ENERGI STYRELSEN

National plan for nearly zero-energy buildings

Danish compliance with Article 9 of Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings

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1. Buildings Directive requirements for nearly zero-energy buildings

Taking into account the climatic and structural differences between the Member States, the EU Directive on the energy performance of buildings[1] (Buildings Directive) contains a number of provisions intended to reduce energy consumption in European buildings.

Article 9 of the Buildings Directive concerns *nearly zero-energy buildings.* A nearly zero-energy building is defined in Article 2 of the Directive as being:

> "…a building that has a very high energy performance, as determined in accordance with Annex I. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby".

Article 9(1) requires that by 31 December 2020, all Member States must ensure that all new buildings shall be nearly zero-energy. From December 31 2018, the same conditions will apply for all new buildings owned and used by public authorities.

In addition to new buildings, Article 9(1) requires that:

> "Member States shall draw up national plans for increasing the number of nearly zero-energy buildings. These national plans may include targets differentiated according to the category of building".

Article 9(2) requires that:

> "Member States shall furthermore, following the leading example of the public sector, develop policies and take measures such as the setting of targets in order to stimulate the transformation of buildings that are refurbished into nearly zero-energy buildings, and inform the Commission thereof in their national plans referred to in paragraph 1."

The content of the National Plans is further defined in Article 9(3), which states that:

> The national plans shall include, inter alia, the following elements:
> (a) the Member State's detailed application in practice of the definition of nearly zero-energy buildings, reflecting their national, regional or local conditions, and including a numerical indicator of primary energy use expressed in kWh/m^2 annually. Primary energy factors used for the determination of the primary energy use may be based on national or regional yearly average values and may take into account relevant European standards;
> (b) intermediate targets for improving the energy performance of new buildings, by 2015, with a view to preparing the implementation of paragraph 1;
> (c) information on the policies and financial or other measures adopted in the context of paragraphs 1 and 2 for the promotion of nearly zero-energy buildings, including details of

[1] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) 18.6.2010 L 153/13

national requirements and measures concerning the use of energy from renewable sources in new buildings and existing buildings undergoing major renovation in the context of Article 13(4) of Directive 2009/28/EC and Articles 6 and 7 of this Directive.

The Commission's assessment and report on the national plans is described in paragraphs 4 and 5 of the Article.

Article 9(6) allows Member States to decide not to apply the requirements for paragraph 1 with regard to new buildings, if it can be shown in the cost-benefit analysis that the economic lifecycle of the building in question is negative. The Commission must be informed if Article 9(6) is to be invoked.

This action plan explains the Danish implementation of Article 9 in all of the above areas. To begin with, Danish energy policy priorities and targets will be described here as background to the implementation of the requirements for nearly zero-energy buildings. Following this, Denmark's definition of nearly zero-energy buildings in *Building Class 2020* will then be reviewed. The review will then go on to examine the considerations and concerns that are the basis of this Building Class and the voluntary *Low-Energy Class 2015.* The intermediate targets for 2015 will then be described and finally, policies and other actions that promote energy efficiency in the building industry and the spread of nearly zero-energy buildings will be examined.

2. Danish energy policy – priorities and targets

The Energy Policy Agreement – 2008
In February 2008 an Energy Policy Agreement was entered into between the incumbent government at that time (the Danish Conservative People's Party (Det Konservative Folkeparti) and the Liberal Party of Denmark (Venstre)) and the Social Democrats (Socialdemokraterne), the Danish People's Party (Dansk Folkeparti), the Socialist People's Party (Socialistisk Folkeparti), the Danish Social-Liberal Party (Det Radikale Venstre) and the Liberal Alliance (Ny Alliance)[2]. The agreement determined Danish energy policy for the period from 2008-2011. One of the targets laid down by the agreement was that the total gross energy consumption should be reduced by 2 % in 2011 and 4 % by 2020 in relation to 2006, signifying an increase in development since 1980.

With regard to the energy consumption of buildings, the Energy Agreement determined that there should be stricter requirements for new buildings, resulting in reductions in energy consumption of at least 25 % in 2010, a further 25 % in 2015 and a further 25 % in 2020. Altogether, a reduction of 75 % by 2020 at the latest. The reduced figures were agreed in relation to the 2006 level.

On the basis of input from a partnership comprised of a number of enterprises, repositories of knowledge and relevant organisations, the government launched its "Strategi for reduction af energiforbrug i bygninger" ["Strategy for the reduction of energy consumption in buildings"] in April 2009, which contained a number of initiatives for the reduction of energy consumption in buildings[3]. Many of these initiatives were with regard to proposals for stricter energy requirements

[2] Agreement on Danish energy policy between the Danish Conservative People's Party, the Liberal Party of Denmark, the Social Democrats, the Danish People's Party, the Socialist People's Party, the Danish Social-Liberal Party and the Liberal Alliance from 2008-2011. 21.
February 2008. http://193.88.185.141/Graphics/ENS_Energipolitik/Energiaftalen/energiaftale-21022008_final.pdf
[3] The Strategy for the reduction of energy consumption in buildings. The Danish Government. April 2009

for new buildings. To a large extent, the partnership's work and subsequent strategy laid the foundations for the stricter energy requirements for new buildings that came later.

In 2010, the 2010 reduction target for energy consumption in buildings became law with the introduction of new energy requirements into the 2010 Building Regulations (BR10)[4]. At the same time, a new voluntary Low-Energy Class 2015 was introduced into the Building Regulations with energy frameworks that were 57 % lower than the 2006 level. The requirements for this class will become binding from 2015.

A new building class with a reduction target of 75 % was prepared in 2011, with the intention of complying with the requirements for nearly zero-energy buildings in Article 9 of the Building Directive. This zero-energy class, entitled Building Class 2020 was introduced into BR10 on 18 August 2011, as another voluntary class in the building regulations[5].

The Energy Policy Agreement – 2012

On 22 March 2012, the 2008 Energy Agreement was superseded by a new energy agreement for the period from 2010-2020[6]. The agreement was a political accord between the Danish government (the Social Democrats, the Social-Liberal Party and the Socialist People's Party) and the Liberal Party of Denmark, the Danish People's Party, the Red/Green Alliance (Enhedslisten) and the Conservative People's Party.

The Energy Agreement, which also focuses on energy reduction in the building stock, continues and intensifies a number of the initiatives from the previous agreement and is intended to contribute to changing Denmark into a country with an energy supply provided from renewable energy sources. In its mandate to govern, the government has stated the ambition that Denmark's greenhouse gas emissions in 2020 will be reduced by 40 % in relation to the 1990 level, with a calculated total reduction of 34 %, the Energy Agreement will fulfil a large part of this ambition.

http://www.ebst.dk/file/43439/reduktion-af-energiforbruget-i-bygninger.pdf

[4] BEK nr. 810 af 28/06/2010 [Order No 810 of 28/06/2010]

[5] BEK nr. 909 af 18/08/2011 [Order No 909 of 18/08/2011]

[6] Agreement between the Danish Government, (the Social Democrats, the Social-Liberal Party and the Socialist People's Party) and the Liberal Party of Denmark, the Danish People's Party, the Red/Green Alliance and the Conservative People's Party on the Danish Energy policy 2012-2020.22 March 2012.http://www.ens.dk/da-DK/Info/Nyheder/Nyhedsarkiv/2012/Documents/Aftale_22-03-2012_FINAL_ren.doc.pdf

3. Building Class 2020 – nearly-zero energy buildings in Denmark

Building Class 2020 has been prepared with the intention of being able to meet the Building Directive's requirements for nearly-zero energy buildings. Building Class 2020 has been introduced into BR10, the current Building Regulation, as a voluntary building class until it is introduced as a legal requirement. The definition of Building Class 2020 can be seen in the requirements in Chapter 7.2.1 (paragraphs 12 and 13) and Chapter 7.2.5 of BR10. The provisions in Building Class 2020 are included in Annex 1[7]. Unless stated otherwise, the Building Regulations' other requirement for buildings, including the location of the building, the layout of the building, fire precautions, indoor climate, etc. apply irrespective of the energy classification of the building.

