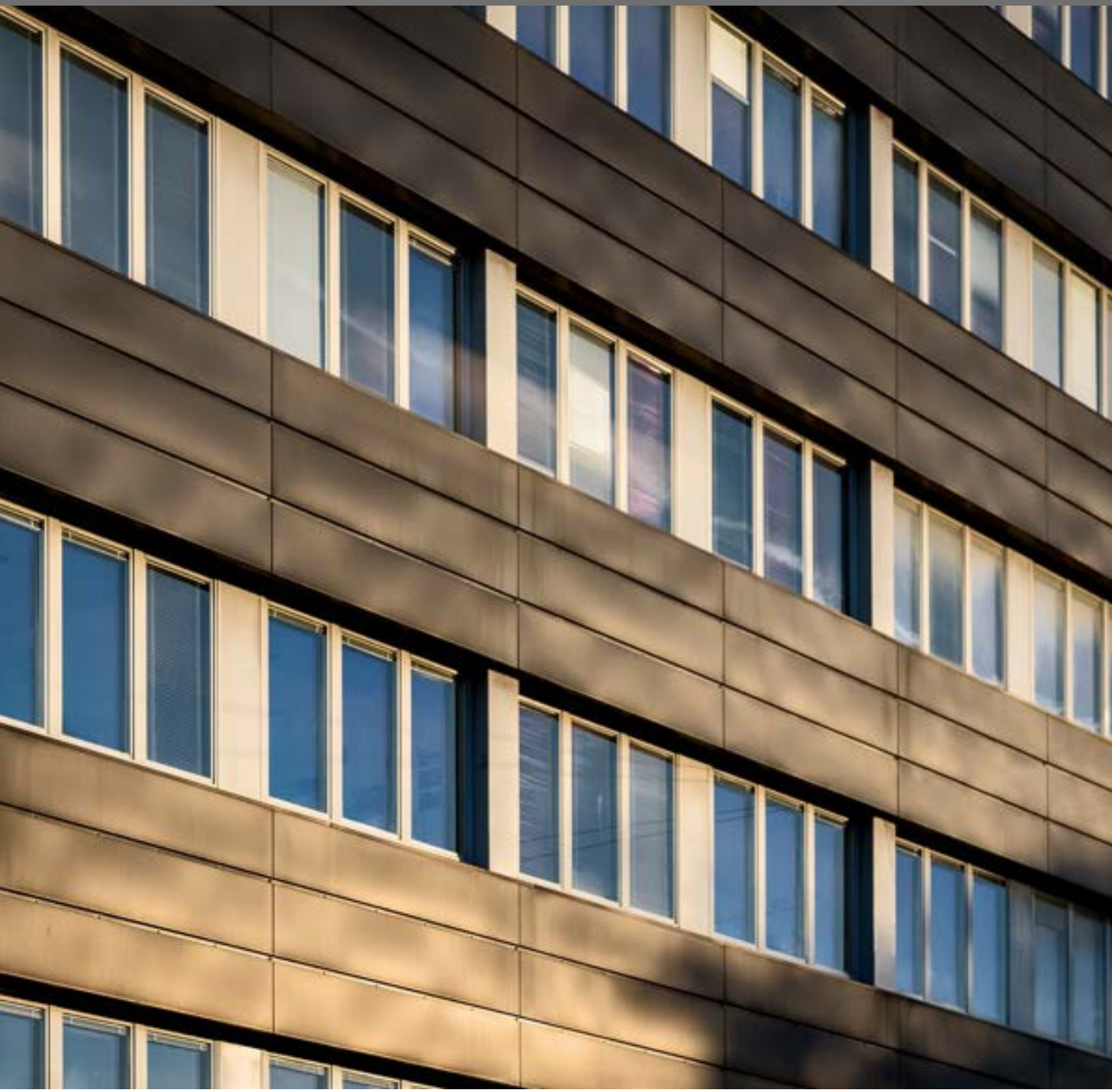
Energy Requirements of BR18

A quick guide for the construction industry on the Danish Building Regulations 2018



Danish Knowledge Centre for
Energy Savings in Buildings

Published April 2018

Table of Contents

Change in the Building Regulations’ requirements for energy demand of single family houses 1961-2020

