

# Interreg

EUROPEAN UNION

## Grande Région | Großregion

### PtH4GR<sup>2</sup>ID

Fonds européen de développement régional | Europäischer Fonds für regionale Entwicklung

## Action 15

### Refurbishment Handbook

Part of the project:

Power to Heat for the Greater Region's Renewables Integration and Development -  
PtH4GR<sup>2</sup>ID

Project number : 031-4-09-004

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## Content

The project PtH4GR<sup>2</sup>ID aims (among others) to evaluate the flexibility potential of domestic buildings in the Greater Region (GR). The flexibility of buildings is decisive for a possible load-shifting of the heat generation. In combination with a predictive control system that was developed within the project (see Action 8), it should be analysed how the operation of heat pumps can be shifted to the most economic times.

In Actions 8 and 15, these investigations were carried out based on simulations. Single-family houses (SFH) as well as multi-family houses (MFH) were under consideration. It could be clearly demonstrated that buildings can offer a very promising flexibility, resulting in a potential for load-shifting. The evaluations have been analysed in combination with flexible electricity tariffs that do currently not exist in any country of the GR, but represent a possible development of the market until 2030. The results of the simulations can be seen in the final reports of Actions 8 (SFHs) and 15 (MFHs).

However, the results also clearly demonstrated that buildings need a certain thermal standard in order to feature a usable flexibility. Old buildings without or with very little insulation have a high heat demand that requires the HP to run every few hours. On the other hand, it could be shown that HPs in refurbished or new buildings can avoid consuming electricity during peak hours in most winter days. This can support an electricity grid that is facing increasing challenges due to the rising share of fluctuation renewable energies (REs). Furthermore, consumers can benefit from exploiting cheaper electricity prices in combination with the controller.

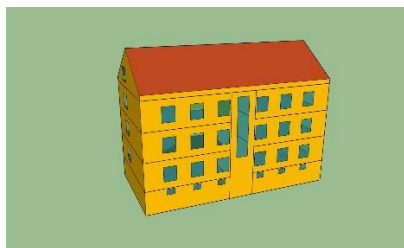
The requirement of well insulated buildings is in line with the targets of the individual countries. To reach the climate targets set by the European Union and its members, it is not only necessary to increase the share of REs but also to decrease the total energy demand in domestic buildings. Accordingly, a growth of the refurbishment rate is necessary in all countries of the GR except of Luxembourg, where the share of new buildings is significantly higher.

To achieve this goal, national funding programs and policy guidelines are necessary. In this report, concrete refurbishment strategies for MFHs are presented for Germany, France and Belgium in the form of a handbook. It contains different profiles for every construction class in the single countries. In Germany, the target values are set by the KfW (Kreditanstalt für Wiederaufbau) and are based on three different standards (KfW85, KfW70, KfW55). In France and Belgium, the values refer to minimum requirements set by policy.

The amount of profiles per country is different. This can be explained by the different amount of construction classes. In Germany, construction classes between A (older than 1859) and L (younger than 2016) exist, so a total of 12. In Belgium, there are only 6 different classes between A (older than 1945) and F (younger than 2012). The oldest classes have not been taken into account. Such old, domestic buildings that have not been refurbished by now, often are listed under monumental protection. This complicates refurbishment as a modification of the external layers is often forbidden and is therefore not taken into account in this report. On the other hand, buildings from the 2000s or younger are also not considered. They already have a good thermal standard and do not indicate an urgent need for refurbishment.

The presented buildings are reference buildings, details can be found in the report of Action 15. The presented heating demand is merely an estimation and is based on a method of calculation from the German standard DIN 4108. In general, refurbishment strategies always have to be adapted to the specific building. This report aims to give an overview of possible strategies and their influence on the heating demand of the whole building. The roof, the external walls and the windows have been taken into account for possible renovations.

## Refurbishment profile



**Multi-Family House,  
Germany**  
**construction class C**  
**1912-1948**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	full brickwork	1,81
Roof	pitched roof with wooden rafters	2,02
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

211,22 kWh/m<sup>2</sup>

**Refurbishment concept:**

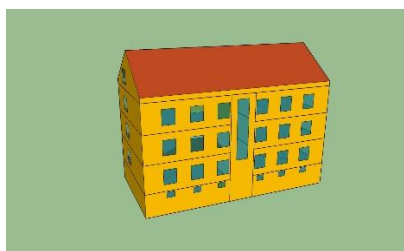
**KfW85**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,39
Roof	Insulation between rafters, 14cm	0,32
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

69,85 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class C**  
**1919-1948**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	full brickwork	1,81
Roof	pitched roof with wooden rafters	2,02
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

211,22 kWh/m<sup>2</sup>

**Refurbishment concept:**

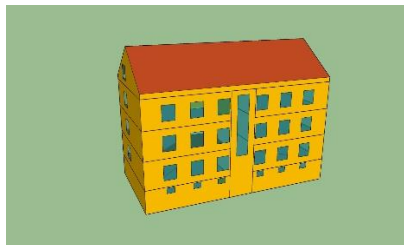
**KfW70**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,39
Roof	Insulation between rafters, 14cm Above-rafter insulation, 14cm	0,22
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

