatpersonen/index-3.html
http://www.dena.de/en/topics-projects/energy-efficiency/buildings/

1. Introduction

A holistic approach to energy efficiency in buildings was first introduced in Germany in 2002 with the Energy Saving Ordinance (*EnEV*[1]). The *EnEV* replaced legislation on the thermal insulation of buildings (*WschV*[2]) and on system requirements for central heating (*HeizAnlV*[3]), which had been in place for 25 years. For the replacement to be successful, a method for calculating the heat requirement of a building was developed as a national pre-standard, widely based on the former European standard EN 832. In order to implement the EPBD, Directive 2002/91/EC, the German standardisation institute DIN was developed, and in 2005 the calculation standard DIN V 18599[4] for overall energy performance of buildings was published. The latter covers a wide range of use patterns and – in addition to heating, ventilation and domestic hot water - cooling, lighting and component interaction and building services. The second edition of this standard, published in 2007, was used as a compulsory calculation method for non-residential buildings. Two years later, the energy efficiency requirements were strengthened with the Energy Saving Ordinance 2009[5]. At the same time, the percentage of use of RES for new buildings was legally introduced with the Renewable Energies Heat Act (*EEWärmeG*[6]), which was amended in 2011 to extend the requirements to cases of major renovations of public buildings.

The Energy Saving Act (EnEG), the Energy Saving Ordinance (EnEV) 2013[7] and the Renewable Energies Heat Act (EEWärmeG) implement the requirements of the EPBD, Directive 2010/31/EU. Strengthened minimum requirements, which are the NZEB standard, were fixed and came into force for all new buildings from 1 January 2016 (application for building permit). The requirements are expressed by a reference building

method, not by fixed values. The requirements are linked to compulsory calculation methods (DIN V 18599: 2011-12 and, alternatively for residential buildings without AC, the old method according to DIN V 4701-10: 2003-08). Both methods include mandatory boundary conditions. A simplified method[8] using a model building approach, applicable to a broad range of residential buildings, came into force in 2016.

The Energy Saving Act standards (Energieeinsparungsgesetz - EnEG), the Energy Saving Regulation (Energieeinsparverordnung - EnEV) and the Renewable Energy Heat Act (Erneuerbare-Energien-Wärmegesetz - EEWärmeG) are merged in the so-called German Energy Act for Buildings (Gebäudeenergiegesetz 2020 GEG)[9], which integrates energy efficiency and renewable energy provisions.

The German Energy Act for Buildings contributes to achieving the national energy efficiency and climate goals. Moreover, this further development towards a coordinated system adds to the achievement of an almost climate-neutral building stock. This structurally new concept simplifies and encompasses regulations for a better integration of RES into the buildings' heat supply and introduces a district approach.

The next review process concerning energetic standards for new and existing buildings will start in 2023. This process shall address economic viability and shall be technology neutral. The energy performance requirements for residential and non-residential buildings will be further developed as part of this review process. A key focus point will be the affordability of building and living.

The provisions of the EPBD as amended by Directive 2018/844/EU are implemented into national law through the development of the German Energy Act for Buildings and the Draft of the Act for the establishment of a building integrated charging and cabling infrastructure (Entwurf eines Gesetzes zum Aufbau einer gebäudeintegrierten Lade- und Leitungsinfrastruktur für die Elektromobilität - GEIG).

2. Current Status of Implementation of the EPBD

2.I. Energy performance requirements: NEW BUILDINGS

The main energy performance requirements for new buildings are defined in the Energy Saving Ordinance (*EnEV*) 2013[9] comprising:

- a maximum non-renewable primary energy demand, which is determined individually for each building using a reference building with the same building geometry, orientation and use, but with a certain quality of all energy-relevant systems and components;
- a minimum requirement for the energy performance of the building's thermal envelope, which is determined:
    - for residential buildings, using the reference building approach as well;
    - and for non-residential buildings, by a certain set of maximum mean U-values for opaque and transparent elements respecting the design indoor temperature of the building's zones;
- a minimum percentage of RES used for heating (Table 1), domestic hot water and cooling; the percentage is different for the various technologies.

Furthermore, a set of requirements addresses technical building systems or system components. New public buildings are treated in the same way as any other new non-residential building.

Options to comply with the Renewable Energies Heat Act

	Option according to annex		Minimum share
Renewable Energies	Energy from **solar radiation** (collectors)		15 %
	or default collector size for residential buildings (m^2 collector aperture area per m^2 living space)	≤ 2 dwellings	0.04 [m^2/m^2]
		> 2 dwellings	0.03 [m^2/m^2]
	Geothermic energy or **ambient heat** by heat-pumps (performance requirements given for heat-pumps)		50 %
	Biomass from sustainable sources (proof by bills required)		
	• **Gaseous** (mostly restricted to use in CHP-appliances only)		30 %
	• **Fluid** (best affordable boiler technology)		50 %
	• **Solid** (minimum efficiency values given for boilers)		50 %
Substitute measures	Heat from **waste combustion**		50 %
	CHP plants		50 %
	District heat with substantial share of RES / waste / CHP		100 %
	Measures to save energy in buildings		EnEV-req. -15 %
	Combinations of several measures		$\sum_i \frac{share_i}{share_{min,i}} \geq 1$

Table 1. Options to comply with the Renewable Energies Heat Act.

2.I.i. Progress and current status of new buildings (regulation overall performance)

As a first step towards NZEB, the requirements for new buildings were tightened in January 2016 (Table 2). The maximum primary energy demand now equals 75% of the 2014 value, whereas the requirements addressing the thermal envelope were strengthened by 20%. The German report[10], as required by Article 5 paragraph 2 of the EPBD, proved the 2016 requirements to be cost-optimal.

Component	Reference design / value	2nd requirement
Strengthening factor January 2016	$Q_{p,max,2016} = 0.75 \cdot Q_{p,ref,2009}$	$H'_{T,max,2016} = 1.0 \cdot H'_{T,ref,2009}$
	Reference 2009	
External walls, Floors	U = 0.28 W/(m²·K)	$H'_{T,max,2009} \cong 1.25 \cdot H'_{T,ref,2009}$ [requirement 2009 is legally defined by tabled values according to situation and size of the building]
Floor, basement structural element	U = 0.35 W/(m²·K)	
Roof, upper ceiling	U = 0.20 W/(m²·K)	
Windows incl. French windows	U = 1.3 W/(m²·K) (Skylight U = 1.4 W/(m²·K))	
Entrance doors	U = 1.8 W/(m²·K)	
Boilers	Condensing boilers	Requirements for pipe insulation and controls
Hot water	Central, with solar system	
Cooling	None	Thermal protection in summer
Ventilation	Central exhaust fan, demand-controlled	large systems: SFP_{max}, heat recovery

Table 2. Requirements for new residential buildings: reference construction to determine the maximum primary energy demand and additional requirements to building envelope and system performance.

2.I.ii. Format of national transposition and implementation of existing regulations

The regulations concerning the percentage of RES use – including possible substitute measures – are subject of the Renewable Energies Heat Act[11], last amended in 2010. Efficiency requirements for new buildings are set out by the Energy Saving Ordinance[12], which was subject to a major amendment in 2013. During the course of the 2013 amendment, the current requirements that came into force in January 2016 were already fixed.

The Energy Saving Ordinance refers to the German pre-standard DIN V 18599, version 2011-12, as the compulsory method for the proof of compliance and the calculation of the values for the EPC. Some international standards (e.g., EN ISO 13790, EN ISO 13789, EN ISO 6946) are included in the method; others are addressed by the ordinance in order to define additional requirements (e.g., EN ISO 13779 for AC system performance). The majority of boundary conditions and primary factors (Table 3) are given in the calculation standard as well.

Calculations of energy performance of new buildings are performed by experts using advanced software solutions. The 'Quality Community 18599'[13] comprises the software companies and performs regular quality control of the software products. This is also a prerequisite for any software used for application in *KfW* funding schemes. In case that – on purpose or because of serious neglect – false calculations are performed or the building's real design is different from the calculations, the expert risks a penalty of up to 50,000 €. Calculations performed during construction of new buildings are checked – mostly as samples – by the local authorities in charge.