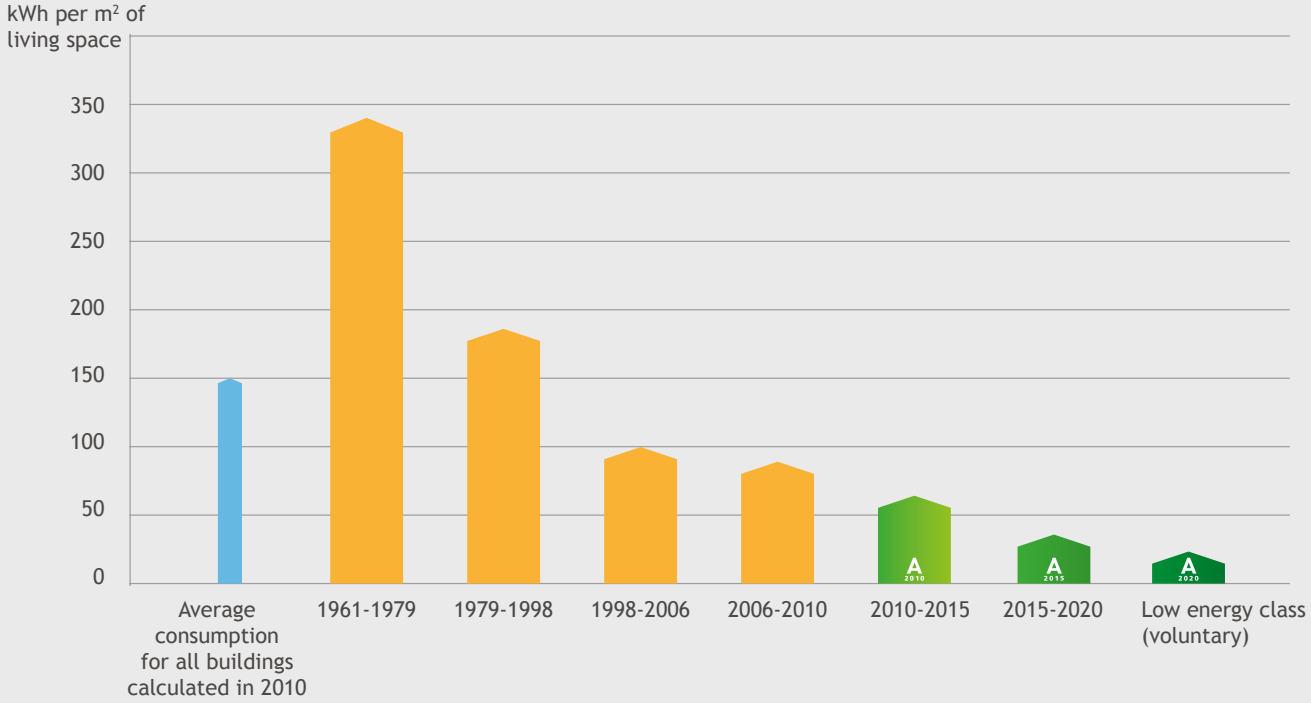


Figure 1

Energy requirements of the Building Regulations

The Building Regulations 2018 – BR18 – are in effect in Denmark as of January 1st 2018 with a transitional period until July 1st 2018.

The energy requirements are largely the same as in BR15. However, the building class 2020 has become voluntary rather than statutory also after 2020 and is now included in the regulations as a low energy class. Further, the structure of BR18 has changed significantly. It has a new subject and chapter structure, there are new instructional texts and attachments as well as a number of linguistic clarifications.

This quick guide gives you a quick overview of how to ensure that the buildings you construct or renovate live up to BR18's energy requirements. In the actual regulations, these requirements are found in Chapter 11 on energy consumption, in Chapter 19 about thermal indoor climate and installations as well as Chapter 22 on ventilation. In addition, there is instructional text to BR18's Chapter 11 and an Annex 2: "Tables for Chapter 11 - Energy Consumption".

Both are important to be familiar with. You will find the specific requirements for U values and line losses in Annex 2.

Building in accordance with BR18 of course requires a deeper insight into all of BR18 than this quick guide on the energy requirements can provide. The quick guide will, however, be a good primer when it comes to the energy requirements of heated buildings.

Six categories of construction projects
The Building Regulations operate with six different categories of construction projects that differ in relation to the energy requirements.

In order to figure out how to adhere to the Building Regulations, you should begin by placing your project in the proper category and finding the proper paragraphs of BR18.

For the first five categories, § 250 to § 258 in BR18 apply. In addition, there are specific paragraphs for each category.

 **New buildings**	 **Change of use**	 **Extensions**	 **Conversions and other alterations**	 **Replacements of building elements and installations**	 **Reparations***
Energy requirements §§ 250-258 §§ 259-266	Energy requirements §§ 250-258 §§ 267-270	Energy requirements §§ 250-258 §§ 271-273	Energy requirements (cost-effective) §§ 250-258 §§ 274-279	Energy requirements §§ 250-258 §§ 274-279	No energy requirements Instructional text about energy consumption item 4.0

* Reparations include paint treatment, mending plaster, plastering the facade, new roof valleys and covering, mending holes in the roof, etc.

Figure 2

What energy requirements does BR18 pose?

Here, you can see the energy requirements posed by BR18 for the different categories of projects and where they can be found in BR18. Please note that regardless of other requirements, there are always requirements in relation to moisture in chapter 14 and durability in chapter 15 of BR18.

New buildings

Requirements	§ in BR
Energy performance framework	§§ 259-260 + §§ 261-266
& Requirements for airtightness	§ 263
& Requirements for design transmission loss	§ 264
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

Change of use

Requirements	§ in BR
Energy performance framework as for new buildings	§§ 259-260 + §§ 261-266
& Requirements for design transmission loss	§ 264
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

OR

Minimum requirements for the building envelope for change of use	§ 268 + Annex 2, table 2
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

Conversions and other alterations

Requirements	§ in BR
Minimum requirements for the building envelope for conversions and other alterations concerning cost-effective energy improvements (a calculation of cost-effectiveness must be available if requirements are not complied with)	§ 279 + Annex 2, table 3

OR

Energy performance framework for existing buildings - called "renovation classes"	§§ 280-282

ALWAYS REQUIREMENTS FOR INSTALLATIONS
- when components are altered or replaced

Extensions

Requirements	§ in BR
Energy performance framework as for new buildings	§§ 259-260 + §§ 261-266
& Requirements for design transmission loss	§ 264
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

OR (e.g. max. 22 % windows and doors)

Minimum requirements for the building envelope for extensions	§ 257 + Annex 2, table 2
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

OR (e.g. more than 22 % windows and doors)

Heat loss framework corresponding to the U values and linear losses	§ 272
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

Replacements of building parts

Requirements	§ in BR
Minimum requirements for the building envelope for conversions and other alterations - regardless of cost-effectiveness	§ 279 + Annex 2, table 3
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs skylights and glass roofs - regardless of cost-effectiveness	§ 258

Figure 3

Always consider energy and indoor climate

According to BR18, it is not legal to make alterations to a building without considering both the energy and ventilation conditions.

