CONCERTED ACTION
ENERGY PERFORMANCE OF BUILDINGS

EPBD Implementation in **Denmark**

Status in December 2016

AUTHORS

Kirsten Engelund Thomsen, Kim B. Wittchen, *Danish Building Research Institute, Aalborg University*

Birgitte Ostertag, Ruth Severinsen, Jacob Palm, Troels Hartung, *Danish Energy Agency*

Niels Bruus Varming, *Danish Transport and Construction Agency*

NATIONAL WEBSITES

www.ens.dk, www.sbi.dk, www.trafikstyrelsen.dk, www.bygningsreglementet.dk, www.sparenergi.dk, www.boligejer.dk

1. Introduction

This report presents an overview of the current implementation status of the EPBD and relevant initiatives planned in Denmark. The report addresses the energy performance requirements for buildings, including an outline of the national plan for NZEB and Danish requirements for technical building systems. It also provides an update on the implementation of the EPC and the inspection requirements for heating and AC systems.

The "*Building Class 2020"*, equivalent to the Danish NZEB definition, is under revision and expected to be finalised in spring 2018. As of 18 August 2011, the "*Building Class 2020"* was already designated as a voluntary class via the Statutory Order *("Bekendtgørelse")* No. 909. An early introduction of future requirements is tradition in Danish building policy and regulation, since it gives the building industry as well as building owners an opportunity to prepare, develop and experiment with the building of tomorrow. The method has been a successful way to push the Danish building industry in an ambitious direction and has ensured new buildings to be highly energy efficient at a cost-efficient level. It is also tradition that future requirements are evaluated before they become final and binding.

Responsible for implementing the EPBD in Denmark is the Danish Energy Agency, under the Danish Ministry for Energy, Utilities and Climate.

2. Current Status of Implementation of the EPBD

2.I. Energy performance requirements: NEW BUILDINGS

2.I.i. Progress and current status of new buildings

The current energy performance requirement methodologies for new residential and non-residential buildings were implemented through the *2006 Danish Building Regulation* as an implementation of Directive 2002/91/EC.

Denmark has focused on reducing energy consumption in new buildings for many years. The energy consumption in new buildings has steadily declined since the introduction of the first energy requirements in building regulations in 1961. Since 2006, requirements have been set for a building's overall energy consumption in accordance with the EPBD. In 2008, the Danish government entered an energy agreement on reducing energy needs of buildings by 25% in 2010, 25% in 2015 and another 25% in 2020 - a total reduction of 75% compared to the 2006 requirements-, which was supported by a broad majority of political parties in the Danish Parliament. In 2010, the first steps were taken with the introduction of *Building Regulation 2010* (*BR2010*), in which the energy requirements were tightened by about 25% and a voluntary energy class was revised and renamed "*Low-energy Class 2015 (Lavenergiklasse 2015)*". Already in 2011, the new "*Building Class 2020"* was introduced – also as a voluntary building class – due to requests from the Danish building industry to have sufficient time for developing new products for the future.

In July 2016, the previously voluntary "*Low-energy Class 2015*" became final and binding and was named the "*Danish Building Regulation 2015"* (*BR2015*). The *BR2015* sets minimum energy performance requirements for all types of new buildings. In addition to the minimum requirements, the *BR2015* also sets requirements for a voluntary low-energy class, "*Building Class 2020*" (equivalent to NZEB level). If the voluntary class of 2020 becomes the minimum requirement in 2020 as planned, it will represent the last step in implementing the *Energy Agreement 2008* as regards energy requirements for new buildings.

Figure 1. Danish Building Regulations 2015. The Danish Building Regulation (current and historic) can be found at: http://bygningsreglementet.dk.

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

The *BR2015* sets minimum energy performance requirements for all types of new buildings, including NZEB requirements.

The minimum energy performance sets the limit in terms of maximum allowed primary energy demand for a building, including, e.g., thermal bridges, solar gains, shading, infiltration, ventilation, heat recovery, cooling, lighting (for non-residential buildings only), boiler and heat pump efficiency, electricity for

operating the building as well as sanctions for overheating. The overheating penalty is calculated as a fictive energy demand, equal to the energy demanded by an imaginary mechanical cooling system in order to keep the indoor temperature at 26 °C. This additional energy demand is included in the calculated overall energy consumption of the building by the monthly based compliance checking tool, "*Be15*" (www.sbi.dk/be15).

Renewable energy is included in the calculation. However, for all buildings, the maximum electricity production to be factored in from RES, e.g., solar cells and wind turbines, corresponds to a reduction of the need for supplied energy of 25 kWh/m² per year in the energy performance framework (primary energy).