Energy carrier [1]		Primary Energy Factor	
		total	non-renewable fraction
Fossil fuels	Light fuel oil	1.1	1.1
	Natural gas (grid)	1.1	1.1
	Liquid gas	1.1	1.1
	Coal	1.1	1.1
	Brown coal	1.2	1.2
Bio fuels	Biogas [2]	1.5	0.5
	Liquid bio fuel [2]	1.5	0.5
	Wood	1.2	0.2
District heat from CHP [3 4]	Fossil fuel (default)	0.7	0.7
	Renewable fuel (default)	0.7	0.0
District heat from heating plant [4]	Fossil fuel (default)	1.3	1.3
	Renewable fuel (default)	1.3	0.1
Electricity	Grid-Mix (2014)	2.8	2.4 [5]
	Grid-Mix (2016)	2.8	1.8 [5]
	Substitution mix [6]	2.8	2.8
Environmental energy	Solar energy	1.0	0.0
	Ground heat, geothermal energy	1.0	0.0
	Ambient heat	1.0	0.0
	Ambient cooling	1.0	0.0
Waste heat	from (industrial) processes on-site	1.0	0.0

[1] Reference: calorific value
[2] restricted to on-site / nearby generation
[3] default values for CHP ≥ 70 %
[4] calculation of local PE-factors foreseen
[5] Values given by the Energy Saving Ordinance (deviation from standard)
[6] used for electricity delivered by CHP-plants to the public grid

Table 3. Primary Energy Factors; non-renewable fractions for use in energy performance calculations.

2.I.iii. Action plan for progression to NZEB for new buildings

With the strengthening of the new building requirements valid from 1 January 2016, Germany made a decision on the NZEB level. Compared to the former performance values, the maximum primary energy demand was reduced by 25%, as were the requirements to limit the heat transfer, which were reduced by an average of 20%. This level was identified as cost-optimal.

The Energy Saving Act[14] was amended in 2013 with a verbal description of the NZEB (in accordance with the EPBD) and the obligation to comply with this level, applicable to new buildings owned and occupied by public authorities by 1 January 2019 and to all other new buildings by 1 January 2021. Furthermore, the act obliges the government to specify the NZEB level for new public buildings in an ordinance issued before 2017, and for all other buildings in another ordinance issued before 2019.

2.I.iv. Requirements for building components for new buildings

The overall performance requirement (non-renewable primary energy demand) is accompanied by a requirement that limits the overall specific heat transmission coefficient[17]. This requirement can turn out to be the main efficiency requirement in buildings where the energy is provided mainly by RES.

The heating and cooling demand of new buildings and of public buildings undergoing major renovations must be at least partially covered by systems that use RES. There are specific percentages given for the different RES-based systems, which can be combined which each other. The use of RES can be substituted by the use of waste heat (subject to certain conditions), district heating or cooling (subject to certain conditions), the installation of a combined heat and power system or cooling (subject to certain conditions) or with an energy performance of at least 15% better than the required performance (substitute measures).

2.I.v. Enforcement systems new buildings

The federal states (Bundesländer) are responsible for the enforcement of the Energy Saving Act (EnEG), the Energy Saving Ordinance (EnEV) and the Renewable Energies Heat Act (EEWärmeG). Therefore, it is impossible to present a homogeneous enforceability rule.

2.II. Energy performance requirements: EXISTING BUILDINGS

2.II.i. Progress and current status of existing buildings (regulation overall performance)

Germany does not have a database describing the energy efficiency features of the building stock as a whole. For residential buildings – mainly for apartment buildings – the consumption and the development of the normalised average are known from several studies performed with data derived from individual heating-cost billing. The current average consumption of existing buildings was reduced from 230 kWh/(m².year) in the 1990s to 155 kWh/(m².year). Details about the German stock of residential buildings can be found in a study from 2016[18]. A total of 16,982 datasets of residential buildings give details of their current condition and implemented refurbishment measures: e.g., 50.4% of the external walls of these buildings had already been equipped with thermal insulation. The reduction of average consumption is not only due to refurbishment, but is also partly a result of rising awareness and actions resulting from mandatory individual heat billing and increased energy prices. In a current project called 'ENOB:dataNWG' a consortium is establishing a scientific database with actual data of the German non-residential building stock. This data has been collected with a specific method during the project.

Requirements to upgrade the building stock comprise conditional requirements in case of relevant refurbishments, mandatory update requirements to be met without any triggering measures (e.g., insulation of the highest floor slap) and requirements in case of extensions (Figure 2).

Heaters running on fossil fuels that have been installed before 1 October 1978 cannot be used any more. Heaters running on fossil fuels that have been installed before 1 January 1985 are not allowed since 2015. Effectively, heaters older than 30 years are not allowed anymore.

Furthermore, building owners have to make sure that the insulation of the highest floor slap or roof does not exceed a certain U-value. As of 31 December 2015, building owners need to ensure that these building parts do not exceed 0.24W/m^{2}K. There are some exceptions to this rule. Particularly, these rules do not have to be followed if the building owner himself has lived in the building before 1 February 2002 or if the measures would not be economically feasible.

After a change of ownership, the deadline to fulfil the above obligations is two years.

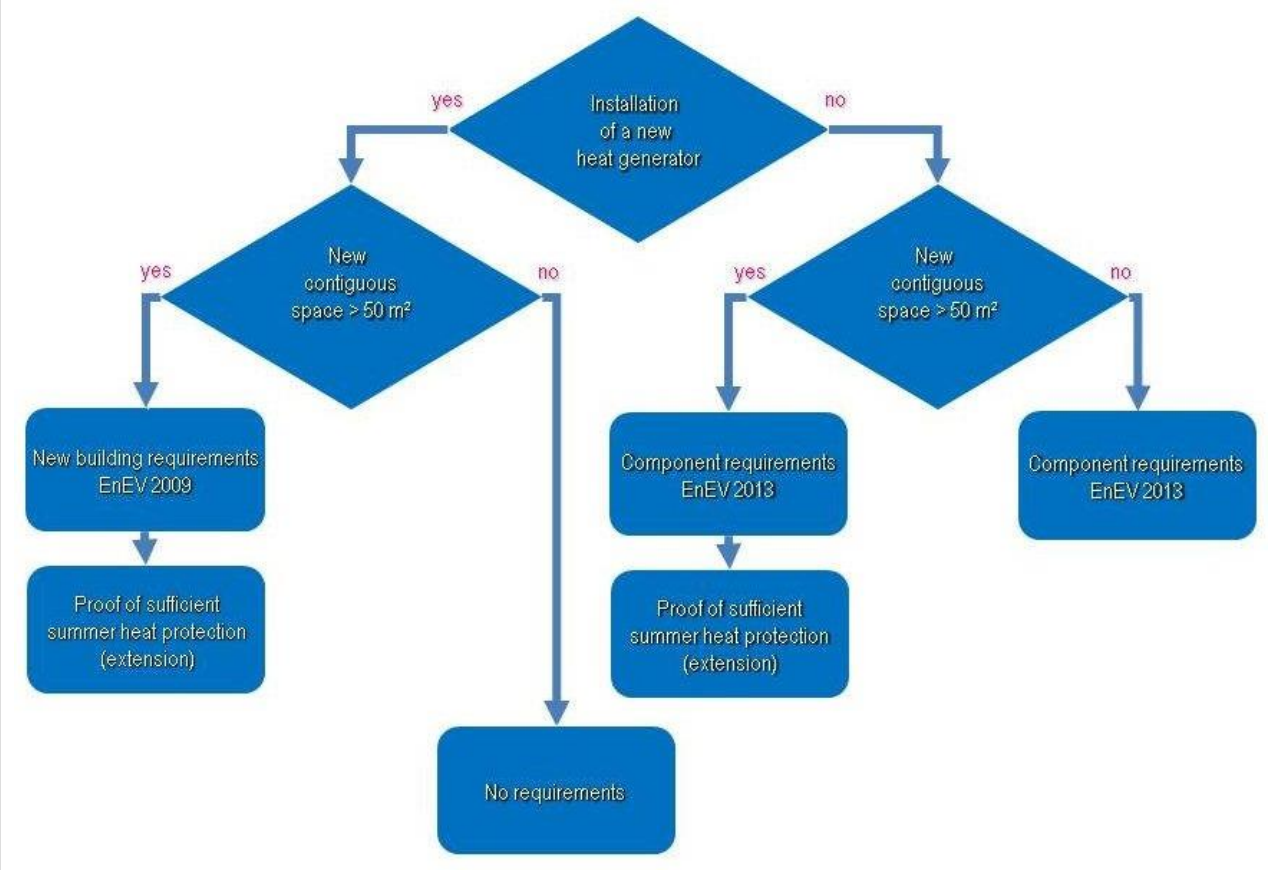

Figure 2. Requirements in case of extensions of existing buildings.