As such, the energy requirements of the Building Regulations do not only apply to new buildings, change of use and extensions but also existing buildings when making alterations and other changes (including replacements) and when the alterations affect the energy consumption in the building.

The only exceptions are reparations, according to the regulations' instructional text to energy consumption, item 4.0.

Likewise, there are also requirements in relation to ventilation in existing buildings in the case of change of use, alterations and other changes. In the case of smaller renovation jobs, for example replacement of windows or doors, the ventilation conditions at the time of construction must be maintained. This is specified by BR18's instructional text about ventilation, item 1.1.

New buildings

In relation to new buildings, there are four primary levels of requirements that combined ensure that buildings have a low energy demand, are well-insulated and are problem-free when it comes to moisture. Neither of the four requirement levels can achieve this alone.

The four levels are: the energy performance framework, design transmission loss, general minimum demands for the building envelope and requirements for airtightness.

Requirements	§ in BR
Energy performance framework	§§ 259-260 + §§ 261-266
& Requirements for airtightness	§ 263
& Requirements for design transmission loss	§ 264
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

Calculation programs will help out

Be18 and equivalent calculation programs automatically calculate the energy performance framework and the design transmission loss when you have entered your data. It will quickly show you the effect of even just a small change in a U value, for example.

The energy performance framework
The energy performance framework of the Building Regulations indicates an upper limit for a newly erected building's total need for supplied energy to heating, ventilation, cooling and domestic hot water. Lighting is only included for buildings other than dwellings.

The energy demand of a building design is determined by means of an energy performance framework calculation. For this purpose, the calculation program Be18 will be used. How this is done is described in SBi Direction 213, Energy demands of buildings.

The developer is to submit the energy performance framework calculation along with his application for a building permit. Once permission has been given and the building has been erected, the calculation in combination with the energy labelling of the building will document that it adheres to the requirements of BR18.

BR18 includes a requirement for all buildings, which states that the energy performance framework can at most include electricity production from renewable energy (for example solar cells or wind turbines) equal to a reduction in the need for supplied energy of 25 kWh per m^2. The various forms of energy are weighted differently, which is described in § 252 of BR18. The Be18 calculation program takes this into account.

Requirements for airtightness
Buildings should be tight in order to retain heat and not have drafts. As such, there are requirements for the airtightness of new buildings in § 263. It is 1.0 l/s per m^2 of the heated floor area at a pressure differential of 50 Pa. This must be performed as specified in DS/EN 9972, Thermal performance of buildings.

Energy framework of BR18 for new buildings

Dwellings, student accommodations, hotels, etc.	Offices, schools, institutions, etc.
Total energy demand per year must not exceed :	Total energy demand per year must not exceed:
$30{,}0 + \frac{1{,}000}{\text{heated floor area}}$ kWh/m^2 per year	$41{,}0 + \frac{1{,}000}{\text{heated floor area}}$ kWh/m^2 per year

The reason for the Building Regulations having a higher energy performance framework for buildings that are not dwellings is that the energy demand for lighting in these buildings - for example offices, schools and institutions - is included when calculating the energy demand.

Figure 4

The airtightness is established individually in the energy performance framework calculation and can be documented by a pressure differential with a blower door test. If a pressure test is not conducted, 1.5 l/s per m^2 should be used when calculating the building's heating demand. This is in order to generate motivation for always having a pressure test conducted.

In general, it is recommended to always measure the tightness. It is part of good quality that you can document the tightness.

Definition of the design transmission loss

The design transmission loss per m^2 of the building envelope is the sum of the total heat transmission loss through the building envelope excluding windows, roof lights, glazed outer walls, glazed roofs and skylight domes. The designed temperatures and areas are determined as specified in DS 418, Calculation of heat loss from buildings.

Requirements for the design transmission loss

There are also requirements for the design transmission loss of new buildings. This requirement is to ensure well-insulated constructions. It also ensures that you cannot comply with the energy performance framework primarily by renewable energy; no matter the level of renewable energy, the constructions should always be well-insulated.

BR requirements in § 269 and § 476 for design transmission loss in W per m^2 of the building envelope excluding windows and doors

	Excisting	Voluntary low energy class
Single-storey	4.0	3.7
Two-storey	5.0	4.7
Three or more storeys	6.0	5.7

Figure 5

General minimum requirements for the building envelope

The individual building elements should be insulated such that the heat losses through them do not exceed the values in figure 6 below.

Typically, the U values will have to be considerably lower than the requirements for the general requirements for the building envelope in order to comply with the energy performance framework and the requirements for the design transmission loss.

As such, the purpose of the values in relation to new buildings is primarily to ensure that all building parts – e.g. also small areas – are constructed with a level of insulation that does not result in condensation and moisture issues.

The stated maximum U values apply to the entire building part. Any cold bridges in the building part must therefore be included. DS 418, Calculation of heat loss from buildings, details typical cold bridges and their contribution to the heat loss.