For buildings to comply with the *BR2015* and the voluntary low-energy class, it must be proven that they have a good thermal indoor climate during hot periods. The indoor temperature in residential buildings must not exceed 27 °C for more than 100 hours per year, and 28 °C for more than 25 hours per year. This can be done either through "*Be15"* or via a dynamic simulation tool. In non-residential buildings, the building owner decides the temperature limits, and summer comfort must be proven using a dynamic simulation tool. Additionally, the airtightness for a building to fall under the voluntary "*Building Class 2020"* must be proven through a pressurisation test, by meeting a maximum airflow rate (0.5 l/s.m² at a pressure difference of 50 Pa).

The minimum energy performance for the *BR2015* requirements (A2015) is:

30 + 1,000 / A [kWh/m^2.year] for residential buildings, and

41 + 1,000 / A [kWh/m^2.year] for non-residential buildings.

The minimum energy performance for the voluntary Building Class 2020 (NZEB - A2020) is:

20 [kWh/m^2.year] for residential buildings, and

25 [kWh/m^2.year] for non-residential buildings.

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

The Danish national plan for NZEB (2011)[1] lists the initiatives and policies that will increase the number of NZEB. Examples of strategies and policies include:

- The energy-saving initiative for energy supplying companies: The government has developed a comprehensive strategy for upgrading the energy performance of the existing building stock. Danish supply companies are obliged to provide an energy saving corresponding to 2.6% of the national energy consumption (exclusive transport) in 2013-2014, and 3.0% in 2015-2020. Compared with 2010-2012, in 2013 and 2014 the obligation to provide energy saving has increased by 75%.
- The NZEB level for new buildings is encouraged through information campaigns and building guidelines have been drawn up for contractors, architects and engineers who wish to build in an energy-efficient manner.
- Changing over to RES: As a general rule, oil and natural gas boilers are no longer allowed in new buildings as of 2013.
- Public action: Reducing the energy consumption in public buildings by 14% in 2020 compared to 2006 levels.