2.II.ii. Regulation on individual parts, distinct from whole building performance

Several requirements address the performance of individual building parts in existing buildings. Table 4 shows the regulations on individual building parts concerning their first instalment, replacement or renewal.

Component	Residential buildings and zones of non-residential buildings with indoor temperature ≥ 19°C	Zones of non-residential buildings with indoor temperature 12 to < 19°C
outside walls	0.24 W/(m².K)	0.35 W/(m².K)
windows, window doors	1.3 W/(m².K) [2]	1.9 W/(m².K) [2]
roof windows	1.4 W/(m².K) [2]	1.9 W/(m².K) [2]
glazing	1.1 W/(m².K) [3]	No requirement
curtain wall	1.5 W/(m².K) [4]	1.9 W/(m².K) [4]
glass roofs	2.0 W/(m².K) [3]	2.7 W/(m².K) [3]
window doors with folding, pushing, lifting mechanisms	1.6 W/(m².K) [2]	1.9 W/(m².K) [2]
windows, window doors, roof windows with special glazing	2.0 W/(m².K) [2]	2.8 W/(m².K) [2]
special glazing	1.6 W/(m².K) [3]	No requirement
curtain walls with special glazing	2.3 W/(m².K) [4]	3.0 W/(m².K) [4]
roof surfaces and dormers, walls towards unheated attic, top floor ceilings	0.24 W/(m².K)	0.35 W/(m².K)
roof surfaces with sealing	0.20 W/(m².K)	0.35 W/(m².K)
walls towards soil or unheated rooms (excluding roof rooms) and ceilings towards soil or unheated rooms	0.30 W/(m².K)	No requirement
floor constructions	0.50 W/(m².K)	No requirement
overhangs flanking the exterior	0.24 W/(m².K)	0.35 W/(m².K)

Table 4. Regulations on individual building parts concerning their first instalment, replacement or renewal.

2.II.iii. Initiatives/plans to improve the existing building stock

The energy strategy of the Federal Government of Germany aims for an energy-neutral building stock by 2050[19]. To reach that goal, the non-renewable primary energy demand of the building stock needs to be reduced by 80%. The three instruments considered to be used in that strategy are regulatory law and financial incentives as well as information and advice.

Whenever relevant refurbishment is done, the minimum requirements given by the Energy Saving Ordinance have to be met. The requirements of the ordinance can be fulfilled in two ways:

- by meeting specific energy performance requirements for building elements and installations;
- by attaining 140% of the performance requirements for a new building (calculated using the 2014 reference building status).

Due to a number of policies that promote energy efficiency and provide financial support, a lot of buildings are retrofitted to a higher energy performance level than required. Programmes like the *KfW* programme for residential and non-residential buildings, and the incentives programme for heating with RES (*MAP*)[21] contribute to the goal of an energy-neutral building stock. In the past 15 years, for example, the *KfW* has provided financial support for the retrofitting and construction of four million residential housing units. This represents in total approximately 10% of the German building stock.

Germany has chosen an alternative approach to renovating 3% of the total floor area of buildings owned and occupied by its central government as required by Article 5 (6) EED. Therefore, cost-efficient measures are carried out including extensive retrofitting and measures to change user behaviour. The national energetic retrofitting schedule for federal property (*Sanierungsfahrplan Bundesliegenschaften* (ESB)) was established in 2011. To reach the 3% goal, federal government buildings need to get refurbished to an energy quality as required by the Energy Saving Ordinance.

2.II.iv. Long Term Renovation Strategies, status

The LTRS shows measures and incentives for the renovation of the national building stock. Germany defines overall energy efficiency as a first indicator, and intends to establish additional indicators, for example, concerning final energy consumption, as soon as the LTRS is updated. Other indicators are generated from future databases (concerning renovation rate and intensity), energy performance certificates and the heating label.

Following the revision of the EPBD in 2018 and the EnEV, Germany defines overall energy efficiency as a primary indicator and numerically models it with regard to the non-renewable primary energy consumption ($PEV_{n.E.}$). The overall energy efficiency refers to the provision of heating, cooling and warm water and, for non-residential buildings, lighting. Moreover, the non-renewable impact for production, transformation and transportation or distribution of energy sources is also considered in this indicator (polluter pays principle). The overall energy efficiency can be increased by strengthening energy efficiency as well as raising the share of RES to cover heating demands.

As an indicative milestone for 2030, Germany aims at lowering the non-renewable primary energy consumption to 2,000 PJ (556 TWh) for the overall energy efficiency. This indicative milestone refers to a reduction of **$PEV_{n.E.}$** by approx. 55% compared to the base year of 2008 (4,400 PJ). In 2018, as the **$PEV_{n.E.}$** was approx. 3,300 PJ (preliminary estimate by AGEB); a reduction of approx. 25% was reached compared to the base year of 2008.

2.II.v. Financial instruments and incentives for existing buildings

The *KfW*[23] promotional programme 'Energy Efficient Refurbishment'[24], funded by the Federal Ministry for Economic Affairs and Energy, is the most significant provider of financial incentives for energy efficiency in the German housing sector. The programme aims to promote energy savings and greenhouse gas reductions as well as to encourage investments and create or safeguard jobs.

The level of financial support available is linked to the ambition of the refurbishment. There are in total six (6) deep retrofit promotional levels: starting with the Efficiency House 55 as the most ambitious level, followed by Efficiency House 70, 85, 100 and 115 as well as a separate level for heritage buildings (Table 5). The figures indicate in % how much of the maximum primary energy requirement specified by the Energy Saving Ordinance 2013 the house needs.

In terms of partial debt relief, the incentive starts at 25% and reaches up to 40% at the most ambitious level, the Efficiency House 55. The maximum loan is 120,000 € per housing unit. Alternatively, there is an option to apply for a grant for investment[25] (a maximum of 48,000 € per housing unit).

For those customers who do not target a comprehensive refurbishment of their building or housing unit, *KfW* offers promotional loans for packages of measures and single measures such as windows, or insulation (maximum 50,000 € per housing unit). There is also an option to apply for a grant (a maximum of 10,000 € per housing unit).

The promotional programmes are available for all private investors in the residential building sector in Germany as well as housing companies at equal conditions.

Standard	annual primary energy demand*	specific transmission heat loss*	repayment subsidy	alternative: grant for investment
Efficiency House 55	55 %	70 %	40 %	40 %
Efficiency House 70	70 %	85 %	35 %	35 %
Efficiency House 85	85 %	100 %	30 %	30 %
Efficiency House 100	100 %	115 %	27.5 %	21.5 %
Efficiency House 115	115 %	130 %	25 %	25 %
Efficiency House Monument	160 %	175 %	25 %	25 %
Single measures	-	-	20 %	20 %

** compared to the corresponding value of the EnEV-reference-building*

Table 5. Efficiency-House-Standards defined by comparing to the corresponding value of the reference building of Germany's Energy Saving Ordinance; repayment subsidy in % of the maximum loan amount; grant for investment in percentage of a maximum investment of 120,000 € in case of Efficiency-House, and 50,000 € in case of single measures.