New buildings (and possibly extensions). Annex 2: Tables for Chapter 11, Table 1	**U value** W/m² K	**Approximate insulation thicknesses** mm
External walls and basement walls in contact with the soil	0.30	150
Suspended upper floors and partition walls to adjoining rooms/ spaces where there is a 5° C temperature difference or more	0.40	75
Ground slabs, basement floors in contact with the soil and suspended upper floors above open air or a ventilated crawl space	0.20	150
Suspended floors below floors with underfloor heating adjoining heated rooms/spaces	0.50	50
Ceiling and roof structures, including jamb walls, flat roofs and sloping walls directly adjoining the roof	0.20	200
External doors without glazing (reference size: 1.23 m × 2.18 m)	1.40	-
External doors with glazing (reference size: 1.23 m × 2.18 m)	1.50	-
Gates and hatches to the outside or to rooms that are unheated and glazed external glass walls and windows where there is a 5° C temperature difference or more	1.80	-
Skylight domes	1.40	-
Insulated sections in glazed external walls and windows	0.60	50
Suspended upper floors and walls against freezer rooms	0.15	275
Suspended upper floors and walls against cold stores	0.25	150
Requirements for linear loss for joints between building elements	**Ψ-value** W/m K	
Foundations around spaces that are heated to a minimum of 5° C	0.40	
Joints between external walls, windows, external doors, glazed external walls, gates and hatches	0.06	
Joints between roof construction and roof lights or skylight domes	0.20	

Figure 6

Figure 7

Requirements for windows and glazed doors

BR18 (Building Regulation 2018)	BR20 (Building Regulation 2020)
E_{ref} ≥ -17 kWh/ m^2/year	E_{ref} ≥ 0 kWh/ m^2/year
Energy label B	Energy label A
U ≈ 1.1 W/m^2 K	U ≈ 0.8 W/m^2 K

E_{ref} = 196.4 x g_w - 90.36 x U_w
Reference window 1.23 m x 1.48 m
Energy labels at **www.energivinduer.dk** (Danish)

Requirements for roof lights and glazed roofs

BR18 (Building Regulation 2018)	BR20 (Building Regulation 2020)
E_{ref} ≥ 0 kWh/m^2 /year	E_{ref} ≥ 10 kWh/m^2 /year

E_{ref} = 345 x g_w - 90.36 x U_w
Reference window 1.23 m x 1.48 m
Roof slope 45°

Figure 8

Low Energy Class

There is a volunteer Building Class 2020 in BR18. In addition to the tightened requirements for design transmission loss, which are specified in figure 5, it involves a number of specific requirements. These are described in chapter 25 of BR18 and must be adhered to if you want to classify your building as having been constructed in accordance with the low energy class.

Please note that the 2020 requirements for windows, glazed external walls, skylight domes and glazed roofs will still be mandatory from 2020 even though it is voluntary to use the low energy class.

Percentage of renewable energy

As a new addition, BR18 includes a requirement to use renewable energy in new buildings and in substantial conversions if it is cost-effective (read more on page 14 about cost-effectiveness).

The phrase “substantial conversions and alterations” is in BR18 used only in this context and is defined as renovations that include a considerable percentage of the building envelope and simultaneous replacement of a boiler. The same applies for conversions in a building with electrical heating.

The percentage of renewable energy in the energy supply cannot be included when calculating the energy performance framework.

What can satisfy the requirement for renewable energy?

- Heating by means of district heating, heat pumps and biofuel boilers
- Wind power and solar energy on building owner’s own land

Change of use

Change of use:
When you convert a room for a new purpose with a significantly higher energy consumption – for example an outbuilding or usable roof space being included for dwelling, or a warehouse or stables being converted into offices.

The energy requirements in case of change of use can be satisfied by two methods, as shown in the figure to the right.

Requirements	§ in BR
Energy performance framework as for new buildings	§§ 259-260 + §§ 261-266
& Requirements for design transmission loss	§ 264
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258
OR	
Minimum requirements for the building envelope for change of use	§ 268 + Annex 2, table 2
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

1. Energy framework

The first method is to adhere to the energy performance framework for new buildings in combination with the general minimum requirements for the building envelope in Annex 2 to Chapter 11, Table 1 in BR18. Read about the energy performance framework on page 6 and see the general minimum requirements for the building envelope in figure 6 (similar requirements as for new buildings). When calculating the energy performance framework, the area in m² for the entire building should be used. The energy performance framework is, however, rarely used in cases of change of use. In cases of change of use, there are no requirements for airtightness or percentage of renewable energy.

2. Minimum requirements for the building envelope

The other method is to adhere to the minimum requirements for the building envelope as specified in Annex 2 to Chapter 11, Table 2 in BR18 (see figure 9) in combination with the requirements for windows, glazed doors, roof lights and glazed roofs in § 258 (see figure 8).

Change of use and extensions. Annex 2: Tables for Chapter 11 - Energy consumption, Table 2	**U value** W/m² K	**Approximate insulation thicknesses** mm
External walls and basement walls in contact with the soil	0.15	300
Suspended upper floors and partition walls to adjoining rooms/ spaces where there is a 5° C temperature difference or more	0.40	75
Ground slabs, basement floors in contact with the soil and suspended upper floors above open air or a ventilated crawl space	0.10	300
Ceiling and roof structures, including jamb walls, flat roofs and sloping walls directly adjoining the roof	0.12	300
Doors/gates	1.80	
Hatches to the outside or to rooms where there is a 5° C temperature difference or more (does not apply to ventilation openings of less than 500 cm²)	1.40	
Skylight domes	1.40	
Requirements for linear loss for joints between building elements	**Ψ value** W/m K	
Foundations	0.12	
Joints between external walls, windows, external doors, glazed external walls, gates and hatches	0.03	
Joints between roof construction and roof lights or skylight domes	0.10	

Figure 10

Figure 9

Extensions

Extensions:
When you erect more square metres attached to an existing building. E.g. a new wing, new top storey or a new attic that provides an extra area.