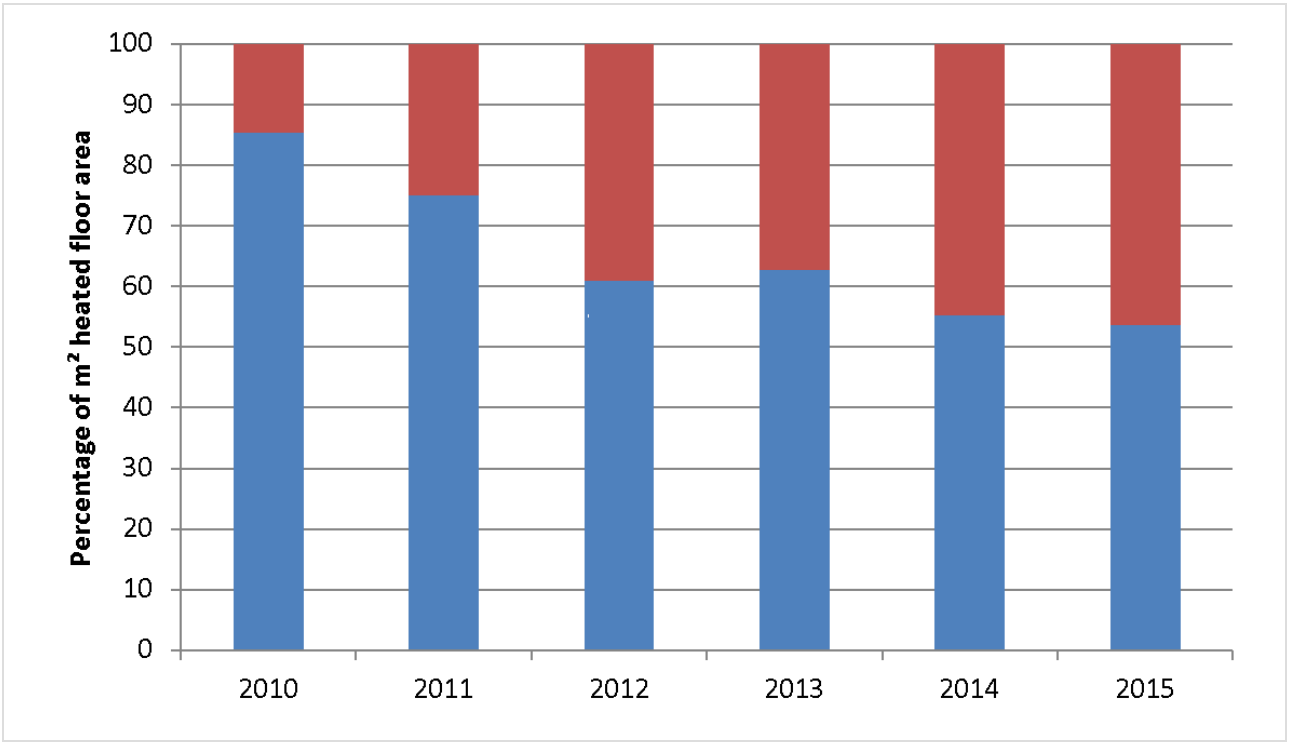
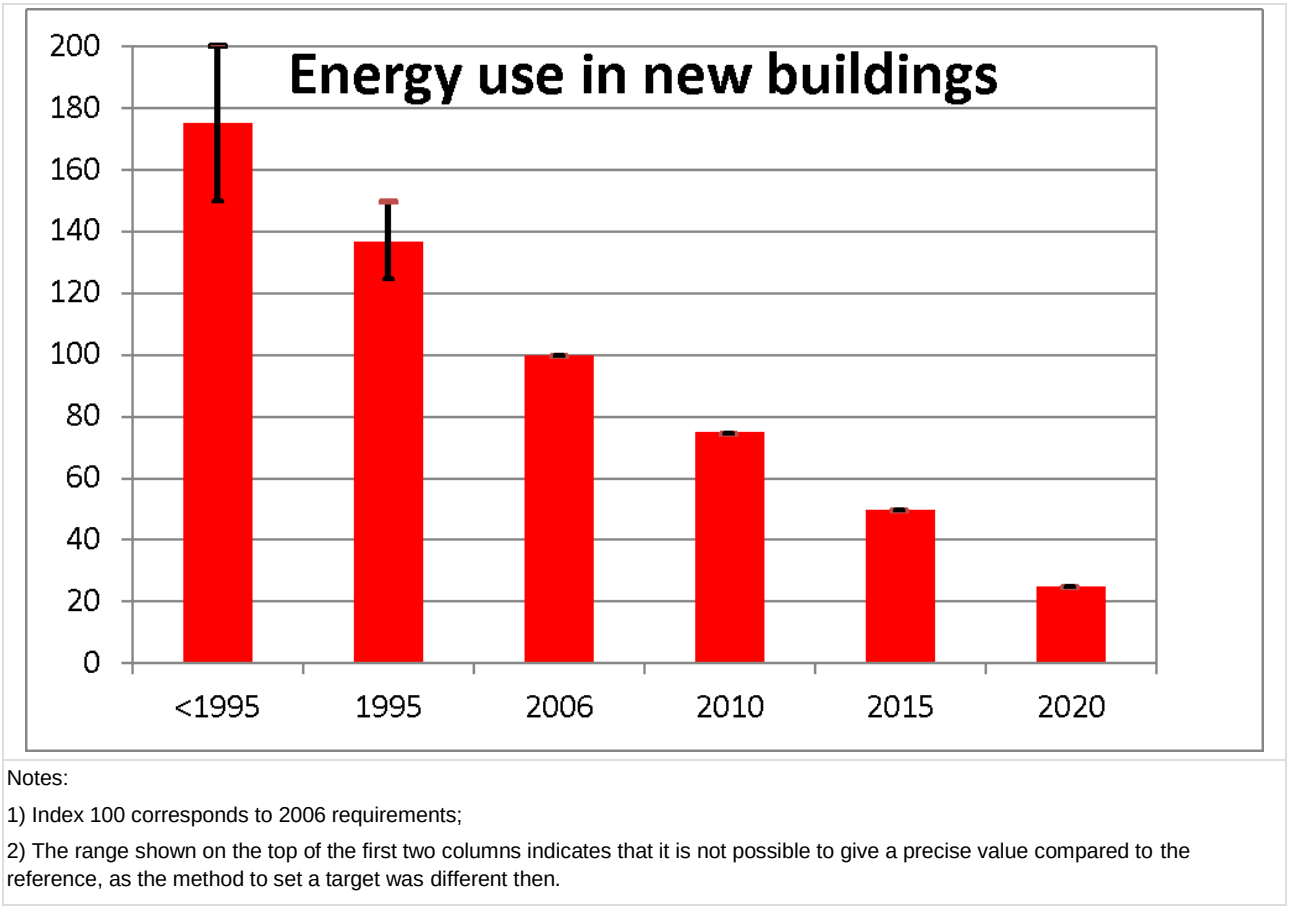


Figure 2. Share of low-energy buildings (red) compared to buildings meeting the various minimum requirements in the Danish Building Regulations (blue). Low energy buildings are those energy performance classes which were valid (have changed over time) in the respective years.



Notes:

1) Index 100 corresponds to 2006 requirements;

2) The range shown on the top of the first two columns indicates that it is not possible to give a precise value compared to the reference, as the method to set a target was different then.

Figure 3. Development of relative energy use in new buildings.

2.I.iv. Requirements for systems and / or building components for new buildings

The Danish Building Regulations include requirements for a wide range of technical building systems.

There are specific energy-related requirements for boilers based on coal, biomass and similar fuels. Boilers operating on coal, biofuels and biomass should, as a minimum, meet the energy requirements of boiler class 5 in the standard EN 303-5.