2.II.vi. Information campaigns / complementary policies

The Federal Government financially supports the advice given by energy experts to building owners. The Federal Office for Economic Affairs and Export Control (*BAFA*) supports on-site-advice for residential buildings ('*Energieberatung für Wohngebäude*'), energy advice for medium-sized enterprises ('*Energieberatung Mittelstand*') and energy advice for municipal non-residential buildings ('*Energieberatung für Nichtwohngebäude von Kommunen und gemeinnützigen Organisationen'*). The advice of listed energy efficiency experts can also be financially supported by the *KfW*.

In addition, the '*Verbraucherzentrale*' (publicly supported organisation providing advice to consumers) provides information and energy checks for households.

Since 2016, the Federal Ministry for Economic Affairs and Energy informs private households, companies and public bodies with its campaign 'Germany makes it efficient'. Everyone should be motivated to use

heat and electricity as efficiently as possible. The Federal Ministry for Economic Affairs and Energy is backing the campaign by providing information and funding.

Potential funding recipients are often insufficiently informed about the funding programmes available to strengthen energy efficiency and to foster the use of RES in building heating, industrial processes and plants. Moreover, the application process for funding is often seen as being too complex.

Therefore, BMWi, BAFA and KfW established an online tool called 'Energy efficiency funding guide' ('Förderwegweiser Energieeffizienz') which by means of a question-answer system guides the user towards a suitable funding programme for the corresponding target group.

2.III. Energy performance certificate requirements

2.III.i. Progress and current status on EPCs at sale or rental of buildings

The requirement to show or hand out the EPC is compulsory when showing a flat or building to the prospective buyer or tenant at the latest. In case of non-compliance, a penalty can be issued to the owner of the building by the local authorities named by the regions (normally the building authority).

2.III.ii. Quality Assurance of EPCs

The independent control system works efficiently and allows keeping both efforts and costs as low as possible. It works without general data storage in a central database. A commissioned and authorised body (*'Deutsches Institut für Bautechnik – DIBt'*) holds a central EPC register without generally collecting the contents of the issued EPCs. The register collects data from the assessor concerning the type of EPC issued and the location of the building. Each EPC receives an individual registration number and is part of the random quality checks. The contents of the EPC and additional input data are only collected for EPCs that are drawn as part of the random samples. For the purpose of later long-time storage in a database, and after all the checks are done, the datasets have to be anonymised to secure data privacy for property owners, which is held in high esteem in Germany.

The first step of plausibility checks is carried out automatically by *DIBt* on behalf of the local authorities. The current Energy Saving Ordinance came into force on 1 May 2014 and introduced the registration of EPCs. So far, 2,984,254 registration numbers were allocated, out of which 5-6% got into the random first step check. The results are communicated to the local authorities (location of the building) and the assessor. Further and more detailed controls (2nd and 3rd level check) are the responsibility of local authorities, as they are also responsible for imposing fines in case of breaches of the regulations, e.g., incorrect issuing of EPCs, refusal to issue or to submit an EPC, or deliberately including incorrect information in EPCs.

2.III.iii. Progress and current status of EPCs on public and large buildings visited by the public

Concerning the format and content of EPCs, German legislation does not distinguish between public and large private buildings visited by the public, and other non-residential buildings. The display form (Figure 3) is provided by the printing tool as an integrated part of every EPC for a non-residential building. Thus, a display form is at hand in case that the display becomes compulsory for the building in question in the future, or in case that the owner wants to put out a voluntary display. In case that an EPC was issued under former legislation, a new display based on this EPC must mention the applied version of the ordinance.

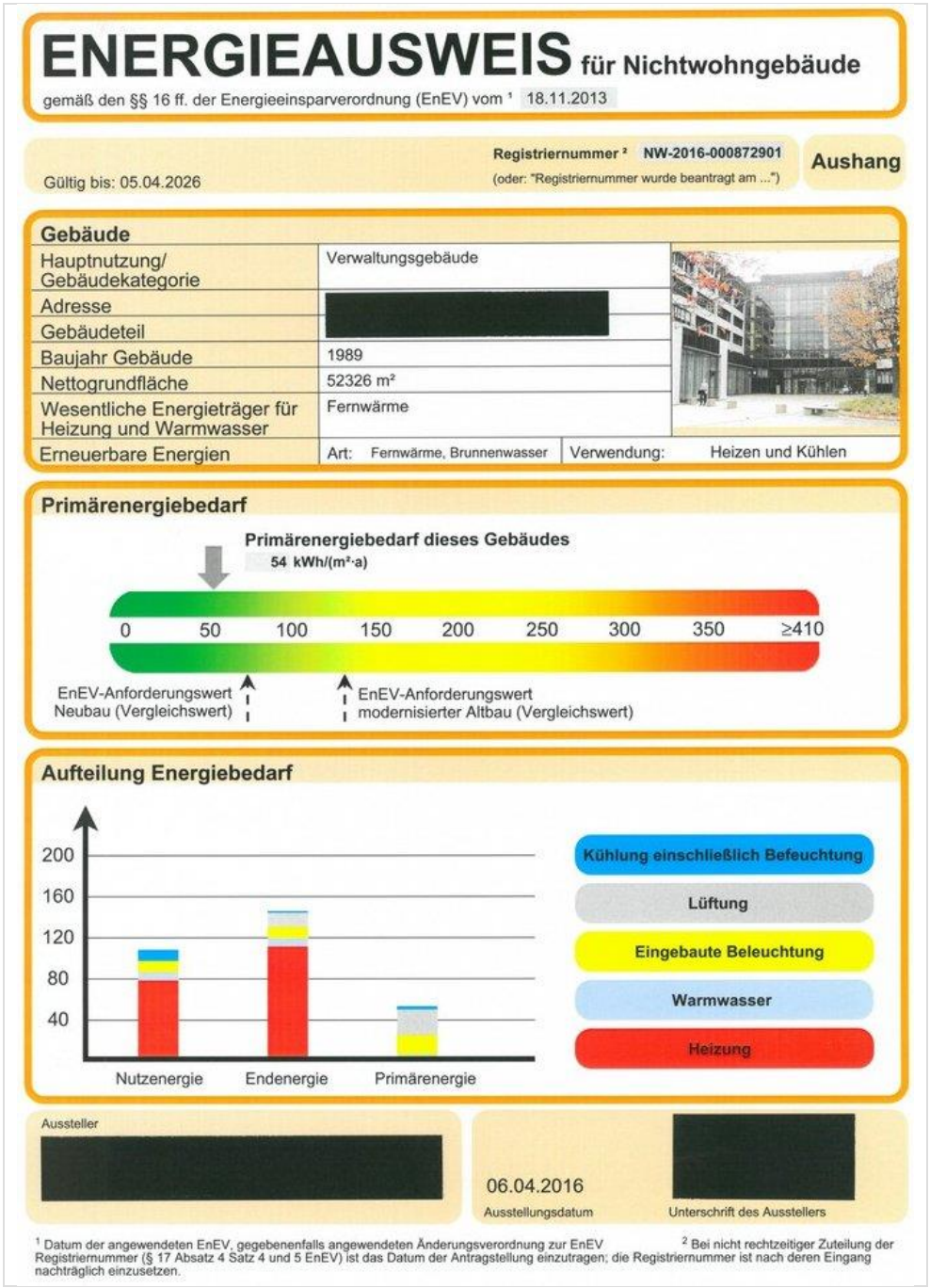

Figure 3. Example of a filled-in display form (anonymised)

2.III.iv. Implementation of mandatory advertising requirement – status

The obligation to include an energy performance indicator in advertisements in commercial media was introduced in accordance with the current Energy Saving Ordinance. In order to provide comprehensive information, the advertisements have to state:

- the year of construction of the building;
- the value of consumption or demand of delivered energy;
- the main energy carrier used for heating and domestic hot water;
- the type of EPC (based on calculated or measured consumption) from which the information was taken;

and in addition:

- for residential buildings, if applicable, the efficiency class;
- for non-residential buildings, the delivered energy value for electricity.