The energy requirements for extensions can be satisfied by three different methods, as shown in the figure to the right.

The first two methods are similar to cases of change of use and are specified on the previous page. When calculating the energy performance framework, the area in m^2 for the entire building should be used. The energy performance framework is, however, rarely used for extensions.

The third method is to employ a heat loss framework. If this method is used, you should stay within a framework that does not make the extension's heat loss bigger than if the minimum requirements for the building envelope described in Table 2, Annex 2 to Chapter 11 (see figure 9) were satisfied.

Furthermore, the minimum requirements for the building envelope for building elements described in Table 1, Annex 2 to Chapter 11 should be adhered to (see figure 6).

What is a heat loss framework?
In combination with adhering to the general minimum requirements for the building envelope, a heat loss framework calculation can be used to ensure that you meet the requirements for extensions added to an existing building and for new holiday homes in designated "summer house" areas as well as extensions to these holiday homes.

The heat loss framework indicates the maximum heat transmission loss allowed. The maximum framework varies from construction to construction as it is calculated based on information on square metres for the extension in question.

The Building Regulations are as such adhered to when the actual heat loss is below the maximum allowed heat loss framework – while also satisfying the requirements for general minimum requirements for the building envelope indicated in Table 1, Annex 2 to Chapter 11 of BR18 (see figure 6).

Requirements	§ in BR
Energy performance framework as for new buildings	§§ 259-260 + §§ 261-266
& Requirements for design transmission loss	§ 264
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258
OR (e.g. max. 22 % windows and doors)	
Minimum requirements for the building envelope for extensions	§ 257 + Annex 2, table 2
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258
OR (e.g. more than 22 % windows and doors)	
Heat loss framework corresponding to the U values and linear losses	§ 272
& General minimum requirements for the building envelope	§ 257 + Annex 2, table 1
& General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs	§ 258

To demonstrate that the actual heat loss is below the heat loss framework, two separate calculations are required:

- Calculation of the heat loss framework
- Calculation of the extension's actual heat loss

These two calculations differ in two manners:

First of all, the U values and linear losses of the actual calculation can vary in relation to the U values and linear losses in Table 2, Annex 2 to Chapter 11 (figure 9); some U values may be higher, some may be lower.

Secondly, in the actual calculation, 50 % of the heat loss that the extension covers of the existing building can be deducted. This does not apply to dwellings in roofs and second storeys.

There is furthermore a requirement that window areas, etc. in the heat loss framework is set to 22 % of the heated storey area in the extension. In the actual building, there may be a larger area of windows, etc. as long as you stay within the heat loss framework overall.

Example

Basis	New extension of 36.0 m² added to existing 1960 single-family house. The extension is on one floor with ground deck and underfloor heating and a 25 ° roof with loft insulation.
Therefore the area of windows and doors in the heat loss framework must be:	22 % of 36 m² = 7.9 m²
The window area is one large window section of 6 metres from floor to ceiling	Length of joint between external wall and window for sides and top: 2 x 7.9/6 = 8.6 m
The extension will cover the following area of the existing building:	External wall 9.8 m² Window section with double-glazed glass 12.6 m² Joints against windows 10.2 m

Figure 11

Heat loss framework	Area/length	U value and linear loss (Ψ value)	Temperature difference	Heat loss
Roof in extension	36.0 m²	0.12 W/m²K	32 K	138 W
Ground deck in extension	30.3 m²	0.10 W/m²K	20 K	61 W
Foundation in extension	17.0 m	0.12 W/mK	42 K	86 W
External wall in extension	39.7 m²	0.15 W/m²K	32 K	191 W
Window section in extension (6 m x 1.32 m)	7.9 m²	1.20 W/m²K	32 K	303 W
Joints against windows	8.6 m	0.03 W/mK	32 K	8 W
Result of heat loss framework				787 W

* Requirements for U values and line loss are given in Table 2 of Annex 2 to Chapter 11 of BR18. For the window part, U value is found in Section 273.

Actual heat loss	Area/length	U value and linear loss (Ψ value)	Temperature difference	Heat loss
Roof in extension	36.0 m²	0.13 W/m²K	32 K	150 W
Ground deck in extension	30.3 m²	0.12 W/m²K	20 K	73 W
Foundation in extension	17.0 m	0.14 W/mK	42 K	100 W
External wall in extension	14.1 m²	0.25 W/m²K	32 K	113 W
Window section in extension	33.5 m²	0.85 W/m²K	32 K	911 W
Joints against windows and external walls	28.5 m	0.05 W/mK	32 K	46 W
External wall in existing building (50 %)	- 4.9 m²	0.4 W/m²K	32 K	- 63 W
Window section in existing building (50 %)	- 6.3 m²	2.7 W/m²K	32 K	- 544 W
Joints against windows (50 %)	- 5.1 m	0.05 W/mK	32 K	- 8 W
Result of actual heat loss				778 W

Figure 12

Conclusion

In the example, the result of calculating the heat loss of the actual building is 778 W. This is lower than the 787 W, which is the result of the heat loss calculation in the example. As such, the example building is within the heat loss framework and adheres to BR18.