The Ecodesign Regulations include requirements for ventilation units, combined heat & power appliances, oil/gas boilers, heat pumps and circulation pumps for installations. These requirements replace the former requirements for individual components in the "*Danish Building Regulation 2010*" and are included in the "*Danish Building Regulations 2015"*. In the long term these references will be phased out, as it will be the duty of the owner to stay up-to-date on existing and new requirements in EU regulations.

Individual building elements must be insulated to a level ensuring that the heat losses through them do not exceed the values included in the following table:

Building element	**U-value** [W/m²K]
External walls and basement walls in contact with the soil.	0.30
Suspended upper floors and partition walls adjoining rooms/spaces that are unheated or heated to a temperature which is 5 °C or more below the temperature in the room concerned.	0.40
Ground slabs, basement floors in contact with the soil and suspended upper floors above open air or a ventilated crawl space.	0.20
Suspended floors below floors with underfloor heating adjoining heated rooms/spaces.	0.50
Ceiling and roof structures, including jamb walls, flat roofs and sloping walls directly adjoining the roof.	0.20
External doors without glazing.	1.40
External doors with glazing.	1.50
Doors and hatches to the outside or to rooms/spaces that are unheated and these as well as glass walls and windows to rooms that are heated to a temperature which is 5°C or more below the temperature in the room concerned.	1.80
Skylight domes.	1.40
Insulated sections in glazed external walls and windows.	0.60
Suspended upper floors and walls against freezer rooms.	0.15
Suspended upper floors and walls against cold stores.	0.25
Building element	**Linear losses**
Foundations around spaces that are heated to a minimum of 5 °C.	0.40
Foundations around floors with underfloor heating.	0.20
Joint between external wall and windows or external doors and hatches.	0.06
Joint between roof structure and roof lights or skylight domes.	0.20

Table 1: Maximum U-values and linear losses.

Additionally, the energy balance of windows and glazed outer walls must not be less than -17 kWh/m²/year (equal to a B-label window in the voluntary Danish window labelling scheme). The energy balance through roof lights and glazed roofs must not be less than 0.0 kWh/m² per year. The energy balance is calculated for a standard sized window with standardised outdoor conditions.

New buildings must be built such that the design transmission loss does not exceed 4.0 W/m² of the building envelope in the case of single-storey buildings, 5.0 W/m² for two-storey buildings and 6.0 W/m² for buildings with three storeys or more. The calculation does not take into account the area of windows and doors, nor transmission loss through them.

2.II. Energy performance requirements: EXISTING BUILDINGS

2.II.i. Progress and current status of existing buildings

The *BR2015* tightened the energy performance requirements for individual building components for all building types. This applies to the replacement of components and to major renovations. Measures must be economically plus technically feasible, i.e., they must have a simple payback time of less than 75% of their expected lifetime as defined in the Danish Building Regulations. In case of the full replacement of a component (e.g., a new roof, new window, new outer wall), the new component must meet the requirements set in the BR2015, regardless of profitability.

All existing buildings	Changed use and extensions	Single component requirements for new / replaced parts	Holiday homes	Minimum requirements*
U-value requirements [W/m²K]				
External walls and basement walls towards ground	0.18	0.15	0.25	0.30
Slab on ground, etc.	0.10	0.10	0.15	0.20
Loft and roof constructions	0.12	0.12	0.15	0.20
Windows	-	1.80 (doors)	1.80	-
Roof windows	-	-	1.80	-
Thermal bridges [W/(m K)]				
Foundations	0.12	0.12	0.15	0.40/0.20
Joints between windows and walls	0.03	0.03	0.03	0.06
Joint between roof structure and windows in the roof	0.10	0.10	0,10	0.20
Minimum energy gain [kWh/m².year]				
Facade windows	-17	-17	-	-17
Roof windows	0	0	-	0

Note: Minimum requirements are primarily set to eliminate the risk of surface condensation and hence mould growth. Applies for both new and existing buildings being renovated.

Table 2. U-values and thermal bridges requirements for existing buildings – examples.

As an alternative to the component analyses, two voluntary low-energy classes have been introduced:

- A residential building may be classified as "Renovation Class 2" when the total demand for energy supply for heating, ventilation, cooling and domestic hot water per square meter of heated floor area does not exceed 110 kWh/m² per year plus 3,200 kWh per year divided by the heated floor area.

- A residential building may be classified as "Renovation Class 1" when the total demand for energy supply for heating, ventilation, cooling and domestic hot water per square meter of heated floor area does not exceed 52.5 kWh/m² per year plus 1,650 kWh per year divided by the heated floor area.

Requirements for non-residential buildings are presented below. Verification must be on the basis of SBi's *"Energy demands of buildings" ("SBi Direction 213 Bygningers energibehov")*[2] where the energy demand for the whole building must be calculated.

To comply with the renovation classes, the requirement for supplied energy must be improved by at least 30 kWh/m² per year. To obtain "*Renovation Class 1"*, the requirements for the indoor climate for new buildings must be observed as well.