Because of the extent of the required information, most major newspapers provide a standardised system of abbreviations for their advertising to customers.

The requirement applies to buildings that have an EPC. Since an EPC has to be presented at the time of viewing the building, the necessary information is normally included in most advertisements for existing buildings. Non-compliance can be fined with a penalty of up to 5,000 €. Professional estate agents are also aware that, in case of non-compliance, they might be sued by competitors or consumer organisations using a procedure which is common in German competition law.

2.IV. Smart buildings and building systems

2.IV.i. Status and plans on smart buildings

With the funding programme 'Pilotprogramm Einsparzähler' the Federal Ministry for Economic Affairs and Energy supports the development and testing of measuring systems to quantify savings on electricity, gas, oil and biomass and cooling. It is up to the developer to decide which target group (industry, private households, public bodies) is addressed with the measuring system and which technical system the metering device is based on. The programme aims to support the development of energy savings measuring systems, thereby promoting research for the development of innovative technologies/solutions. The ultimate goal is to offer users the possibility to continuously monitor their energy consumption in order to take informed decisions on how to reduce it.

The KfW programme ‘Energy-efficient urban redevelopment –KfW432’ supports integrated neighbourhood concepts and refurbishment management. The programme is designed as an ‘investment preparing’ programme that solely promotes concepts and their implementation. Investment for the refurbishment itself, for which there are other KfW support programmes (e.g., the CO_2 building refurbishment programme) is not included. Integrated neighbourhood concepts show the technical and economic potential for energy savings at the neighbourhood level, taking into account urban planning, existing monuments, building culture and housing economics as well as demographic and social aspects. The supported 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 KfW436 programme for model projects in the ‘Smart City’ area where local authorities and local government enterprises may apply for KfW grants of up to 65% per action.

2.IV.ii. Regulation of system performance

The following requirements have to be met, even without the 'trigger' of a relevant modernisation:

- Water-based central heating systems have to be equipped with controls that adjust the temperature of the heating medium based on time and outside temperature, and through which circulating pumps are shut down accordingly; there are exemptions.
- Water-based central heating systems have to be equipped with room-temperature controls; there are exemptions for small rooms with floor heating, old floor heating and for non-residential buildings, where rooms of similar type and use may share controls.

- AC systems with more than 12 kW output and due to influence humidity must have controls with separate set-points for humidification and dehumidification.

The following requirements must be met in case of relevant changes to the system:

- Circulation pumps in water-based heating systems with more than 25 kW heat output must be controlled automatically; there are exemptions.
- Circulation pumps in domestic hot water systems must have a time control.
- Newly installed heating and domestic hot water pipes as well as cold water pipes in AC systems must be insulated; there are exemptions, especially for heating pipes in a heated space.
- AC systems with more than 12 kW output and ventilation systems with more than 4,000 m^3/h supply air must meet the following requirements in case of first-time installation and major changes:
    - the specific fan power (SFP) value may not exceed class SFP 4 (EN 13779: 2007);
    - the air flow must be controlled automatically according to the thermal and sensible load if the hourly flow exceeds 9 m^3/m^2; there are exemptions;
    - the systems must be equipped with heat recovery units of class H3 (EN 13053: 2007) or better.

2.IV.iii Building Automation and Controls (BACs)

The German Energy Act offers new possibilities as building automation is now also considered in residential buildings within the reference building method. The effects will be calculated according to the DIN V 18599.

2.IV.iv. Status and encouragement of intelligent metering

The Act on the Digitisation of the Energy Transition (2016) bridges the gap between providing the energy sector with a reliable framework for investment and achieving wider acceptance for smart meters among consumers. It sets out clear rules stipulating who is required to use smart meters, and who can use smart meters as an option.

For consumers, this depends on the amount of electricity that is consumed annually, whereas for producers, this depends on the amount of capacity that is installed. Not all consumers and producers will be required to install smart meters right away. Small-scale consumers and producers are required to install smart meters since 2020, so they can benefit from the lessons learnt by those groups that have introduced smart meters right from the start.

New rules on price caps play a crucial role. These price caps will ensure that the costs and benefits of installing and operating a smart meter will be proportionate. They are based upon the potential benefits that accrue from the use of smart meters, as calculated by the Federal Ministry for Economic Affairs and Energy in its cost-benefit analyses[22].

By keeping costs at a proportionate level whilst providing grid operators with a reliable framework for devising their rollout strategy, this helps achieve wider acceptance for smart meters among consumers and plant operators.

2.IV.v. Progress and current status on heating systems (Inspection / Equivalence)

Concerning heating systems, Germany has chosen the equivalence approach. This choice was made considering:

- the long tradition of system requirements in Germany (thermostatic valves, pipe insulation, time- and weather-driven controls);
- the compulsory measurement scheme for flue gas losses and pollutants of boilers, established since 1982;
- and the mandatory upgraded requirements concerning the replacement of old boilers and the insulation of heat distribution and hot water pipework.

Since these measures were already in place when the EPBD was due for transposition, a further inspection scheme was not considered necessary.

On the other hand, due to the climate in Germany, AC systems are not a common feature in buildings. Therefore, a tradition of requirements comparable to those for heating systems does not exist for AC systems. Considering this, a combination of recurrent inspections and compulsory regular maintenance was established in 2007. The provisions in the Energy Saving Ordinance were amended in 2013 to introduce a registration and control system for inspection reports.

The most recent equivalence report, for the period 2014 to 2016, shows that the required equivalence of the effects of alternative measures according to Article 14 paragraph 4 of the EPBD are ensured in Germany. Also previous studies showed that the impact of equivalent measures by far exceeds the possible impact of inspections combined with recommendations. In consideration of these results, the presentation of a reference scenario in this CA EPBD country report has not been considered necessary and instead it was chosen to present new alternative measures according to Article 14 paragraph 4 of the EPBD (Heating Label, Individual Renovation Roadmap, Heating Optimisation Programme). For example, the Individual Renovation Roadmap (iSFP) was established in 2017 as a standardised form for reporting on building energy consultation which aims to show the owner a reliable plan for action for the building in the next few years.

The so-called 'Heizungscheck' is carried out by the 'Bundesverband der Verbraucherzentralen e.V. (vzbv)' together with the Consumer Association of the federal states and energy consultants. It is funded by the Federal Ministry for Economic Affairs and Energy. The voluntary 'Heiz-check' has been available since October 2015 and integrates the previously known 'Brennwert-check'. The 'Heiz-check' includes checking the optimal settings and the efficiency of the entire heating system. Due to the funding provided by the BMWi, consumers only have to pay a very small contribution (40 €). For households with a low income, the check is free of charge. In the years 2016 and 2017, up to 3,000 'Heiz-checks' have been carried out annually.

2.IV.vi. Progress and current status on AC systems (Inspection / Equivalence)

In 2007, a compulsory Heizungscheck inspection scheme was introduced for AC systems combined with compulsory maintenance. The combination with regular maintenance allows for longer intervals for the inspections, currently ten (10) years (i.e., twice during normal lifespan).

Energy Act for Buildings (GEG), Energy Saving Regulation (EnEV)

The Energy Act for Buildings (GEG) essentially replaces the previous regulation in Section 12 (1) of the Energy Saving Regulation and supplements the regulation with the new requirements of the EPBD as amended by Directive 2018/844. In general, AC and ventilation systems of 12 kW or more have to undergo an energetic inspection within certain periods. In specific cases, random checks will suffice; this applies in the case where one building owner has at least ten (10) similar ventilation systems of 12 kW or more each installed in different but similar buildings. Inspection obligations do not apply if an AC system or a combined AC and ventilation system is installed in a non-residential building, or if the building has a system for building automation and control in accordance with the GEG specifications. The same also applies to residential buildings fulfilling these conditions.

In the near future, for AC systems and combined AC and ventilation systems with more than 70 kW, inspections will be carried out in accordance with the specifications included in DIN SPEC 15240: 2013-10.