Building Class 2020, which reduces the energy consumption of the building by 75 % in relation to the 2006 level, is introduced as a voluntary building class at a relatively early stage in the Building Regulations considering that the requirements for nearly zero-energy buildings in the Building Directive with regard to publicly occupied and owned buildings and private buildings respectively, will not come into force until 31 December 2018 and 31 December 2020 respectively. The intention of this early introduction is to send a definitive signal to players in the building industry with regard to the coming requirements. The intention is also to give a positive assurance to the sector of the development of energy requirements and to create a healthy basis for the development and sale of building materials, building technology, consultancy, etc. that complies with the strict energy requirements. Building Class 2020 will therefore contribute to the promotion of innovation in the Danish building industry.

The guidelines for BR10 state that Building Class 2020 is expected to become a compulsory requirement for the construction of new public buildings by the end of 2018 and of other new buildings by the end of 2020.[8]

It is not yet thought to be viable from a total economical (cost optimum) viewpoint to build in accordance with Building Class 2020, however, it is thought that Building Class 2020 will be economically viable when a minimum requirement is introduced into the Building Regulations. This is due to assumptions on the price trend in among other things, energy and energy-efficient building materials. These assumptions may not ultimately be correct. Building Class 2020 is therefore a development class which it may be necessary to adjust over the coming years. Introducing Building Class 2020 as a development class also allows for the development of new building technologies or methods that will change the basis for the total economy of the building industry.

The application of Building Class 2020 is based on the principles behind the government's strategy for the reduction of energy consumption in buildings from 2009. These principles contain a number of considerations that ensure that the energy requirements of the Building Regulations continue to provide good global solutions for the low-energy buildings of the future that, in addition to Low-Energy consumption, also comply with the people's expectations for quality buildings that are architecturally exciting, healthy and comfortable.

[7] All requirements for Building Class 2020 are given in Annex 1, while the text in Section 3 in this national plan describes most significant parameters of the Building Class.

[8] Guidelines for BR10, Chapter 7.2.5.2 and 7.2.5.3

Low-Energy consumption, a healthy and comfortable indoor climate and exciting architecture do not necessarily contradict each other. On the contrary, well-insulated buildings benefit their inhabitants because cold and draughts are no longer present. Similarly, there are many examples of low-energy buildings providing their inhabitants with beautiful and aesthetic surroundings. However, the challenge with Low-Energy buildings is that as the energy requirements become more stringent, it is becoming increasingly important to take energy savings, a healthy indoor climate and architecture into consideration when planning total solutions.

Energy framework for Building Class 2020:
The energy requirements in the Building Regulations comprise an overall framework for the energy consumption of a building, combined with specific requirements for its building envelope, elements and components. This ensures that the basic building is of a high quality and has Low-Energy consumption and heat loss.

Building Regulations operate with two building categories: Residential buildings and other buildings. Residential buildings are defined as homes, residential colleges and hotels etc. Other buildings are defined as schools, institutions etc., that are not covered by homes, residential colleges and hotels etc. With both categories of building, a limit has been set for the maximum permitted primary energy consumption.

A residential building can be classified as Building Class 2020 when the overall requirement for solar gain for heating, ventilation and hot water per m² heated floor area does not exceed 20 kWh annually.

Other buildings can be classified as Building Class 2020 when the overall requirement for solar gain supplied for heating, ventilation, cooling, hot water and lighting per m² heated floor area does not exceed 25 kWh annually.

The energy framework is technology-neutral and allows the contractor flexibility when choosing a solution to be used in a specific building to ensure compliance with the framework.

Energy from plants that produce renewable energy (RE) for the building is offset against the energy framework. Similarly, a shared RE plant established in connection with a new development, where the contractor contributes financially to the construction of the RE plant can be included in the energy framework. In this regard, it is a requirement that the RE plant must be in or in close proximity to the development. Shared RE plants can, for example, be wind turbines, shared solar heating, solar panel installations or geothermal installations.

The total additional permitted energy consumption of 20 kWh/m² annually for residential buildings and 25 kWh/m² annually for other buildings, complies with the requirements for nearly zero-energy buildings. From a technical viewpoint, the requirements are difficult to meet without using RE plants and the assessment emphasises that electricity produced by RE plants will often exceed the requirements, whereby energy consumption will be lower than the minimum requirement during some periods and similarly, the excess electricity will be used for electrical devices in the building such as refrigerators, washing machines etc.

Table 1 shows the development in the energy framework for the applicable requirements in BR08, BR10, low-energy class 2015 and Building Class 2020.

Table 1: Energy framework requirements in BR08, BR10, low-energy class 2015 and Building Class 2020, in terms of primary energy.

	BR08	BR10	Low-energy class 2015	Building Class 2020
Homes, residential colleges and hotels, etc.	(70 + 2200/A) kWh/m² annually	(52.5 + 1650/A) kWh/m² annually	(30 + 1000/A) kWh/m² annually	20 kWh/m² annually
Schools, institutions etc., that are not covered by homes, residential colleges, hotels, etc.	(95 + 2200/A) kWh/m² annually	(71.3 + 1650/A) kWh/m² annually	(41 + 1000/A) kWh/m² annually	25 kWh/m² annually

The most significant reduction in energy consumption in buildings built according to Building Class 2020 in relation to the other energy frameworks is shown in Table 2, where energy consumption per m² annually, is given for a number of types of building.

	BR08	BR10	2015	2020
150 m² single family house	84.7	63.5	36.7	20
1000 m² multi-storey building	72.2	54.2	31	20
10 000 m² school	95.2	71.5	41.1	25
1000 m² office building	97.2	73.0	42	25
300 m² children's institution	102.3	76.8	44.3	25

Renewable energy

In connection with the preparation of Building Class 2020, it has been calculated how it will be possible to comply with the various requirements. The final energy requirements are laid down to ensure that the building is robust, well-insulated and with a high performance building envelope. At the same time, the permitted energy consumption is so low that in practice, it will be impossible for most buildings to comply with the energy requirements without using RE plants. The class thus complies with the Buildings Directive's requirements that nearly zero-energy buildings should have a very high energy performance and that the remaining requirement for solar gain is mostly renewable energy[9]. Table 3 shows calculations illustrating how great the need for solar panels will be for a number of buildings where the heat supply either comes from heat pumps or district heating.

[9] The solar gain for the building that is not covered by RE will, eventually change over to renewable energy (cf. the section on primary energy factors in the current National Plan).