The energy performance framework for the voluntary "*Renovation Class 2"* (Energy label C) is:

110 + 3,200 / A [kWh/m^2.year] for residential buildings, and

135 + 3,200 / A [kWh/m^2.year] for non-residential buildings

The energy performance framework for the voluntary "*Renovation Class 1"* (Energy label A2010) is:

52.5 + 1,650 / A [kWh/m^2.year] for residential buildings, and

71.3 + 1,650 / A [kWh/m^2.year] for non-residential buildings

2.II.ii. Plans to improve the existing building stock

For existing buildings, the government has developed a comprehensive strategy for the energy upgrading of the building stock. The implementation of the initiative started in 2014, including the analyses of the energy requirements for the *BR2015*.

The requirements for conversion may be met through component requirements mentioned in Table 2 or through compliance with the energy performance frameworks for existing buildings corresponding to the calculation for new buildings. The use of the energy frames mentioned in section I for existing buildings is a voluntary option for owners that engage in deep energy renovation projects. This method is intended to increase the number of NZEB, as the owner has the possibility to look at the buildings' energy performance in a more holistic way.

Denmark has committed to reduce the energy consumption in buildings owned and used by the government by 14% by 2020, with 2006 as the base year. This initiative targets the energy efficiency in public buildings and it will also ensure implementation of the EED Article 5, which Denmark has chosen to implement using the alternative approach, and has committed to obtain energy savings equivalent to 148,192 MWh from 2014-2020, corresponding to a reduction target of 9.1% for this period. The initiative is a continuation of a long-term Danish effort since 2006 to reduce the energy consumption in buildings used by the government.

2.II.iii. Regulation of system performance, distinct from whole building performance

There is a general requirement in the Danish Building Regulations that services have to be built in a manner that prevents unnecessary energy consumption. This means, for example, that heating systems must be designed and built for energy-efficient operation, including the components, which must be compatible with one another and suited to the intended use of the building and building systems.

Heating and cooling systems must be sized, designed, controlled and operated as specified in the Danish Standard DS 469 "Varme - og køleanlæg I bygninger" ("*Heating and cooling systems in buildings*"), which has different functional requirements for the commissioning of heating and cooling systems as well as additional requirements for use, operation and maintenance. Ventilation systems must be designed, installed, fully commissioned and handed over as stated in DS 447 "Ventilation i bygninger - Mekaniske, naturlige og hybride ventilationssystemer" ("*Ventilation for buildings – Mechanical, natural and hybrid ventilation systems*").

All technical building systems must be insulated as required by DS 452 *"Termisk isolering af tekniske installationer"* ("*Thermal insulation of technical installations"*).

2.II.iv. Encouragement of intelligent metering

Technical systems with significant energy consumption must have individual meters installed if energy consumption exceeds a certain level.

System	Minimum annual energy use triggering metering
Heat pumps / cooling plants	3,000 kWh electricity
Server rooms	Always
Ventilation units	3,000 kWh electricity for air transport
Heating coils	3,000 kWh electricity or 10,000 kWh heat
Domestic hot water	10,000 kWh heat for heating and circulation of domestic hot water

Table 3. Minimum annual energy use that triggers metering for individual parts of technical building systems.

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

Financing of energy efficiency in buildings is primarily privately funded in Denmark. Building owners have easy access to capital for improving their buildings through the well-functioning Danish mortgage system. The system gives owners of new as well as existing buildings the opportunity to borrow money at attractive rates and conditions.

On an annual basis, between 10 and 13 billion € – equivalent to 2.1-2.7% of the value of the building mass – is invested in various forms of renovations and other investments in buildings. There are no specific public support schemes for projects related to energy efficiency in buildings, but rather a wide range of national schemes which aim to boost investments in energy efficiency.

Among these initiatives are:

1. A tax-deduction scheme[3] for deducting salary expenses for works in relation to green initiatives in private buildings. The initiative is planned to come to an end by the end of 2017.

2. The "*BetterHouses*" ("*Bedre Bolig*")[4] initiative, a one-stop shop for assisting home owners as regards cost-optimal energy savings. As of 2017, the scheme has been extended to include apartment blocks and large buildings.

3. Between 2016 and 2019, an interesting scheme is aimed at supporting partnerships between public and private partners regarding energy efficiency in buildings, mainly with support in developing new business models and fostering cooperation between multiple partners such as municipalities, regional units, utility companies, banks, housing associations, businesses, etc. Based on a tender, the nine best-qualified projects have obtained public funding. The total value of the tender is 1 million € to cover up to 50% of the expenses of the selected projects[5].

4. Finally, the establishment of a market for energy services targeting the replacement of fossil-fuel-based heating with heat pumps is supported. This is done by providing initial financial support for the purchase of heat pumps by a number of energy service companies. These heat pumps are installed and operated in private homes, which in turn pay for their consumption of heat from the heat pump.

Figure 4. The "Bedre Bolig" ("BetterHouses") campaign - www.BedreBolig.dk.