The eligibility of experts is defined by the Energy Saving Ordinance and comprises different possible combinations of fields of study in engineering combined with specific minimum practical experience concerning ventilation and AC systems. Since May 2014, the experts have to obtain a registration number for each inspection report. For this purpose, they need to set up a personal account with the registration authority *DIBt*. As many experts are entitled to do both inspections and certificates, it is not possible to determine how many of the 31,422 registered experts actually perform AC inspections. This regulation will be continued in the Energy Act for Buildings (GEG) with only minor changes.

2.IV.vii. Enforcement and impact assessment of inspections

Enforcement and penalties

The person or entity in charge of operating an AC system can be fined up to 5,000 € if the inspection is not commissioned in time or not at all. A person who performs an inspection without being entitled to do so (i.e., without having the required professional education and experience) can be fined with such a penalty as well. Since the local authorities are in charge of the penalty system, there are no general numbers indicating the activities for Germany as a whole.

Quality control of inspection reports

The control system for inspection reports for AC systems was launched on 1 May 2014. In 2017, 2018 and 2019, a total of 11,372 new inspection reports were registered. The Federal States have established their individual system of authorities or entities in charge of the sample controls. It is their responsibility to define the samples. The registration authority *DIBt* provides the control authorities with the addresses of the experts whose inspection reports are drawn as samples. Since the start of the system, 940 reports were subject to control. As a result of a common project, the Federal States have introduced an electronic tool to support the control process in order to get comprehensive and comparable results. Reports by the Federal States about the results of the sample controls are due every three (3) years, the first of which was due in March 2017.

Impact assessment

The requirements for new Buildings in the Energy Act for Buildings (GEG) are going to be reviewed in 2023. Depending on the results of the review, a legislative proposal for further development of the requirements for buildings will be submitted. The affordability of building and living remains a key objective.

3. A success story in EPBD implementation

Involving banks in energy efficiency financing

KfW is Germany's state-owned promotional bank mandated by law to carry out its promotional activities[29]. *KfW* acts in close cooperation with the Federal Ministry for Economic Affairs and Energy.

The objective of the programme 'Energy Efficient Construction and Refurbishment' is to provide financing by soft loans and grants for energy efficient construction and refurbishment activities for the German residential sector.

Additionally, the Federal Office for Economic Affairs and Export Control (BAFA) is administrating several funding programmes for the Federal Ministry of Economy and Energy. BAFA is for example in charge of giving grants for energy advice for both residential and non-residential buildings.

Key principles of promotion:

In order to benefit from financial support, it is a precondition that the efficiency standards achieved are better than the requirements set up in the German Energy Savings Ordinance. Individual or combined measures as well as complete packages seeking to achieve an 'Efficient House' Standard are promoted.

Who are the key people involved?

As *KfW* does not have a branch network (the so-called on-lending principle involves financial intermediaries), customers usually file the application for the promotional loans at banks or insurance companies of their preference. The application for grants however is processed directly by *KfW*.

The involvement of an energy consultant is mandatory in the process of application for promotional loans or grants. It is the consultant's responsibility to check whether the construction or refurbishment project is properly designed to achieve the targeted efficiency level by using an internet-based tool to compare the technical details of the project with the targeted efficiency level.

What were the key achievements?

The promotional programmes have a proven and very positive impact on climate and economy:

- during the period between 2005 and 2015, the programmes led to a total reduction of 6.4 million tons of CO_2-equivalents per year;
- high volume of investment triggered;
- high number of jobs created or conserved;
- in 2019 alone, 282,000 housing units were refurbished to more energy efficient levels and 86,000 housing units were newly built with a very high energy performance with support of the programmes;
- well established programme structure and distribution network;
- benefit for public households.

What were the key lessons learned?

The more transparent and simple the structure of the overall promotional scheme is, the more it is understandable by the parties involved, and the easier to distribute.

The mandatory involvement of an energy expert from the beginning of the application process until completion of the construction or refurbishment project is very important to:

- provide confidence to the investor regarding their energy efficiency project;
- assure a high degree of quality and reliability regarding the energy efficiency level reached;
- assure target-oriented use of public funds;
- assure a high degree of reliability regarding the promotional effects.

What makes this a good practice example?

The promotional scheme provides a win-win situation to all parties involved:

- customers benefit from very attractive promotional conditions;
- commercial banks benefit from both an enhanced product spectrum for their clients which improves cross-selling potential, as well as from additional liquidity without refinancing cost and with an attractive margin;
- public budget benefits from additional income (tax and social security contributions);
- economy benefits from the creation of job positions particularly in small- and medium-sized enterprises due to the volume of investment triggered;
- environmental benefits from the high volume of CO_2

In addition:

- a high number of new housing units is reached and a high number of investors are incentivised to invest in energy efficient construction and refurbishment measures;
- the scheme is transparent and attractive for customers (provides a high and increasing level of demand);
- it comprises a standard setting with wide acceptance;
- provides systematic and comprehensive quality control;
- includes the mandatory involvement of energy experts;
- secures the continued development of energy efficiency in society.

4. Conclusions, future plans

Currently, the requirements on energy performance of buildings and the requirements on the minimum percentage of RES used for heating and cooling of buildings are the subject of different legal acts:

- the Energy Saving Ordinance (in pursuit of the Energy Saving Act) regulates the energy performance of new and existing buildings;
- the Renewable Energies Heat Act ('*Erneuerbare-Energien-Wärmegesetz*') sets an obligation to use a minimum percentage of RES to cover the demand of heating, domestic hot water and cooling of new buildings, as well as existing public buildings subject to certain major renovations.

The Federal Government has combined these two legal sectors in order to simplify their application. This is foreseen in a new legal act, the '*Gebäudeenergiegesetz*' (GEG). The GEG has now been adopted by both the German Bundestag and the Bundesrat. It should come into force by October 2020.

The German calculation method DIN V 18599 was amended in October 2016 and a simplified method for residential buildings will be issued in July 2020. Since the current Energy Saving Ordinance refers to the 2011 version of the energy performance calculation method, the applicability of these new standards depends on the above-mentioned legal process. An application of the revised standard is also necessary to better cover advanced technologies.

From 2021 onwards, there will be a new funding structure in the building sector. The 'Bundesförderung für effiziente Gebäude' (BEG) will reduce complexity of subsidy programmes for buildings. The new guideline will bring together several programmes, including already established programmes like the 'Bundesförderung für Heizen mit erneuerbaren Energien' better known as the 'Marktanreizprogramm' (MAP) and the 'CO2-Gebäudesanierungsprogramm'.

To address the different financing needs of citizens, the BEG will offer low-interest loans with both a repayment and a simple subsidy. The new layout will increase transparency and accessibility to funding.

Endnotes

1. Energy Saving Ordinance (*Energieeinsparverordnung*) 2002: bbsr-energieeinsparung.de/EnEVPortal/DE/Archiv/EnEV/EnEV2002/2002_node.html

2. Thermal Insulation Ordinance (*Wärmeschutzverordnung*): bbsr-energieeinsparung.de/EnEVPortal/DE/Archiv/WaermeschutzV/wschv_node.html

3. Heating Appliance Ordinance (*Heizungsanlagen-Verordnung*): bbsr-energieeinsparung.de/EnEVPortal/EN/Archive/HeatingAppliances/heatingappliances_node.html; www.bbsr-energieeinsparung.de/EnEVPortal/DE/Archiv/HeizanlV/heizanlv_node.html

4. DIN V 18599 'Energy efficiency of buildings - Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting'; first edition 2005-07, current version 2016-12. All DIN Standards mentioned in this report – as well as German editions of EN and ISO standards – are available at beuth.de/en. A special collection of standards used in course of the EPBD-implementation is available at www.enev-normen.de (German language).