Rows 1 and 3 of the table show the requirement for solar panels in buildings where the building is optimised with the best building materials and fittings on the market. There is thus the need for solar panels to address those deficiencies that will result in compliance with the energy framework in a building with an extremely high energy performance.

Rows 2 and 3 show how great an area of solar panels are needed if the total electricity consumption is to be covered by energy from solar panels in buildings where the minimum requirements for the building envelope, components etc. have been complied with.

Altogether, the figures show that the requirement for solar panels is relatively small in buildings with a high energy performance, although a significant area of solar panels will be needed if a lesser energy-optimised construction is chosen.

Table 3: Area of solar panels necessary to cover the deficiency for the energy framework and area of solar panels necessary to cover the total electricity consumption (rounded figures):

	Heat pumps:	Single family house (150 m²)	Terraced house (132 m²)	Multi-storey building (1 081 m²)	Office building (3 283 m²)
1	m² of solar panels to cover deficiency	4	1	35	150
2	m² of solar panels to cover total electricity consumption	25	25	200	690
	District heating:				
3	m² of solar panels to cover deficiency	4	2	35	140
4	m² of solar panels to cover total electricity consumption	20	20	175	660

Building envelope

As well as additional primary energy for the building, in the form of requirements for energy frameworks, Building Class 2020 also includes requirements for the building envelope, insulation and components. These requirements are included to ensure that "tents with solar panels" are not being built, or in other words, to ensure the quality of the basic building, which is designed to last for many years and is expensive to change once it is built. Requirements for the building envelope also termed the dimensioning heat loss, states the maximum amount of heat that may be lost per m² of building envelope (walls, foundation, floors and roof). This does not include windows and doors, thus avoiding unnecessarily small windows and "glughulsarkitektur" ["peephole architecture"].

In Building Class 2020, the requirement is that the dimensioning heat loss must not exceed:

1.7 W per m² building envelope in a one storey building,
4.7 W per m² building envelope in a two storey building, and
5.7 W per m² building envelope in a building of three or more storeys.

The area of windows and doors and the dimensioning heat loss through these is not included in the calculation. For buildings with high rooms that are comparable with buildings of two or three storeys or above, the corresponding dimensioning heat loss is 4.7 and 5.7 W respectively per m² building envelope.

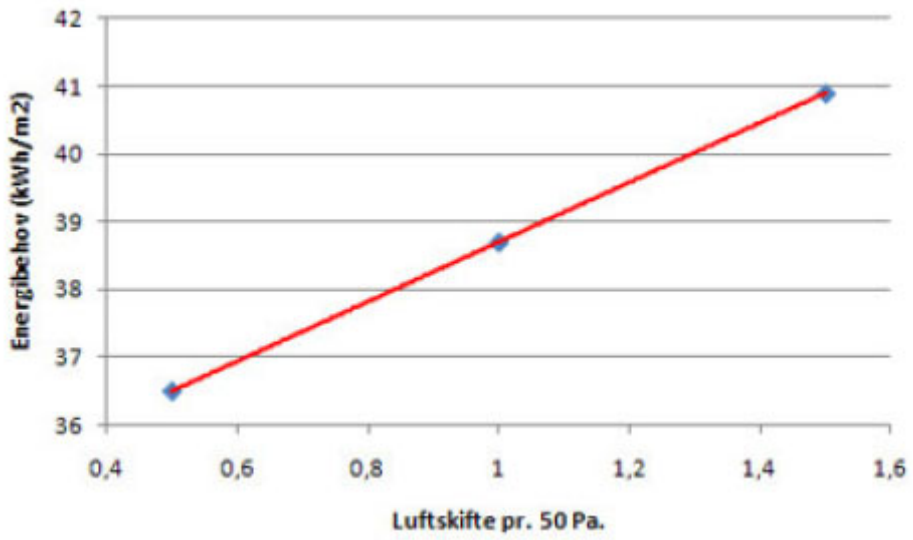
Insulation requirements:
Leakages in the building envelope can reduce the effect that increased insulation would otherwise have on the energy consumption of the building. Leakages can also affect the comfort of the people who live or work in the building. Developments in the building industry allow us to construct ever more highly insulated buildings, in some instances as low as 0.3 l/s per m². As a well-insulated building envelope is decisive in achieving further energy reductions, requirements for insulation in Building Class 2020 have been increased in relation to those in BR10 and Low-Energy Class 2015, cf. Table 4.

Table 4. Insulation requirements (l/s per m² at 50 Pa with over/underpressure)

	BR10	Low-Energy Class 2015	Building Class 2020
Standard buildings	1.5	1.0	0.5

An insulation figure in buildings of 0.5 instead of 1.5 will result in significant energy savings. Figure 1 shows that the energy requirement is reduced by 4-5 kWh/m², with an improvement in insulation of 1.0 l/s per m² which, in relation to Building Class 2020, corresponds to 20-25 % of the permitted energy consumption in the energy framework.

Figure 1: Energy requirement for a single family house



Key to graph:
Energibehov (kWh/m²) = Energy requirement (kWh/m²)
Luftskifte pr. 50 Pa = Air change per 50 Pa

Components:
A further increase in the energy standard of the basic building is ensured via requirements for a number of building components and fittings that have a bearing on the energy consumption of the building. In connection with the introduction of Low-Energy Class 2015 a number of requirements were introduced for components that must be complied with when building in accordance with this Low-Energy class. There are similar requirements for Building Class 2020. When the maximum heat loss per m² building envelope, not including windows and doors, is increased, the energy standard of windows and doors must also be increased. The difference between windows and the rest of the building envelope is that there is both additional solar radiation as well as heat loss through the windows. Solar gain through the windows can be used to cover part of the heat requirements of the house and requirements for this are stipulated in a EREF (European Renewable Energy Federation) value that allows for both solar gain and heat loss through windows. The requirement for solar gain through windows in the warming-up season is -33 kWh/m² annually.

Significant technological advances in the window industry in recent years have meant that leading manufacturers can already deliver products with positive solar gain. These advances are expected to become widespread within the industry in coming years. For this reason, stricter requirements for solar gain through windows have been introduced with Low-Energy Class 2015. These have become even stricter in Building Class 2020, where there are increased requirements for solar gain through windows during the warming-up season, cf. Table 5.

Table 5. Requirements for the energy balance of windows - solar gain during the warming-up season in kWh/m² annually

	BR10	Low-Energy Class 2015	Building Class 2020
Windows	-33	-17	+0
Skylights	-10	+0	+10

In Building Class 2020, outer doors and openings must not have a U value higher than 0.80 W/m²K. Glass outer doors must not have a U value higher than 1.00 W/m²K or solar gain through the door in the warming-up season of less than 0 kWh/m² annually. There are special rules for fire doors[10]. Finally, entrances must have a U value of at most, 1.40 W/m²K.

Heat pumps
It is expected that the energy supply in buildings of the future will largely be composed of district heating and heat pumps. For this reason, DKK 30 million was earmarked in the Energy Agreement for developing initiatives to promote heat pumps with special focus on replacing oil fired boilers with heat pumps.

Heat pumps must comply with a series of minimum requirements laid down in the Building Regulations (BR10 Chapter 8.6.4). The requirements depend on the type of heat pump and apply to the installation of heat pumps in all types of building and are thus not a specific requirement of Building Class 2020.