2.II.vi. Information campaigns / complementary policies

Information initiatives to reduce the energy consumption in the existing building stock are one of the key elements in the Danish Energy Agreement of 22 March 2012. Previous and current activities aim at producing cost-efficient information material in cooperation with relevant actors that deal with energy saving. The importance of the local perspective and private ownership is a significant part of the activities.

The Danish Energy Agency hosts websites containing both general and specific information on energy savings in buildings as well as on the EPC. The main website of the information campaign, www.SparEnergi.dk, contains a variety of tools, information and knowledge that supports energy saving.

The Danish Government has recently launched an initiative with free-of-charge telephone support and email advice, as well as information activities about available energy consulting services for private households.

Furthermore, a number of initiatives have been launched to promote the EPC and reduce energy consumption in buildings, e.g., "*BetterHouses*". "*BetterHouses*" is a Danish national consultancy scheme, which is voluntary and market-driven. It extends the EPC scheme and aims to promote refurbishment of private residential buildings by removing barriers and making it easier and more manageable to refurbish and reduce the buildings' energy consumption through counselling during the building process.

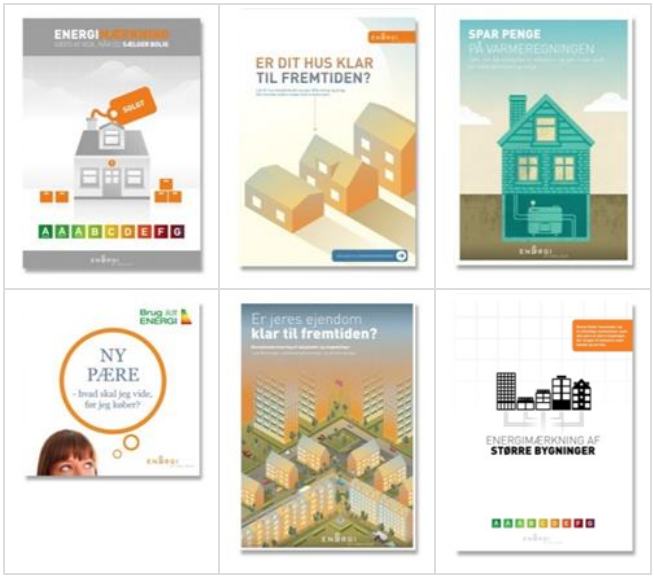


Figure 5. Guides and EPC-information.

2.III. Energy performance certificate requirements

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

The Danish Energy Agency is responsible for implementing the EPC system. All EPCs are registered in a central database and displayed on the public website www.sparenergi.dk. In Denmark, a total of around 60,000 new EPCs are registered annually (Table 4).

Year	2010	2011	2012	2013	2014	2015	2016*
Single-family	50,774	41,904	41,359	43,493	44,524	48,903	40,473
Multi-family	8,891	5,466	5,312	4,758	4,383	5,179	3,627
Non-residential	6,567	3,256	3,099	4,347	3,557	3,212	2,895
Holiday houses	4,418	389	726	824	871	886	647
Total	70,650	51,015	50,496	53,422	53,335	58,180	47,642
* period from January to September							

Table 4. Number of yearly issued EPCs for private buildings (2010 to 2016).

It is estimated that the compliance level is high due to few complaints by tenants and buyers.

A survey from 2016 reveals a high awareness about the EPC in Denmark. Nine out of 10 respondents recognise that they have received an EPC in connection with the purchase of their property. In addition to that, 92% have read parts of the report, and more than half have read the entire report.

The survey also showed that the recommendations in the EPC report are particularly relevant to owners with properties marked as either D, E, F or G. Among these, 39% have acted on the proposals in the EPC report to make energy-efficient renovations.

Figure 6. Labels used in the Danish building energy performance certification scheme.

2.III.ii. Quality Assessment of EPCs

Every year, 0.25% of the newly issued EPCs are randomly selected for an independent quality control. In addition to that, the Danish Energy Agency conducts quality control based on complaints received from owners. Annually, a total of approximately 150 EPCs are reviewed.

In Denmark, three different levels of penalties are foreseen:

1. In case of error, companies must correct the certificate.
2. In case of serious errors, the company will get a warning notice and the certifying accreditation agency is informed.
3. In cases where errors are serious and/or repeated, a public notice will be made available online as a "*name and shame*" sanction. The certifying accreditation agency is informed and is able to suspend the certification of the company if they find it appropriate. Companies must carry out their own quality control according to DS/EN ISO 9001.

EPCs may not differ by more than +/-10% of the total calculated energy demand of the building.

The Danish Energy Agency has worked systematically to increase the overall quality of the EPCs with a special effort regarding, e.g., education and enforcement.