5. Energy Saving Ordinance (*Energieeinsparverordnung*) 2009: bbsr-energieeinsparung.de/EnEVPortal/EN/Archive/EnEV/EnEV2009/2009_node.html; www.bbsr-energieeinsparung.de/EnEVPortal/DE/Archiv/EnEV/EnEV2009/2009_node.html

6. *Erneuerbare-Energien-Wärmegesetz* (German only): erneuerbare-energien.de/EE/Navigation/DE/Recht-Politik/Das_EEWaermeG/das_eewaermeg.html

7. Energy Saving Ordinance (*Energieeinsparverordnung*) 2013: bbsr-energieeinsparung.de/EnEVPortal/EN/EnEV/EnEV2013/EnEV2013_node.html; www.bbsr-energieeinsparung.de/EnEVPortal/DE/EnEV/EnEV2013/EnEV2013_node.html

8. Model building approach (abridged '*EnEV* easy') / *Modellgebäudeverfahren*: bbsr-energieeinsparung.de/EnEVPortal/EN/EnEV/NewBuildings/Residential/Residential-node.html; www.bbsr-energieeinsparung.de/EnEVPortal/DE/EnEV/Neubau/Wohngebaeude/Wohngebaeude-node.html

9. https://www.gesetze-im-internet.de/geg/GEG.pdf

10. bbsr-energieeinsparung.de/EnEVPortal/EN/EnEV/EnEV2013/EnEV2013_node.html

11. https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings

12. 'Erneuerbare-Energien-Wärmegesetz'; more (German language only): erneuerbare-energien.de/EE/Navigation/DE/Recht-Politik/Das_EEWaermeG/das_eewaermeg.html

13. 'Energieeinsparverordnung'; more: bbsr-energieeinsparung.de/EnEVPortal/EN/EnEV/enev_node.html

14. '18599 Gütegemeinschaft'; more (German language only): 18599siegel.de/

15. Energy Saving Act (*Energieeinsparungsgesetz*) (EnEG): current version with English introduction: bbsr-energieeinsparung.de/EnEVPortal/EN/Regulation/EnEG/eneg_node.html; current version with German introduction: www.bbsr-

energieeinsparung.de/EnEVPortal/DE/Regelungen/EnEG/eneg_node.html; former versions: www.bbsr-energieeinsparung.de/EnEVPortal/EN/Archive/EnEG/eneg_node.html

16. More about 'Efficiency House' levels see section 2.II.v

17. The compactness indicator depends on size and layout of a building. It influences the resulting energy demand value for the individual building via the reference building scheme and has an impact on economic issues of the different possible solutions to fulfil the requirements.

18. The specific heat transmission coefficient (mean value of heat transmission per Kelvin and square meter of building surface) of a new residential building since January 2016 may not exceed the heat transmission coefficient of the reference building (u-values see Table 2).

19. Diefenbach, Nikolaus et al. '*Datenbasis Gebäudebestand*'; more (report in German language, English summary): iwu.de/forschung/energie/ongoing-projects/epi-soho/

20. '*Energeeffizienzstrategie Gebäude*'; download English version: bmwi.de/Redaktion/EN/Publikationen/energy-efficiency-strategy-buildings.html

21. '*Anreizprogramm Energieeffizienz*'; more (German language only): bafa.de/DE/Energie/Heizen_mit_Erneuerbaren_Energien/Anreizprogramm_Energieeffizienz/anreizprogramm_energieeffizienz_node.html

22. '*Marktanreizprogramm*'; more (German language only): erneuerbare-energien.de/EE/Navigation/DE/Foerderung/Marktanreizprogramm/marktanreizprogramm.html

23. bmwi.de/Redaktion/DE/Downloads/Studien/variantenrechnungen-von-in-diskussion-befindlichen-rollout-strategien.pdf?__blob=publicationFile&v=1

24. More about *KfW* promotional bank: see section 3.

25. '*Energieeffizient Sanieren – Kredit*', kfw.de/151

26. '*Energieeffizient Sanieren – Investitionszuschuss*', kfw.de/430

27. National Annex included in DIN EN 15378: 2008-07 'Heating systems in buildings - Inspection of boilers and heating systems; German version EN 15378:2007', for availability see endnote 4.

28. DIN SPEC 15240: 2013-10 'Ventilation for buildings - Energy performance of buildings - Inspection of air-conditioning systems', for availability see endnote 4.

29. Text of the official interpretation (German language only): bbsr-energieeinsparung.de/EnEVPortal/DE/EnEV/Auslegungen/Auslegungen/XIX09raumlufttechnisch.html?nn=738208

30. More about *KfW*'s structure, basis and activities: kfw.de/kfw.de-2.html

Annexes - Key Indicators & Decisions

Key Indicators & Decisions - General Background

no	Key Implementation Decisions – General Background	Description / value / response	Comments
01.01	Definition of public buildings (according to article 9 b)	Non-residential buildings which are owned and used by public authorities	Described in §2a (1) of the Energy Saving Act
01.02	Definition of public buildings used by the public (according to article 13)	The owner of a building used by public authorities and with more than 250 m^2 frequently used by the public has to display an EPC.	Described in Article 16 (3) of the Energy Saving Ordinance
01.03	Number of residential buildings	19,000,000	Destatis (Federal Statistical Office of Germany) https://www.destatis.de/
01.04	Number of non-residential buildings	3,500,000 non-residential buildings	Dämmbarkeit des deutschen Gebäudebestands; Beuth Hochschule für Technik Berlin, ifeu-Institut für Energie- und Umweltforschung Heidelberg; Juli 2015
01.05	If possible, share of public buildings included in the number given in 01.04	175,000	Dena, 2018
01.06	If possible, share of commercial buildings included in the number given in 01.04	undocumented	
01.07	Number of buildings constructed per year (estimate)	145,016 (2018) 146,012 (2017) 154,258 (2016)	Average over last 2 years: 145,514 Number of building permits for construction of new (source: destatis)
01.08	If possible, share of residential buildings constructed per year (estimate, included in the number given in 01.07)	Approx. 117,869 (2018) 119,060 (2017) 125,157 (2016)	Average over last 2 years: 118,464 Number of building permits for residential new buildings (source: destatis)
01.09	If possible, share of non-residential buildings constructed per year (estimate, included in the number given in 01.07)	27,147 (2018) 26,952 (2017) 29,101(2016) 26,533 (2015)	Average over last 4 years: 27,433 Number of building permits for new buildings (source: destatis)
01.10	Useful floor area of buildings constructed per year in million square meters (estimate)	31,547 (2019) 30,589 (2018) 30,377 (2017) 31,805 (2016) 28,510 (2015) living space only	Average over last 3 years: 28,938 No data available for total constructed floor area (source: destatis)

Key Indicators & Decisions – New Buildings

no	Key Implementation Decision – New Buildings	Description / value / response	Comments
02.01	Are building codes set as overall value, primary energy, environment (CO_2), reference building or other?	See below	
02.02	Requirements for energy performance of residential buildings in current building code	- A maximum non-renewable primary energy demand which is determined individually for each building using a reference building with similar geometry, orientation and use, but with a certain quality of all energy-relevant systems and components AND - A requirement for the energy performance of the building's thermal envelope which is determined by using the reference building approach	The reference building approach is used. In addition, a minimum quota of RES is used for heating, domestic hot water and cooling; the quota is different for the different technologies.
02.03	Requirements for energy performance of non-residential commercial buildings in current building code	- A maximum non-renewable primary energy demand which is determined individually for each building using a reference building with similar geometry, orientation and use, but with a certain quality of all energy-relevant systems and components AND - A requirement for the energy performance of the building's thermal envelope which is determined by a certain set of maximum U-values for opaque and transparent U-values respecting the design indoor temperature of the building's zones	The reference building approach is used. In addition, a minimum quota of RES is used for heating, domestic hot water and cooling; the quota is different for the different technologies.
02.04	Requirements for energy performance of non-residential public buildings in current building code	See 02.03	
02.05	Is the performance level of nearly zero energy (NZEB) for new buildings defined in national legislation?	The Energy Saving Act, which was amended in 2013, includes a verbal description of the NZEB (in accordance with the EPBD). The GEG defines the NZEB standard. The NZEB standard is consistent with the current specified level of the energy performance of buildings.	
02.06	Nearly zero energy (NZEB) level for residential buildings (level for building code)	No	See 02.02 and 02.05