[10] BR 10 Chapter 7.6

Primary energy factors

Buildings built in accordance with the voluntary low-energy classes in the coming years have an extremely reduced requirement for additional heating. For most single family houses, it will be economically most attractive to install individual heat pumps in these houses. In a number of instances in closely built-up areas the most economical solution will still be to supply new buildings via collective systems, especially district heating.

Buildings built in accordance with Building Class 2020 are designed to stand for many years. Establishment of the factors takes the expected future development of supply systems into consideration. Studies carried out by the Danish Energy Agency, based on projections for energy consumption[11] up to 2020 and the Climate Commission's scenarios[12] show that the primary energy factor (gross energy consumption/actual energy consumption) for electricity will fall from 2.4 in 2009 to between 1.25 and 1.6 in 2050. The electricity factor in Building Class 2020 is therefore lowered from its present level of 2.5 to 1.8. The increasing use of renewable energy in the generation of electricity is the reason why the primary energy factor will in time move towards zero.

The primary energy factor for district heating in Building Class 2020 is set at 0.6. This factor has been set to ensure that district heating is not ignored in favour of, for example, heat pumps in areas where district heating is available. The primary energy factors in BR10, Low-Energy Class 2015 and Building Class 2020 can be seen in Table 6.

Table 6: Development of primary energy factors

	BR 10	Low-Energy Class 2015	Building Class 2020
District heating	1.0	0.8	0.6
Electricity	2.5	2.5	1.8
Gas, oil, wood, etc.	1.0	1.0	1.0
Renewable energy	0.0	0.0	0.0

Note: Renewable energy on the site and in shared RE plants is offset against the energy framework calculations.

Indoor climate conditions

Building Class 2020 has been developed from a global perspective in which energy reduction goes "hand in hand" with a pleasant and comfortable indoor climate. Danes stay indoors approximately 90 % of their time, so a good indoor climate in both new and existing buildings is of great importance to our health and general well-being. A good indoor climate also results in fewer sick days, less stress and better well-being. The indoor climate is affected by a number of different factors including air quality, temperature, daylight etc., which are already requirements in the Building Regulations. Particularly strict requirements for indoor climate in Building Class 2020 will make the low-energy houses, office blocks and institutions of the future attractive to their residents and users.

[11] Basic projection 2012. The Danish Energy Agency: http://www.ens.dk/Documents/Netboghandel%20-%20publikationer/2012/Danmarks energifremskrivning.pdf

[12] Green Energy. Climate Commission. 28 September 2010: http://www.ens.dk/da-DK/Politik/Dansk-klima-og-energi-politik/klimakommissionen/klimakommissionensrapport/Documents/groen%20energi%20DK%20screen%201sidet%20v2.pdf

With regard to the indoor climate in low-energy buildings, there are a number of factors to take into consideration. In low-energy buildings, energy reduction is generally achieved with an extremely well-insulated building envelope, a thick layer of insulation and use of passive sunlight. It is precisely these elements that are the strength of low-energy buildings, as they reduce well-known indoor climate problems such as condensation and damp caused by draughts and cold surfaces. Experience with existing low-energy buildings also shows that in some instances, comfort and indoor climate problems such as overheating during the summer months and inadequate heating during the winter can occur.

Thermal indoor climate
Previous experience with low-energy buildings shows that in some houses, uncomfortably high temperatures can occur. These high temperatures partly occur due to large south-facing windows, which in many cases are badly shielded against sunlight, and partly due to poor ventilation. It is often difficult and expensive to combat overheating in homes and office buildings, e.g. by fitting sun screens, once the building is built. It is therefore an advantage if these problems can already be identified and countered in the design phase.

In Low-Energy Class 2015 and Building Class 2020, the thermal indoor climate on sunny days must be documented through calculations for homes, institutions, offices,° etc. The thermal indoor climate must not exceed 26°C apart from by a few hours during a normal year.

The 26°C limit for homes must not be exceeded by more than 100 hours annually and 27°C must not be exceeded by more than 25 hours annually. For buildings other than houses, the contractor determines the number of hours annually during which the indoor temperature of 26°C must not be exceeded.

Daylight
Daylight in the home has a positive effect on our general well-being and is thus an important part of a good indoor climate. Good access to daylight can improve our concentration and improve our mood. It can also be a positive experience just to look out of the window at the surrounding countryside or garden. In addition to the advantages of good access to daylight in terms of comfort, it also shows up on the energy bill. Increased and conscious use of daylight can save electricity used for lighting in the workplace and the home. Building Regulations contain specific requirements for daylight in office buildings and institutions that ensure adequate light in working situations. The level of the requirement is designed to allow for good light conditions, as well allowing some flexibility in the design of the building, e.g. it is possible to have institutions in multi-storey buildings, or to have office buildings of a certain depth. Building Regulations have a functional requirement for homes that rooms must be well lit, but there are no specific requirements for the level of daylight.

Building Class 2020 demands particularly good lighting conditions, so requirements for a minimum area of glass have been introduced for homes, day-care centres and office buildings. Living areas and kitchens/general purpose areas and working areas in institutions and offices must have a window area corresponding to 15 % of the floor area, provided that the glass has a light transmittance of at least 0.75. The requirement for the window area is easy to comply with and demonstrate and does not make the building any more expensive with costs for measuring the daylight conditions.

The requirement for a specific glass area in the living and working areas of the building has advantages in terms of comfort and aesthetics and will mean that the window area of the building will be more evenly distributed than previously. Up until now, low-energy buildings have had a tendency towards massive over-emphasis of the south facing windows, with an extremely reduced glass area in the north facing ones, which can result in dark rooms in the northern part of the house, with a risk of over-heating and glare (great contrast between sun and shade) in the rooms facing south. It is therefore often more appropriate to have an even distribution of windows in a building, which reduces the risk of over-heating and makes the building more robust in relation to its location on sites facing different directions.

Air Quality
Building Regulations' general requirements for a change of air of minimum 0.3 l/s per m² heated floor in rooms, also applies to rooms in Building Class 2020. Building Class 2020 also has a further requirement that buildings with ventilation systems must have heat recovery units. With multi-storey buildings, a general requirement has been introduced for the installation of ventilation systems with heat recovery units.

There are also stricter requirements for the permissible amount of CO2. A high CO2 level is an indicator of inadequate air change in relation to the number of people in a room. In order to achieve good air quality, Building Class 2020 has a permissible CO2 ceiling of 900 ppm in schools, day-care centres and offices, apart from in shorter periods.

Demand controlled ventilation
Demand controlled ventilation in homes and other buildings ensures that the ventilation suits the actual requirements. Demand controlled ventilation can thus contribute to savings on the electricity bill while at the same time providing the necessary air change.

The rules in the Building Regulations make it possible to use demand controlled ventilation in institutions and to a limited extent in multi-storey buildings. However, with demand controlled ventilation, there is still a minimum air change requirement in all rooms that must guard against increased concentrations of CO2, radon and formaldehyde in the indoor climate. In institutions, demand controlled ventilation means, for example, that the air change is automatically increased in rooms where a lot of children are gathered, while being reduced in others. The use of demand controlled ventilation can lead to significant energy saving. For example, experience with demand controlled ventilation in institution buildings shows that there can be a saving on energy consumption for ventilation of around 40 %. Demand controlled ventilation is therefore an obvious choice for institutions and schools.