Denmark is currently implementing a seven-step plan that entails:

1. tightening supervision and quarantine and requiring consultants who make serious and/or repeated errors to take new exams;
2. shortening the time from error to learning, with a focus on case-handling time;
3. initiating further dialogue with stakeholders regarding quality efforts;
4. revising the regulatory framework,
5. developing educational standards with stricter requirements;
6. applying a user-friendly energy labelling scheme;
7. implementing a user satisfaction survey.

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

An EPC for a public building or a large building often visited by the public has the same format, content and validity as an EPC for any other building type. In addition, it is required that the EPC is placed somewhere visible to the public. Key information about the certificate is available on www.boligejer.dk, where it is possible to find the calculated consumption as well as the name of the energy expert and the certified company who issued the certificate.

The Danish Energy Agency has initiated a review of the current EPC scheme for public and large buildings in order to gather information about the progress and current status of EPCs in this category. The overall goal is to develop an EPC scheme that is more relevant and applicable in the administration of their buildings.

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

In July 2012, a new act implemented mandatory advertising requirements and provided sanctions in case of non-compliance.

When a building is sold or rented out, the commercial media advertisement must display the EPC label. If the advertising requirement is not adhered to, the seller can be fined DKK 2,000 (268 €).

In 2014, the Danish Energy Agency performed a random check of private sales on the internet, which showed a compliance rate of 60%. Furthermore, an initiative has been launched relating to internet sales without the use of a real estate agent. The goal is – in collaboration with the owners of these websites – to develop a technical solution that blocks advertisements without the required EPC.

As of November 2017, three fines have been issued with another few fines currently being processed.

2.IV. Inspection requirements – heating systems, air conditioning

2.IV.i. Report on equivalence of model A and B for Heating Systems

Until 2011, Denmark was implementing Article 14 of the EPBD through mandatory regular inspections of heating systems. However, it was then estimated that the use of regular inspections was not cost-effective within the Danish legislative framework. Therefore, since 2012, the Danish implementation of Article 14 is done through a number of activities such as advisory service, tax benefits and requirements to use RES for building heating, each of which contributes to increasing efficiency or phasing out oil and natural gas boilers. The Danish implementation of Article 14 should be seen as part of a long-term political goal to phase out fossil fuels. Thus, the initiatives for oil-fired boilers are mainly focused on replacement of these boilers with other heating sources, e.g., heat pumps, district heating, or solar energy.

To ensure the maintenance of heating systems which are not phased out, a number of measures contribute either to the efficiency or the phasing out of oil-fired and natural gas boilers. These measures include campaigns to increase building owners´ awareness of the potential value of service checks, as well as the promotion of qualified service providers.

2.IV.ii. Progress and current status on heating systems

As alternatives to inspections, the following initiatives have been implemented to help ensure a higher energy efficiency of heating systems in Denmark

- *Advisory services for craftsmen and building owners* ("*Videncenter for Energibesparelser i Bygninger"*).This service targets craftsmen and provides information and guidelines about how, e.g., to improve heating systems.
- *Tax deduction for craftsmen's labour costs* related to renovations of buildings ("*Bolig-job-ordning"*).The tax deduction has allowed building owners to include the cost of labour for renovations in their tax return forms, thereby giving them incentives to undertake renovation works such as the replacement of heating systems.
- *Obligations for energy service companies* to implement energy savings for their customers.
- *Reduced energy taxes for heat pump owners* compared with owners of other kinds of heating systems. The tax reduction makes electricity-based heating such as heat pumps more economical compared to oil or other fossil fuels.
- *Requirements for the use of RES* in certain types of buildings *and efficiency requirements for boilers*. *In new buildings*, heating with oil or gas is no longer allowed, which means that district heating, heat pumps and other heating systems with high efficiency are promoted. In *existing buildings*, old heating systems must be replaced with district heating, natural gas boilers or RES if the building is placed within a district heating or natural gas grid.
- Finally, in Denmark, the efficiency requirements for newly installed boilers are higher than those required by the ECO-design Directive (2009/125/EC).

2.IV.iii. Progress and current status on AC systems

Denmark has adopted regular inspections for the implementation of Article 15 of the EPBD. The scope of the inspection scheme has been expanded to include all AC and ventilation systems with an effective rated output of more than 5 kW. Certain AC systems for industrial use, as well as systems operating less than 500 hours/year are excluded. The AC and ventilation systems must undergo an inspection every 5 years. Promotion of these inspections is made via the website of the Danish Energy Agency.

The inspection consists of a basic recording of data, e.g., the type of system, effective rate and composition, as well as an indication of the condition of the system. Moreover, the functioning and efficiency of the system are examined during the inspection. Finally, the Danish Energy Agency gives recommendations on energy efficiency with respect to retrofitting, maintenance and adjustment of the system to the owner in a report.

Data from the inspections is submitted to a database in the Danish Energy Agency.