Conversions and other alterations

Conversions and other alterations:
When something is rebuilt, renovated or altered in a manner that does not fall under change of use or extension. E.g. new roofing, new roofing membrane or plastering of a facade that has not previously been plastered.

At **www.eksempelsamling.bygningsreglementet.dk** (Danish) you can see more examples of construction projects that require making them more energy efficient.

Requirements	§ in BR
Minimum requirements for the building envelope for conversions and other alterations concerning cost-effective energy improvements (a calculation of cost-effectiveness must be available if requirements are not complied with)	§ 279 + Annex 2, table 3
OR	
Energy performance framework for existing buildings – called "renovation classes"	§§ 280-282

It is mandatory to carry out energy saving measures during conversions and alterations of existing buildings to the level that the investment is cost-effective – and in connection with outright replacements (read about replacements on page 16). Maybe you cannot quite fulfil the requirements of Table 3, Annex 2 to Chapter 11 (see figure 13) – but you must still improve to a possible lower and cost-effective level.

Digging out an existing ground deck can, for example, require a depth that is below the foundation in order to satisfy the U value requirement. This can result in the foundation having to be undercasted at great expense. In such cases, retrofitting of insulation must only be done to a level that it is structurally safe to dig to.

Conversions and other alterations to the building (cost-effectiveness) and replacement of building parts. Annex 2: Tables for Chapter 11 - Energy consumption, Table 3	**U value** W/m² K	**Approximate insulation thicknesses** mm
External walls and basement walls in contact with the soil	0.18	200 (heavy) / 250 (light)
Suspended upper floors and partition walls to adjoining rooms/ spaces where there is a 5° C temperature difference or more	0.40	75
Ground slabs, basement floors in contact with the soil and suspended upper floors above open air or a ventilated crawl space	0.10	300
Ceiling and roof structures, including jamb walls, flat roofs and sloping walls directly adjoining the roof	0.12	300
Doors/gates	1.80	
Hatches, new secondary windows, skylight domes	1.40	
Renovated secondary windows	1.65	
Requirements for linear loss for joints between building elements	**Ψ value** W/m K	
Foundations	0.12	
Joints between external walls, windows, external doors, glazed external walls, gates and hatches	0.03	
Joints between roof construction and roof lights or skylight domes	0.10	

Figure 14

Figure 13

What is cost-effectiveness?
Cost-effectiveness indicates how rewarding an energy-saving measure is. Or in other words: Does the building owner save more money in the long term than was used to invest in the measure?

Cost-effectiveness is calculated like so:
(cf. § 275 in BR18)

$$\frac{\text{Lifetime in years x annual savings in DKK}}{\text{Extra investment}} \geq 1.33$$

If the cost-effectiveness is greater than or equal to 1.33, the investment is considered cost-effective for the building owner. This corresponds to the measure being repaid within ¾ of the expected lifetime.

The investment sum used in the calculation should only include the price of extra labour and materials for the actual energy improvement – e.g. the insulation and any labour resulting thereof. It is often the case that retrofitting of insulation, for example, is more cost-effective when you are already doing other renovation work.

When determining the lifetime, you can use figure 15, which also appears in BR18's guide to energy consumption (Chapter 11), Cost-effective energy savings.

If an investment is cost-effective, you must adhere to the minimum requirements for the building envelope and linear loss that are specified in Table 3, Annex 2 to Chapter 11 (see figure 13).

New installations must meet the requirements of BR18's chapter 19 according to DS 452, Thermal insulation of technical installations (read more on page 18).

Lifetimes that can be used to calculate cost-effectiveness	Years
Retro-fitted insulation to building elements	40
Windows with secondary windows and coupled frames	30
Heating systems, radiators and underfloor heating and ventilation ducts and fittings including insulation	30
Heat appliances, etc., for example boilers, heat pumps, solar heating systems, ventilation units	20
Lighting fittings	15
Automation for heating and climatic control equipment	15
Joint sealing works	10

Figure 15

Useful guide for assessing cost-effectiveness

A guide from the Danish Transport, Construction and Housing Authority about constructions that are often cost-effective demonstrates a range of the typical cost-effective retrofitting measures during conversions and other alterations.

You can find it at **www.bygningsreglementet.dk** (Danish) under Chapter 11, Guides (*Vejledninger*).

Special conditions for buildings with cavities

When evaluating the cost-effectiveness concerning existing building structures with cavities – for example roofs which offer space for further insulation without changes to the structures – it must first be evaluated whether the filling of cavities is profitable. Often it will be, and if this is the case, the cavities must be insulated if it is estimated a safe solution moisture-wise.

Justifiable moisture- and energy-wise

Constructional conditions can mean that the minimum requirements for the building envelope during conversion and other alterations cannot be met in a justifiable manner in relation to cost-effectiveness or moisture. There may, however, be an opportunity to carry out less extensive work that reduces the energy demand. This would then be the work that needs to be done.

An example:
You are to renovate an outer wall. It is a cavity wall with no room for satisfying the U value requirement of figure 13. You will therefore carry out cost-effectiveness calculations on external an internal retrofitted insulation. But neither turns out to be cost-effective. This means that by insulating the cavity wall to the possible level, you have satisfied the energy requirements.

Energy performance frameworks for existing buildings
During larger building renovations, as an alternative to satisfying the U values and linear losses of Table 3, Annex 2 to Chapter 11, you can choose to use the energy performance frameworks for existing buildings – also called renovation classes.