Heating Building Class 2020 buildings.
With low-energy houses, often only small amounts of energy need to be added to the house to heat it during the winter months. The reduced heat requirement also means that design of technical installations and accurate calculation of heat loss are even more critical, as in some cases, contractors plan the heating system so there is a precise correlation between the estimated heat loss and the amount of additional heat required. Current experience with low-energy housing heated with heat pumps shows that in some houses, there can be problems with insufficient heating of rooms during the winter months. This is because the efficiency of the heat pump is affected by the lower temperature of the air and earth. Previous negative experiences are often because when the capacity of the heating system was planned, the calculations used by the contractor or consultant engineer do not correspond to the actual conditions. If the client has chosen a heating system in which the possible input is very close to the calculated heat loss, the heating system will not have the necessary additional capacity and therefore cannot heat the home adequately.

In connection with the revision of the heating norm, requirements for an amount of extra capacity in heating plants for low-energy buildings have been included in Low-Energy Class 2015 and Building Class 2020 in order to ensure that these problems do not occur in the future[13]. This will ensure robust heating plants that have the capacity to handle situations where the actual conditions deviate from the original estimates, thus ensuring the occupants adequate comfort all year round.

There have also been number of less successful experiences with both Danish and foreign low-energy houses heated by warm air from heat pumps. The problem here has been the difficulty of regulating the temperature in each individual room. Requirements have therefore been introduced into Building Class 2020 stating that warm air must not be the only source of heating in buildings.

Heat recovery ensures that air being expelled through the ventilation system get reused instead of being wasted. The requirements for the degree of effect of heat recovery in schools, institutions and multi-storey buildings has therefore been increased from 70 % in the current Building Regulations to 80 % in Building Class 2020. The requirements for heating systems that supply individual houses have been increased from 0.80 to 0.85. Finally, the requirement for electricity consumption for ventilation has been increased so that in 2020 buildings it must at maximum be 1 500 J/m³, and 800 J/m³ for ventilation systems that only supply houses.

Architecture
Building Class 2020 provides the opportunity to create interesting low-energy buildings of high architectural quality even though requirements for the energy consumption of the building are now considerably stricter. These apply right from the start when designing a new building, where the design and siting can be vital in terms of energy consumption and indoor climate. There is therefore a focus on the design process and the energy reducing considerations that can be applied early on in the design process and which will be important in achieving the desired energy reduction. It is also important that Building Class 2020 allows for a certain degree of architectural freedom, so that the future will see a variety of takes on both traditional and more creative low-energy architecture.

As energy requirements for our housing and other buildings become stricter, the architect's ability and possibility to make informed decisions during the design process will become increasingly important for whether the finished building complies with the Building Regulations as well as being comfortable and aesthetically pleasing.

In the initial phases of the design process it can be an advantage to focus on passive considerations such as the layout of rooms and the various dimensions of the building and how these can contribute to reducing energy consumption. For example, changes in the size of a building can contribute to a reduction in the overall heat loss. Similarly, a redistribution of functional areas in an office building so that those with a greater requirement for light are located on the south side of the building can be a contributory factor in reducing the energy consumption from electric lighting. These passive solutions often have the advantage that they are longer term than active solutions such as solar panels and ventilation with heat recovery. Passive solutions usually require less maintenance during the lifetime of a building and in many cases are less affected by changes in user behaviour.

[13] DS 469, Norm for varmeanlæg [DS (Danish Standard) 469, Norms for heating plants]. A draft proposal was sent for consultation in 2012.

Architectural freedom and innovation
The energy framework and the requirements for building envelopes are intended so that the architectural style is not prescriptive. As the requirement for heat loss is expressed per m² building envelope, this would not prevent designs with protrusions that increase energy consumption. It will thus be possible to construct buildings with a relatively large surface in relation to floor area, e.g. with a number of protrusions in the façade. However, it is obvious that this type of "building envelope" would result in greater overall heat loss, which would need to be kept within the energy framework. In these instances, it is the energy framework that determines the creative possibilities.
As a regulatory instrument, the energy framework offers a certain degree of flexibility and creates incentives for product innovation and solutions. The energy framework lays down requirements for the overall energy efficiency of a building instead of detailed requirements of each individual building element. This allows contractors and consultant engineers to choose the materials, solutions and technologies that are most likely to promote Low-Energy consumption.

4. Intermediate targets for improving the energy performance of buildings no later than 2015

Low-Energy Class 2015
The introduction of a new voluntary Low-Energy Class 2015 in the Building Regulations states a clear objective for the standards new buildings must comply with in 2015. Buildings built in accordance with Low-Energy Class 2015 have an energy framework that is reduced by 57 % in relation to the 2006 level, thus complying with the objective from 2008, for the introduction of a building class in 2015 with a reduced energy consumption of 50 % in relation to 2006.

Requirements for the energy framework, insulation requirements, the energy balance of windows and primary energy factors in Low-Energy Class 2015 can be seen above, in Section 3 of the National Action Plan. The detailed provisions can be seen in Annex II.

Changing over to renewable energy sources in the building industry
Article 13(4) of Directive 2009/28/EC on the promotion of the use of energy from renewable sources states that:

> "Member States shall introduce in their building regulations and codes appropriate measures in order to increase the share of all kinds of energy from renewable sources in the building sector.
>
> In establishing such measures or in their regional support schemes, Member States may take into account national measures relating to substantial increases in energy efficiency and relating to cogeneration and to passive, low or zero-energy buildings.
>
> By 31 December 2014, Member States shall, in their building regulations and codes or by other means with equivalent effect, where appropriate, require the use of minimum levels of energy from renewable sources in new buildings and in existing buildings that are subject to major renovation. Member States shall permit those minimum levels to be fulfilled, inter alia, through district heating and cooling produced using a significant proportion of renewable energy sources.

The requirements of the first Subsection shall apply to the armed forces, only to the extent that its application does not cause any conflict with the nature and primary aim of the activities of the armed forces and with the exception of material used exclusively for military purposes."

Denmark fulfils the first two Subsections in this provision by having some of the world's most stringent requirements for new buildings and by having introduced two voluntary low-energy classes; Low-Energy Class 2015 and Building Class 2020.

As Danish energy production and the infrastructure of the supply sector are undergoing radical changes in terms of adapting to an even greater share of renewable energy, Denmark furthermore fulfils the third Subsection of the provision for a minimum level of renewable energy in new and existing buildings by 31 December 201 at the latest. The share of energy from renewable sources for district heating will also increase as will the share of electricity from wind turbines. Table 7 shows how the overall share of renewable energy sources in the building industry is expected to develop from 2005 to 2020.

Table 7: Expected share of energy from renewable sources in the building industry

	2005			2010			2015			2020		
	Individual	Electricity	District heating	Individual	Electricity	District heating	Individual	Electricity	District heating	Individual	Electricity	District heating
Residential buildings	37	27	28	50	34	35	57	45	44	64	51	51
Commercial premises	12	27	28	10	34	35	9	45	44	9	51	51
Public buildings	14	27	28	20	34	35	20	45	44	20	51	51
Industrial premises	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL	33	27	28	45	34	35	51	45	44	56	51	51

Source: National Renewable Energy Action Plan (Section 4.2.3). The Danish Ministry of Climate and Energy (now the Danish Ministry of Climate, Energy and Building). June 2010.