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

It is the responsibility of the owner of an AC installation to get the required inspections to confirm whether conditions are met. If the mandatory energy measurement or inspections are not carried out, the owner of the AC may face fines. There have been no systematic compliance checks by energy authorities due to the lack of a common registry of ventilation systems in Danish buildings, and no fines have been imposed.

In 2013, 131 inspections of AC and ventilation systems were carried out and reported. Of those, 27 inspection reports where controlled by the Danish Accreditation and Metrology Fund.

Currently, no impact assessment has been made.

3. A success story in EPBD implementation

Common database with information of the existing building stock

In Denmark it has been mandatory to have an energy certification scheme since 1997. Information on the physical stage of the existing building stock is collected by energy experts while carrying out an energy audit for issuing an EPC. All data from the certification scheme is gathered in a common database, so a wide range of information is available with respect to the building stock. This knowledge is used in many ways, e.g., in numerous analyses of energy saving potential. The first comprehensive analyses were made in 2004 and the most recent was published in November 2017. Some results show that it is possible to obtain a reduction of the heat demand of approximately 28% until 2050 if buildings that are being renovated due to end of service life would simultaneously undergo an energy upgrade.. In the analyses, it is assumed that the buildings are thermally upgraded in accordance with the requirements stated in the "*Danish Building Regulations 2010*".

The available data offers a snapshot of the energy standard in the Danish building stock and has been made accessible for research. The analyses have been used for different purposes in the government's strategies for energy upgrading of the existing building stock. The most recent analyses of the Danish building stock and its energy-saving potential are available in the report "*Potential heat savings during ongoing renovations of buildings until 2050*", SBI 2016:04[6], and has been used as part of the foundation for the Danish strategy for energy performance upgrading of the existing building stock, "*The road to energy efficient buildings in the future*" ("*Vejen til energieffektive bygninger i fremtidens Danmark*").

Furthermore, a new analysis has just been conducted based on the available data[7]. The purpose was to analyse the extent to which it is necessary to include RES in the energy performance calculation, in order to compensate for the fact that some buildings may have higher energy needs than the average building due to architectural requirements or limitations from local plans. How and to what extent RES are used as a buffer in such cases is investigated.

These examples show that data of the existing building stock and energy conditions can be used for many useful analyses and is essential to form future national energy strategies.

4. Conclusions, future plans

The transposition of Directive 2010/31/EU – EPBD was completed in Denmark in June 2012. The energy requirements in the Danish Building Regulation for new buildings have been tightened by using a step-by-step approach and by introducing the new requirements as voluntary energy classes before they become mandatory, as is tradition in the Danish Building Regulation. The "*Building Class 2020*", which was introduced in 2011, meets the obligations stipulated in the EPBD regarding NZEB and is currently under evaluation to reflect the actual cost-optimality of the class before introducing it as a mandatory standard. The Danish National Plan for NZEB includes a number of initiatives and policies which will increase the number of NZEB and reduce energy consumption in existing buildings, including energy saving initiatives carried out by energy supply companies, a strategy for the energy renovation of the existing building stock, a changeover to RES, information campaigns and public action.

Since transposing the Directive 2010/31/EU in 2012, a large effort has been made by the Danish Energy Agency and others to raise public awareness concerning energy use. Information campaigns, web-based interactive tools regarding energy saving measures, etc. have been widely distributed, and public awareness has risen considerably. Denmark has succeeded in making the EPC visible, rendering it a clear sales parameter in the market. Denmark is currently implementing a seven-step plan to ensure that EPCs are uniform and of high quality.

The "*BetterHouses*" initiative targets single-family houses and is aimed at accelerating the energy renovation of private homes. The scheme introduces a one-stop shop for private homeowners who wish to renovate the energy efficiency of their homes and is designed to be market based.

As for initiatives targeting the energy efficiency in public buildings, Denmark has committed to reduce the energy consumption in buildings owned and used by the government by 14% by 2020, with 2006 as the base year. The initiative is a continuation of a long-term Danish effort since 2006. In parallel, existing voluntary agreements between the government and local/regional authorities to enhance energy efficiency in the buildings they use will be revised to reflect the EED. The commitment to reducing energy consumption by 14% by 2020 will at the same time complete the Danish implementation of Article 5 of the EED.

Endnotes

1. The Danish national plan for NZEB can be found at http://eur-lex.europa.eu/legal-content/DA/TXT/HTML/?uri=CELEX:52013DC0483R(01)&from=EN.
2. www.sbi.dk/be15
3. http://skat.dk/skat.aspx?oid=2234759
4. https://sparenergi.dk/forbruger/vaerktoejer/bedrebolig
5. https://sparenergi.dk/offentlig/kommuner/tilskud-til-partnerskaber
6. http://sbi.dk/miljo-og-energi/energibesparelser/potential-heat-savings-during-ongoing-renovations-of-buildings-until-2050
7. http://sbi.dk/miljo-og-energi/vedvarende_energi/vedvarende-energi-i-energirammen/vedvarende-energi-i-energirammen

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