no	Key Implementation Decision – New Buildings	Description / value / response	Comments
02.07	Year / date for nearly zero energy (NZEB) as level for residential buildings (as indicated in 02.04)	In force since 2016	For all residential buildings
02.08	Nearly zero energy (NZEB) level for all non-residential buildings (level for building code)	In force since 2016	See 02.03
02.09	Year / date for nearly zero energy (NZEB) as level for non-residential buildings (as indicated in 02.06)	In force since 2016	
02.10	Are nearly zero energy buildings (NZEB) defined using a carbon or environment indicator?	No	See 02.02 and 02.03
02.11	Is renewable energy a part of the overall or an additional requirement?	There is a minimum quota of RES used for heating, domestic hot water and cooling; the quota is different for the different technologies.	It is part of the overall requirement as well as an additional requirement. The overall performance requirement (non-renewable primary energy demand) also includes the necessary use of RES. In addition, the heating and cooling load of new buildings must be at least partially covered by systems using RES.
02.12	If renewable energy is an additional requirement to NZEB, please indicate level	See above	
02.13	Specific comfort criteria for new buildings, provide specific parameters for instance for airtightness, minimum ventilation rates	Comfort criteria are defined in several legal acts not addressing energy efficiency but health and workplace issues. These comfort criteria are respected within the marginal conditions when calculating the energy performance of new/existing buildings.	Partly

Key Indicators & Decisions – Existing Buildings

no	Key Implementation Decision – Existing Buildings	Description / value / response	Comment
03.01	Is the level of nearly zero energy (NZEB) for existing buildings set in national legislation?	Not defined	
03.02	Is the level of nearly zero energy (NZEB) for existing buildings similar to the level for new buildings?	See 03.01	
03.03	Definition of nearly zero energy (NZEB) for existing residential buildings (if different from new buildings)	See 03.01	
03.04	Definition of nearly zero energy (NZEB) for existing non-residential buildings (if different from new buildings)	See 03.01	
03.05	Overall minimum requirements in case of major-renovation	Yes, 140% of the performance requirements of the reference building Overall requirement as alternative option, only in cases of relevant major renovations	There are two options by which the requirements can be met: 1. By meeting the requirements for renovated building elements 2. By meeting 140% of the performance requirements for a new building (status 2014) The requirements for the building stock consist of conditional requirements in case of relevant refurbishments, some mandatory update requirements to be met without any triggering measures, and requirements in case of extensions.
03.06	Minimum requirements for individual building parts in case of renovation	Yes, requirements on building elements and installations have to be met.	Examples for: outer wall: U_{max} = 0.24 W/(m^2.K) windows: U_{max} = 1.3 W/(m^2.K) Minimum U-values are set depending on the element and for non-residential buildings the range of indoor temperature.
03.07	National targets for renovation in connection to Long Term Renovation Strategy (number or percentage of buildings)		
03.08	National targets for renovation in connection to Long Term Renovation Strategy (expected reductions and relevant years)	Emissions of the Building Sector reduced to 70 Mio. t CO_2 until 2030	

Key Indicators & Decisions – Energy Performance Certificates

no	Key Implementation Decision – Energy Performance Certificates	Description / value / response	Comment
04.01	Number of energy performance certificates per year (for instance average or values for of 3-5 years)	2017: 456,503 2018: 819,324 2019: 569,638 Average over three years: 615,155	In 2019, 12% of EPCs were issued for new residential buildings, 82% for existing residential buildings, 1% for new non-residential buildings and 4% for existing non-residential buildings. 2,984,554 EPCs were issued from May 2014 (start of registration) to December 2019. Data taken directly from the registration scheme
04.02	Number of EPCs since start of scheme	2,984,254 (status end of 2019)	In 2019, 272,814 EPCs based on energy consumption and 296,824 EPCs based on energy demand were issued. On 1 May 2014, the new Energy Saving Ordinance came into force and implemented the registration of EPCs. Prior to that, EPCs were not registered in Germany. Data taken directly from the registration scheme
04.03	Number of EPCs for different building types		
04.04	Number of assessors	31,422	Not all assessors issue EPCs based on energy consumption and energy demand and inspection reports. Assessors have to register to be able to draw EPC registration numbers. It is unknown how active each assessor is.
04.05	Basic education requirements for assessors	For new buildings: assessors have to be authorised to sign plans for building permits. For existing buildings in general: architects and engineers with relevant vocational training in combination with proven work experience in the field of energy efficiency. Exclusively for existing residential buildings and with additional vocational training: • master craftsmen in building trades; • building and building services technicians; • interior architects.	Engineer or architectural degree with a core specialisation in energy efficiency or after the degree two years of work experience in energy efficiency or additional training. The requirements for new buildings are in the responsibility of the regions.
04.06	Additional training demands for assessors	See 04.05	Certified course. To be able to sign applications for subsidies, additional continuous vocational training is required.

no	Key Implementation Decision – Energy Performance Certificates	Description / value / response	Comment
04.07	Quality assurance system	When an EPC is checked, the qualification of the assessor is verified as well.	
04.08	National database for EPCs	The independent control system works without general data storage in a central database. A commissioned and authorised body ('Deutsches Institut für Bautechnik - DIBt') holds a central EPC register without generally collecting the contents of the issued EPC. For the purpose of later long-time storage in a database, the collected datasets have to be anonymised to secure data privacy for property owners, which is held in high esteem in Germany.	The anonymised data of the EPCs belong to the regions. Only certain information can be drawn from those data sets. The register collects data from the assessor concerning the name and address of the assessor, the type of EPC issued and the type and location of the building. Each certificate receives an individual registration number and is part of the random quality checks. The contents of the certificate and additional input data are only collected for certificates that are drawn as part of the random samples.
04.09	Link to national information on EPCs / Database		

Key Indicators & Decisions – Smart Buildings and Building Systems

no	Key Implementation Decision – Smart Buildings and Building Systems	Description / value / response	Comment
05.01	Is there a national definition of smart buildings?	No	
05.02	Are there current support systems for smart buildings?		
05.03	Are there currently specific requirements for technical building systems (for instance in building codes)?	Yes	
05.04	Are there current requirements for automatics (for instance in building codes)?	63 GEG: Room by room settings for temperature	
05.05	Chosen option A or B for heating systems (inspection or other measures)	Other, equivalent measures	Option B This choice was made considering the long tradition of system requirements in Germany (thermostatic valves, pipe insulation, time- and weather-driven controls), the compulsory measurement scheme for flue-gas losses and pollutants of boilers, established since 1982 and the mandatory update requirements concerning the replacement of old boilers and the insulation of heat distribution and hot water pipework. Since these measures were already in place when the EPBD was due for transposition, a further inspection scheme was not considered necessary.
05.06	Number of heating inspections; reports per year (if option A)	Option B was chosen	
05.07	Chosen option A or B for cooling systems (inspection or other measures)	Inspection	Option A A combination of recurrent inspections and compulsory regular maintenance was established in 2007. The provisions in the Energy Saving Ordinance were amended in 2013 to introduce a registration and control system for inspection reports.
05.08	Number of air-conditioning / cooling system inspections; reports per year (if option A)	In 2017 (starting in May), 2018 and 2019, a total of 11,372 new inspection reports were registered.	2017: 4,316 2018: 4,270 2019: 2,786 Data directly from registration scheme.
05.09	Is there a national database for heating inspections?	No, Germany runs an alternative system.	Boilers are included as part of a central register for furnaces (for safety and environmental issues).
05.10	Is there a national database for cooling / air-conditioning inspections?	Central register including only macro-data, see 4.1	Due to data security, a database containing the full reports is prohibited.

no	Key Implementation Decision – Smart Buildings and Building Systems	Description / value / response	Comment
05.11	Are inspection databases combined with EPC databases for registration of EPCs and inspection reports?	Registration of inspections (macro-data, see 4.1) through a combined register with EPCs.	
05.12	Link to national information on Inspection / Database		

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