These trends are supported by the Energy Agreement from 2012 which states the following:

- Towards 2020, expansion will be increased by 1 000 MW offshore wind turbines and 500 MW coastal wind turbines
- There will be an amendment to the Heating Supply Act promoting the conversion of the central cogeneration plants to biomass
- In 2012 an overall strategy for the establishment of a smart grid in Denmark will be prepared
- An ambitious expansion with biogas will be carried out including a newly developed support model for biogas.

The increasing share of renewable energy in the electricity and district heating supply will mean an overall increase in renewable energy for both new and existing building, as district heating and electricity will be the primary supply sources in the future.

5. Policies and financial or other measures to be formulated in order to promote nearly-zero energy buildings

Denmark has implemented a number of actions that either directly or indirectly promote the energy efficiency of existing buildings, as well as the number of zero-energy buildings. The specific action to increase the share of renewable energy in the energy supply is described in the *National Renewable Energy Action Plan*[14]*,* cf. the obligations in Article 13(4) of the Directive on the promotion of the use of energy from renewable sources[15].

Energy saving solutions of the energy companies
In Denmark, electricity, gas district heating and oil grid and distribution companies have had energy saving obligations with annual targets since 2006. Following the Energy Agreement of March 2012, this obligation has intensified. The agreement states that the energy companies' savings obligations in 2013 and 2014 will increase by 75 % in relation to the 2010-2012 period, corresponding to 10.7 PJ annually during the 2013-2014 period. From 2015 to 2020, the obligation will increase by 100 %, corresponding to 12.2 PJ annually. This corresponds to around 2.6 and 3.0 % of the final energy consumption respectively, excluding transport.

The Energy Agreement explicitly states that the increased savings obligations are targeted at the energy companies' existing buildings and business.

Please refer to Denmark's second national action plan for energy efficiency in respect of the Directive on energy end-use efficiency and energy services[16].

Strategy for energy renovation of the existing building stock
The Energy Agreement from 2012 obliges the government to prepare an overall strategy for the energy renovation of the existing building stock. The strategy must be based on a general analysis of the existing building stock including possible potentials, and ensuring that it employs the most cost-effective solutions. The strategy is to be discussed between the signatories to the agreement before the end of 2013. The strategy considers possible solutions for all types of building and there is a special focus on incentives and new financial models for promoting energy renovations including ESCOs.

The changeover to renewable energy
In the period from 1 March 2010 to 30 June 2012, it has been possible for owners of oil-fired central heating to apply for a grant to scrap their system and replace it with either a geothermal heating system, an air to water heat pump, a solar panel heating system or connection to district heating. The grant is for 15-25 % of the cost of installing a new energy-efficient solution.
The Energy Agreement of 2012 decided to phase out oil and gas central heating. From 2013, it will no longer be possible to install oil or gas central heating in new buildings, although will be possible in situations where there is no other available alternative. Furthermore, from 2016 it will no longer be possible to install oil-fired central heating in existing buildings in areas where district heating or natural gas is available as an alternative supply source.

[14] National Renewable Energy Action Plan (Section 4.2.3). The Danish Ministry of Climate and Energy (now the Danish Ministry of Climate, Energy and Building). June 2010. http://www.ens.dk/da-DK/Politik/Eus-klima-og-energipolitik/Klima-og-energipakken/Documents/National%20VE-handlingsplan%20juni%202010.pdf
[15] DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
[16] DIRECTIVE 2006/32/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 5 April 2006 on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC

To support the change from oil and gas in existing buildings to heating sources based on renewable sources, a pool of DKK 42 million has been set aside during the period from 2012 to 2015 to promote initiatives for energy-efficient alternatives, including carrying out analyses on the promotion of alternative forms of supply.

The Government's RE objectives and support for solar panels
The Danish objectives for the changeover to renewable energy are stated in the National Renewable Energy Action Plan of June 2012 cf. Article 4 of the Directive on the promotion of the use of energy from renewable sources.[17] A grant scheme for the installation of solar panels has been in existence for a number of years, either as a direct grant or as the possibility for selling extra energy to the grid. This scheme has been especially advantageous for owners of single family houses, aided in particular by a fall in the price of solar panels. This as resulted in a pronounced increase in the number of solar panels installed on or near to these buildings.

On 15 November 2012, a political agreement was entered into for a change in the grant scheme for solar panels that reduces the grant for single family houses without removing the incentive to install solar panels for their owners. At the same time, it has become more advantageous to install larger solar panel plants in villages and housing associations.

Green initiatives in the 2013 Finance Act
The 2013 Finance Act earmarked finance for a number of green initiatives in the building sector, Including DKK 45 million for the energy renovation of public buildings and support for the energy renovation of public housing, as well as DKK 5 million for the development of ESCO models.

Information campaigns
For a number of years, Denmark has made considerable efforts to improve the energy efficiency of buildings. These initiatives have targeted commercial and private buildings as well as public building and there has been a focus on behaviour-related energy consumption process energy and energy improvements to buildings. In relation to new buildings, building process guidelines have been drawn up for contractors, architects and engineers that wish to build energy-efficiently.[18]

<u>Public sector initiatives</u>
With a building area that accounts for 6 % of the total building area, in governmental, regional and local authorities, the public sector is showing the way with a series of energy-saving initiatives that will lead to considerable savings. The public sector example illustrates how energy savings can be implemented.

[17] DIRECTIVE 2009/28/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. L140/16.5.6.2009
The National Action Plan: http://www.ens.dk/da-DK/Politik/Eus-klima-og-energipolitik/Klima-og-energipakken/Documents/National%20VE-handlingsplan%20juni%202010.pdf
[18] Byggeprocesvejledning. Til bygherrer, arkitekter og ingeniører, der vil bygge energieffektivt. Center for Energibesparelser. 2011. [Building process guidelines. For contractors, architects and engineers wishing to build energy-efficiently. The Danish Knowledge Centre for Energy Savings in Buildings]

Energy savings in government buildings
The Circular on energy savings in government buildings[19] from 2009, introduced a framework management target that required each ministry to save 10 % on energy consumption in 2011 in relation to the 2006 level. The Circular also lays down that ministries have an obligation to publish their results on a central publicly accessible internet database. The final results were calculated and presented to the Danish Parliament (Folketinget) in 2012. A new circular is being prepared and will be ready for publication in the middle of 2013.

Energy savings in local authority buildings
The voluntary agreement between Local Government Denmark (Kommunernes Landsforening) and the Minister for Climate, Energy and Buildings, establishes the framework for energy savings in local authorities.[20] The agreement states that local authorities must demonstrate energy-efficient behaviour, undertake energy-efficient procurement and implement energy efficiency initiatives for local authority buildings, including beginning energy renovation with a repayment period of up to five years, carry out energy labelling of local authority buildings etc. The agreement is expected to be re-negotiated at the beginning of 2013.

Furthermore, the Planning Act (planloven)[21] allows local authorities to assign certain areas for buildings that comply with the requirements of Low-Energy Class 2015, which a number of local authorities have taken advantage of.