This new method of satisfying the energy requirements during larger conversions and other alterations is voluntary and has been introduced to allow developers greater flexibility.

This means that instead of having requirements for achieving heat savings by re-insulating per building element and with accompanying cost-effectiveness calculations, the energy performance framework gives the freedom to carry out other energy saving measures that in total bring the building's energy demand down to a future-proof level.

Note, however, that when completely replacing a building element – e.g. an entire roof structure including new trusses, etc., or an installation – the requirements of figure 13 must always be met.

To fulfil the renovation classes, an energy performance framework must be satisfied, and the energy demand must be reduced by at least 30 kWh/m² per year. Furthermore, there must be a percentage of renewable energy in the total energy supply to the building. For Renovation Class 1, a number of requirements for a satisfactory indoor climate must also be met.

Practical savings calculator

In order to calculate the expected savings for single-family houses, terraced houses and tower blocks, you can use the savings calculator at **www.ByggeriogEnergi.dk** (Danish)

Energy performance framework for existing buildings			
Dwellings, student accommodations, hotels, etc.			**Energy label**
Renovation class 1	$52.5 + \frac{1{,}650}{\text{heated floor area}}$	kWh/m² per year	A
Renovation class 2	$110 + \frac{3{,}200}{\text{heated floor area}}$	kWh/m² per year	C
Offices, schools, institutions, etc			**Energy label**
Renovation class 1	$71.3 + \frac{1{,}650}{\text{heated floor area}}$	kWh/m² per year	A
Renovation class 2	$135 + \frac{3{,}200}{\text{heated floor area}}$	kWh/m² per year	C

Figure 16

Replacement of building elements and installations

Replacement:
When a building element is removed from the building and replaced with another – without any other alterations to the building. E.g. replacement of a boiler, window or an entire roof structure including new trusses, etc.

Requirements	§ in BR
Minimum requirements for the building envelope for conversions and other alterations – regardless of cost-effectiveness	§ 279 + Annex 2, table 3
&	
General minimum requirements for windows, glazed external walls, skylight domes and glazed roofs skylights and glass roofs – regardless of cost-effectiveness	§ 258

When being replaced, the building element or installation should in all cases be replaced by a more energy efficient component. As such, when replacing a building element or installation, cost-effectiveness is not a factor – but it is generally most cost-effective to get a more modern central heating system or better insulated windows when installations or building elements are being replaced anyway.

The new building elements should meet the minimum requirements for the building envelope specified in BR18's Table 3, Annex 2 to Chapter 11 (figure 13) and requirements for windows, doors etc. specified in § 258 (figure 8).

New installations should satisfy the requirements in BR18's chapter 19 (read more on page 18). This chapter refers to two standards: DS 469, Heating and cooling systems in buildings and DS 452, Thermal insulation of technical installations.

Remember that the ventilation conditions cannot be impaired when replacing for example windows or doors. In many cases, this can be resolved via valves in external walls.

Holiday homes

New holiday homes in designated “summer house” areas are not covered by the same regulations as other new buildings.

Here, there are no requirements for the energy performance framework – only for the U values and linear loss in figure 17.

This is, however, under the provision that the total area of windows and outer doors, including roof lights and skylight domes, glazed outer walls, glazed roofs and hatches leading outside, make up no more than 30 % of the heated floor area.

There is in-built flexibility that allows you to deviate from U values and linear loss if you can substantiate that the design transmission loss does not become bigger than if the values of figure 17 had been adhered to.

If, for example, you want more window area, you should be able to satisfy a heat loss framework. See pages 11 and 12 on heat loss framework.

When holiday homes, camping cottages and similar holiday dwelling are being rebuilt it is mandatory to implement cost-effective energy saving measures.

Minimum requirements for the building envelope for holiday homes, camping cottages and similar holiday dwelling. Annex 2: Tables for Chapter 11 - Energy consumption, Table 4	**U value** W/m² K	**Approximate insulation thicknesses** mm
External walls and basement walls in contact with the soil	0.25	150
Suspended upper floors and partition walls to adjoining rooms/spaces that are unheated	0.40	75
Ground slabs, basement floors in contact with the soil and suspended upper floors above open air or a ventilated crawl space	0.15	200
Ceiling and roof structures, including jamb walls, flat roofs and sloping walls directly adjoining the roof	0.15	250
Windows, external doors, roof lights, glazed external walls, glazed roofs and skylight domes facing the outside or facing unheated rooms/spaces	1.80	
Requirements for linear loss for joints between building elements	**Ψ value** W/m K	
Foundations	0.15	
Joints between external walls, windows, external doors, glazed external walls, gates and hatches	0.03	
Joints between roof construction and roof lights or skylight domes	0.10	

Figure 18

Figure 17

Requirements for installations

Installations must comply with two standards
The specific energy requirements for technical installations are not described directly in the Building Regulations. There is instructional text to BR18 about the thermal indoor climate and installations for heating and cooling systems as well as instructions for ventilation. In addition, BR18 refers to installations to two standards that installations must comply with: DS 469, Heating and cooling systems in buildings and DS 452, Thermal insulation of technical installations.

Applies to both heating and cooling systems
According to BR18, both heating and cooling systems must be implemented in a sound manner energy-wise. Both types of systems should be dimensioned, constructed, controlled, implemented and operated as specified in DS 469, Heating and cooling systems in buildings.

Energy requirements for the systems
DS 452, Thermal Insulation of Technical Installations, must be observed for heating and cooling systems to minimize the heat loss and protect the installations against condensation. Pipes and tanks should as far as possible be placed so that their emission of heat will benefit the building. Ventilation systems with inlet and outlet must meet the requirements for heat recovery in EU Regulation No. 1253/2014. The requirement in the EU Regulation corresponds to 73 per cent temperature efficiency for all heat recovery systems. The only exception is liquid-cooled batteries for which the requirement is 68 per cent.

Limitations for oil boilers
BR18 requires that heating of buildings is based on renewable energy. This means, among other things, that oil boilers are not allowed for use in new buildings.

For existing buildings – that are located in an area with district heating or natural gas – it is not possible to replace an older oil boiler with a new one. It is, however, possible to heat with oil regardless of previous heating type, if the existing building is located in an area without any existing or planned collective heat supply systems.

Always individual control
There is a requirement for individual control of the room temperature in new buildings. This is regulated in BR18 by referring to DS 469, Heating and cooling systems in buildings, which includes this requirement.

Information requirements for developers and installation contractors

As a result of new energy labelling regulation for heating systems, developers and installation contractors now face new information requirements in relation to the building owner when developers and installation contractors sell a heating system of up to and including 70 kW through their companies. These requirements do not appear from the Building Regulations but are described on the Danish Energy Agency's website: https://ens.dk/sites/ens.dk/files/Energimaerke/brochure_saadan_overholder_du_de_nye_informationskrav_naar_du_forhandler_opvarmningsanlaeg.pdf (Danish)

Everything must be insulated
When it comes to installations, BR18 specifies that all parts of a system should be insulated – and that includes e.g. manifolds, shunts and district heating units. Previously it was possible to not insulate certain parts.

Heat recovery must preheat the intake air
For the inflow of outside air that is achieved via a ventilation intake system, BR18 requires heat recovery that preheats the intake air.

Requirements for functional testing of technical installations
BR18 requires that the energy performance and operative system of new technical installations be checked by functional testing. This applies for ventilation systems, heating and cooling systems, lighting systems and lifts. The requirement applies to both new and existing buildings where new building installations or existing ones are being replaced. In existing buildings, the installations must be central and have an impact on energy consumption before the requirement applies.

The functional test must be carried out after the installations have been installed and before they are put into service. It is the responsibility of the building owner that the functional tests are carried out and that the tests are in accordance with the building regulations requirements for the desired performance.

Energy solutions and BR18 tools
to help you on your way

The Danish Knowledge Centre for Energy Savings in Buildings offers free knowledge and tools to help you satisfy the requirements of BR18. Including energy solutions that in a concrete and practical manner describe how to energy renovate building elements and installations, as well as the BR18 tool that helps you determine whether or not your renovation project prompts energy improvement requirements.

www.ByggeriOgEnergi.dk

Useful links

The Building Regulations in English:
http://bygningsreglementet.dk/~/media/Br/BR-English/BR18_Executive_order_on_building_regulations_2018.pdf

The Building Regulations' instructional text on energy consumption:
http://bygningsreglementet.dk/Tekniske-bestemmelser/11/BRV/Energiforbrug (Danish)

The Building Regulations' Annex 2: Tables for Chapter 11 on energy consumption:
http://bygningsreglementet.dk/Bilag/B2/Bilag_2 (Danish)

The Building Regulations' instructional text on the building envelope and installations for heating and cooling systems:
http://bygningsreglementet.dk/Tekniske-bestemmelser/19/Vejledninger/Termisk-indeklima (Danish)

The Building Regulations' instructional text on ventilation:
http://bygningsreglementet.dk/Tekniske-bestemmelser/22/Vejledninger/Generel_vejledning (Danish)

SBi Direction 213, Energy demands of buildings:
www.sbi.dk/miljo-og-energi/energiberegning/anvisning-213-bygningers-energibehov (Danish)

Energy solutions and savings calculator:
www.ByggeriOgEnergi.dk (Danish)

Experience sheets with buildable solutions:
www.Byg-erfa.dk (Danish)

Danish Transport, Construction and Housing Authority's guide on functional testings:
http://bygningsreglementet.dk/Tekniske-bestemmelser/22/Vejledninger/Generel_vejledning/Kap-1_9 (Danish)

Guides on functional testings published by Danish Knowledge Centre for Energy Savings in Buildings:
http://byggeriogenergi.dk/soeg/?q=funktionsafprøvning (Danish)

About the Danish Knowledge Centre for Energy Savings in Buildings

The Danish Knowledge Centre for Energy Savings in Buildings gathers and communicates knowledge about concrete and practical possibilities for reducing the energy consumption of buildings. This is achieved by the Knowledge Centre having a hand in the parties of the construction sector attaining more qualifications and new tools for implementing energy-saving measures in buildings.

The Knowledge Centre as such assists in the total energy savings effort in Denmark.

The Danish Knowledge Centre for Energy Savings in Buildings was established as part of the Danish energy policy agreement from 2008 and carried on in the agreement from 2012 and 2015.

Our logo – the house in bright colours – is inspired by thermographic imaging, which is an excellent tool in mapping the energy loss of buildings.

Danish Knowledge Centre for Energy Savings in Buildings

Gregersensvej 1 • Building 2 • DK-2630 Taastrup • Tel. +45 7220 2255 • info@ByggeriOgEnergi.dk • www.ByggeriOgEnergi.dk

Energistyrelsen
Danish Energy Agency

Produced in collaboration with:
Trafik-, Bygge- og Boligstyrelsen
Danish Transport, Construction and Housing Authority