Energy saving in regional buildings
Regional buildings are primarily hospitals. A current reorganisation of the infrastructure of the hospital sector indicates that in coming years, a number of 'super hospitals' will be built that are intended to cover a wider geographical area than the present smaller hospitals. The economic framework for this is DKK 43 million up to 2020. Some of these 'super hospital projects have already begun and because of the large investments in the sector, an agreement has already been entered into between the regions and the Danish government allowing extended loan access for hospital buildings built in accordance with Building Class 2020. The agreement allows for a special loan pool of DKK 1bn. It is expected that a significant number of the new hospitals will comply with Building Class 2020 and thus will make a positive contribution to the government's energy policy targets.

Furthermore, as with the local authorities, a voluntary agreement exists between the Danish Government and the Danish Regions for regional energy savings initiatives.[22] The agreement is fundamentally the same as the voluntary agreement with the local authorities, although with special focus on the hospital sector. The agreement is expected to be re-negotiated in 2013.

[19] CIR1H nr 9787 af 01/10/2009: Cirkulære om energieffektivisering i statens institutioner: [CIRC 1H No 9787 of 01/10/2009: Circular on energy efficiency in government institutions:]
[20] Aftale mellem KL og transport- og energiministeriet om realisering af energibesparelser i kommuner. Oktober 2007. [Agreement between Local Government Denmark and the Ministry of Transport and Energy, on achieving energy savings in local authorities. October 2007]
[21] LBK nr 937 af 24/09/2009: Bekendtgørelse af lov om planlægning [Consolidated Act No 937 of 24/09/2009: Order on the Planning Act.]
[22] Aftale mellem Danske regioner og klima- og energiministeren om realiseringen af energibesparelser i regio-nerne.13. januar 2009. [Agreement between the Danish Regions and the Minister for Climate and Energy, on achieving regional energy savings. 13 January 2009.]

ANNEX 1 – Building Regulations 2010: Building Class 2020

Chapter 7.2.1
Subsection 12
If the low-energy framework for Building Class 2020 is complied with, an energy factor of 0.6 applies for buildings supplied with district heating. If the low-energy framework for Building Class 2020 is complied with, irrespective of supply form, an energy factor for electricity of 1.8 applies.

(7.2.1(12))
There is no specific factor for district cooling although district cooling can be assessed on a par with other cooling principles, see Annex 6.

Subsection 13
In Low-Energy Class 2015 and Building Class 2020, the thermal indoor climate on sunny days must be documented through calculations for homes, institutions, offices etc. The thermal indoor climate must not exceed 26°C apart from a few hours in relation to a normal year. For buildings other than homes, the contractor determines the number of hours annually during which the indoor temperature of 26°C must not be exceeded. With homes, the 26°C limit must not be exceeded by more than 100 hours annually and 27°C must not be exceeded by more than 25 hours annually.

(7.2.1 (13))
The specification of the thermal indoor climate is determined on the basis of DS 474 Specifikation af termisk indeklima [DS 474 (Danish Standard 474) Specification of indoor climate]. Documentation of the thermal indoor climate may be determined by simulating conditions in the critical rooms on the basis of the Design Reference Year (DRY). For homes, documentation may be on the basis of a simplified calculation. For buildings other than houses, the number of hours with temperatures over 26°C is determined by the contractor in relation to the DRY.

7.2.5 Building Class 2020

7.2.5.1 Common provisions for buildings covered by Building Class 2020

PROVISION

Subsection 1
Buildings covered by the provisions in Chapter 7.2.5.2 or 7.2.5.3 must be constructed so that the dimensioning heat loss is not above 3.7 W per m² of building envelope for one-storey buildings, 4.7 W for two storeys and 5.7 W when the building has three or more storeys. The area of windows and doors and the dimensioning heat loss through these is not included in the calculation. For buildings with high ceilings that are comparable with buildings of two or three storeys or above, the corresponding dimensioning heat loss is 4.7 and 5.7 W respectively per m² building envelope.

Subsection 2
Solar gain through windows during the warming-up season must not be less than 0 kWh/m² annually. With skylights, solar gain must not be less than 10kWh/m² annually. The U value for skylight domes must not exceed 1.20 W/m²K.

Subsection 3
Outer doors and hatches must not have a U value greater than 0.80 W/m²K. Glass outer doors must not have a U value greater than 1.00 W/m²K or solar gain through the door in the warming-up season of less than 0 kWh/m² annually. With fire doors, the provisions in Chapter 7.6, apply.

Subsection 4
Entrances must have a U value of 1.40 W/m²K

Subsection 5
The air flow through leakages in the building envelope must not exceed 0.5 l/s per m² heated floor area pressure tested at 50 Pa. The result of the pressure test is expressed as the average of the measurement with over/underpressure. With buildings with high rooms, where the surface of the building envelope divided by the floor area is greater than 3, the air flow must not exceed 0.15 l/s per m² building envelope pressure tested at 50 Pa.

Subsection 6
With Building Class 2020 homes, residential colleges, hotels etc., if the light transmittance of the glass is greater than 0.75, the window area must correspond to at least 15 % of the floor area of the room and kitchen/dining area. If the light transmittance is less, the window area must be enlarged correspondingly. With skylights, the area is included in the calculation by a factor of 1.4.

Subsection 7
With offices, schools, institutions etc., not covered by (6) but built in accordance with Building Class 2020, if the light transmittance of the glass is greater than 0.75, the window area in classrooms and day rooms must be at least 15 % of the floor area. If the light transmittance is less, the window area must be enlarged correspondingly. With skylights, the area is included in the calculation by a factor of 1.4.

Subsection 8
Ventilation systems must be designed with heat recovery with a dry temperature efficiency of at least 75 %. Systems that supply individual houses must be fitted with heat recovery with a dry temperature efficiency of at least 85 %.

Subsection 9
Electricity specifically used for ventilation must not exceed 1 500 J/m³. However, with systems that supply only one house, the limit is 800 J/m³.

Subsection 10
Shared RE plants installed in connection with a new development, where the contractor contributes financially to the installation of the RE system, can be included in the energy framework for the new development. The RE plant must be either in the development or in close proximity to it.

Subsection 11
In offices, schools and institutions, it must be ensured that the CO2 content of the indoor air does not exceed 900 ppm for longer periods.

Subsection 12
In Building Class 2020, warm air must not be the only source of heating. The provision does not apply to production halls etc.

GUIDELINES

(7.2.5.1(1))
The dimensioning heat loss is calculated as stated in DS 418 Beregning af bygningers varmetab [DS 418 calculation of the heat loss in buildings]. Windows include skylights and skylight domes.

(7.2.5.1(2))
Solar gain is calculated as shown in Annex 6 and is based on a weighted average. On the other hand, in accordance with the energy framework with regard to windows, information on solar radiation and U values is calculated for each window.

(7.2.5.1(3))
The requirements for outer doors apply for a standard size of 1.23 x 2.18 m. Glass outer doors also include sliding doors. With glass outer doors, either doors that comply with the U value requirements or doors that comply with the solar gain requirement which is less than 0 kWh/m² annually, can be used.

(7.2.5.1(5))
Documentation on air flow is done on the basis of tests in accordance with DS 13829 Bygningers termiske ydeevne – Bestemmelse af luftgennemtrængelighed i bygninger – Prøvningsmetode med overtræk skabt af ventilator [DS 13829 The thermal performance of buildings – Calculation of air flow in buildings – Test method with overpressure caused by a ventilator]. The local authority will require documentation of air flow for all buildings built as Building Class 2020, cf. Chapter 1.4(2) No 2.

(7.2.5.1(6))
Daylight is of great importance for health and wellbeing. The size of windows and their placing is important for viewing. Large window areas without effective solar shading can cause problems with overheating and glare. A more even distribution of windows and, for example, larger north-facing windows can reduce the need for electric light.

(7.2.5.1(7))
Light transmittance applies for the type of windows used. Compensation for glass with less light transmittance can be achieved by a relative enlargement of the room. Windows below chest height do not contribute significantly to the amount of daylight. Alternatively, when assessing the glass area of windows, the amount of daylight is seen as satisfactory if the daylight factors for the rooms are assessed as being better than 3. Calculating daylight may mean that some buildings will not be able to use light sensitive glass.

(7.2.5.1(9)
Electricity consumption for ventilation is calculated as shown in DS 447, Norm for ventilationsanlæg [DS 447, Norms for ventilation systems].

(7.2.5.1(10))
The provision allows for the inclusion of RE plants such as wind turbines, shared solar heating or solar panels or geothermal systems, if the RE plant is established in connection with the construction of a new development. It is a condition that the constructor of the new development makes an economic contribution to the establishment of the RE plant.

7.2.5.1(11))
Requirements for the ventilation rate in offices, schools and institutions, cf. 6.3.1.3, are not alone sufficient in all situations to ensure that the CO2 content in the air does not exceed 900 ppm for longer periods. The ventilation system must therefore be adjustable according to the CO2 content, so that air flow is higher in those rooms where the problem is greatest and lower in those where there is a lesser need.

(7.2.5.1(12)
Solutions with warm air, where all rooms in the house or building are one common temperature zone give comfort problems and do not comply with the provision.

7.2.5.2 Energy framework for homes, residential colleges, hotels etc.

Subsection 1
A building can be classified as Building Class 2020 when the total energy solar gain requirement for heating, ventilation, cooling and hot water pr m² heated floor area does not exceed 20 kWh annually.

(7.2.5.2 and 7.2.5.3)
Building Class 2020 is expected to become a mandatory requirement for the construction of new public buildings by the end of 2018 and of other new buildings by the end of 2020.

7.2.5.3 Energy framework for schools, institutions etc., not covered by Chapter 7.2.5.2

Subsection 1
Offices, schools, institutions and other buildings not covered by 7.2.5.2 can be classified as Building Class 2020 when the total energy solar gain requirement for heating, ventilation, cooling and hot water and lighting pr m² heated floor area does not exceed 25 kWh annually.

(7.2.5.2 and 7.2.5.3)
Building Class 2020 is expected to become a mandatory requirement for the construction of new public buildings by the end of 2018 and of other new buildings by the end of 2020.
(7.2.5.3(1)
The low-energy framework only applies to buildings heated to over 15°C.

Subsection 2
With buildings or extensions in Building Class 2020 with, for example, a high lighting requirement, extra ventilation, great consumption of hot water, long periods of occupation or buildings with particularly high ceilings, the energy framework can be extended with a supplement that corresponds to the estimated energy requirement for the building. Process energy such as ventilation of fume hoods, are not part of the energy framework.

(7.2.5.3(2))
See SBi-anvisning 213 Bygningers energibehov [SBi instruction 213, the energy requirements of buildings], for the assessment of high lighting requirement, extra ventilation, great consumption of hot water, long periods of occupation. Annex 6 contains guidelines for calculation of the supplement for buildings with particularly high ceilings. It should be expected that supplements based on consumption by installations covered by energy requirements will, in future, be reduced in line with the stricter requirements.

ANNEX II – Building Regulations 2010: Building Class 2015

7.2.1

Subsection 11
If the energy framework for Low-Energy Building Class 2015 is complied with, an energy factor of 0.8 applies for buildings supplied with district heating.

(7.2.1(11))
The energy factor is used for calculating the solar gain requirement for low-energy buildings supplied with district heating. See Annex 6 and SBi instruction 213, the energy requirements of buildings.

Subsection 13
The thermal indoor climate on sunny days must be documented by calculations for homes, institutions, offices etc., in Low-Energy Class 2015 and Building Class 2020. The thermal indoor climate must not exceed 26°C apart from some hours in relation to a normal year. For buildings other than houses, the contractor determines the number of hours annually during which the indoor temperature of 26°C must not be exceeded. With homes, the 26°C limit must not be exceeded by more than 100 hours annually and 27°C must not be exceeded by more than 25 hours annually.

(7.2.1(13)
The specification of the thermal indoor climate is determined on the basis of DS 474 Specifikation af termisk indeklima [DS 474 (Danish Standard 474) Specification of indoor climate]. Documentation of the thermal indoor climate may be determined by simulating conditions in the critical rooms on the basis of the Design Reference Year (DRY). For homes, documentation may be on the basis of a simplified calculation. For buildings other than houses, the number of hours with temperatures over 26°C is determined by the contractor in relation to the DRY.

7.2.4 Low-energy buildings 2015
7.2.4.1 Low-energy framework for homes, residential colleges, hotels etc.

PROVISION

Subsection 1
A building can be classified as Low-Energy Building Class 2015 when the overall solar gain requirement for heating, ventilation and hot water per m² heated floor area does not exceed 30 kWh/m² annually plus 1000 kWh divided by the heated floor area.

GUIDELINES

(7.2.4.1(1))

The low-energy framework for Low-Energy Building Class 2015 is (30 +1000/A) kWh/m² annually, where A is the heated floor area. The low-energy class is expected to become mandatory in 2015.

7.2.4.2 Low-energy framework for offices, schools, institutions etc. not covered by 7.2.4.1

PROVISION

Subsection 1
Offices, schools, institutions and other buildings not covered by 7.2.4.1 can be classified as Low-Energy Class 2015 if their overall solar gain requirement for heating, ventilation, cooling, hot water and light per m² heated floor area does not exceed 41 kWh/m² annually plus 1000 kWh annually divided by the heated floor area.

Subsection 2
With buildings or extensions in Building Class 2015 with, for example, a high lighting requirement, extra ventilation, great consumption hot water, long periods of occupation or buildings with particularly high ceilings, the energy framework can be extended with a supplement that corresponds to the estimated energy requirement for the building. Process energy such as ventilation of fume hoods, are not part of the energy framework.

GUIDELINES

(7.2.4.2(1))
The low-energy framework for Low-Energy Building Class 2015 is (41 +1000/A) kWh/m² annually, where A is the heated floor area. The low-energy class is expected to become mandatory in 2015.

(7.2.4.2(2))

See SBi instruction 213, the energy requirements of buildings, for assessment of a high lighting requirement, extra ventilation, great consumption of hot water, or long periods of occupation. Annex 6 contains guidelines for calculation of the supplement to the energy framework for buildings with particularly high ceilings. It must be expected that supplements granted as a consequence of requirements for technical installations will be reduced in line with stricter regulation of these requirements as a result of technological development in the area.