67,11 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class C**  
**1919-1948**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	full brickwork	1,81
Roof	pitched roof with wooden rafters	2,02
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

211,22 kWh/m<sup>2</sup>

**Refurbishment concept:**

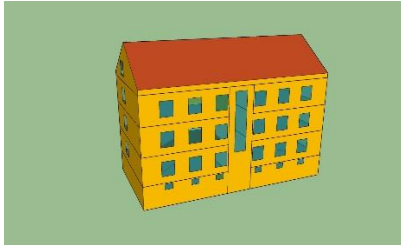
**KfW55**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 18cm	0,27
Roof	Insulation between rafters, 14cm Above-rafter insulation, 14cm	0,22
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

61,06 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class D**  
**1949-1957**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	cavity wall	1,98
Roof	pitched roof with wooden rafters	2,01
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

161,68 kWh/m<sup>2</sup>

**Refurbishment concept:**

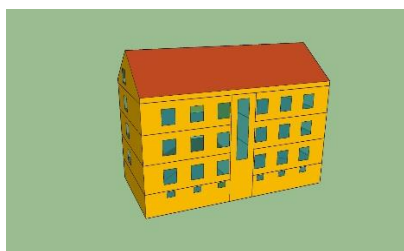
**KfW85**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,4
Roof	Insulation between rafters, 14cm	0,32
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

67,63 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class D**  
**1949-1957**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	cavity wall	1,98
Roof	pitched roof with wooden rafters	2,01
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

161,68 kWh/m<sup>2</sup>

**Refurbishment concept:**

**KfW70**

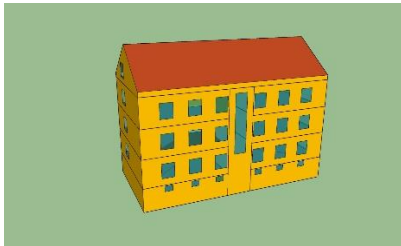
Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,4
Roof	Insulation between rafters, 14cm Above-rafter insulation, 14cm	0,22
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

64,96 kWh/m<sup>2</sup>



## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class D**  
**1949-1957**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	cavity wall	1,98
Roof	pitched roof with wooden rafters	2,01
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

161,68 kWh/m<sup>2</sup>

**Refurbishment concept:**

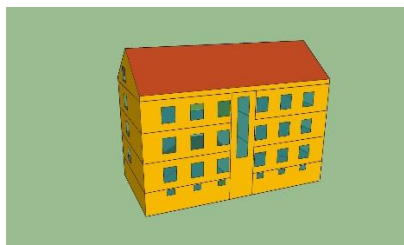
**KfW55**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 18cm	0,28
Roof	Insulation between rafters, 14cm Above-rafter insulation, 14cm	0,22
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

58,92 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class E**  
**1958-1968**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Hollow block masonry	1,31
Roof	pitched roof with 5cm insulation	0,97
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

127,18 kWh/m<sup>2</sup>

**Refurbishment concept:**

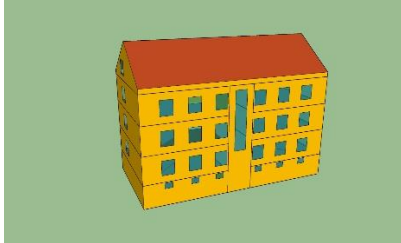
**KfW85**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,37
Roof	Insulation between rafters, 14cm	0,29
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

65,49 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class E**  
**1958-1968**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Hollow block masonry	1,31
Roof	pitched roof with 5cm insulation	0,97
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

127,18 kWh/m<sup>2</sup>

**Refurbishment concept:**

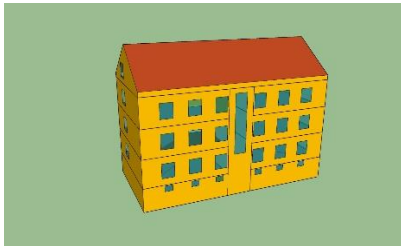
**KfW70**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,37
Roof	Insulation between rafters, 14cm	0,24
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

64,09 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class E**  
**1958-1968**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Hollow block masonry	1,31
Roof	pitched roof with 5cm insulation	0,97
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

127,18 kWh/m<sup>2</sup>

**Refurbishment concept:**

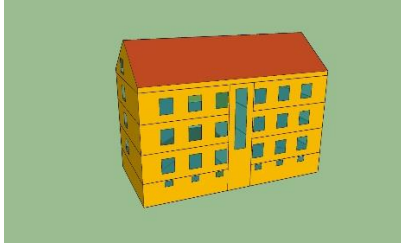
**KfW55**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 18cm	0,29
Roof	Insulation between rafters, 14cm Above-rafter insulation, 14cm	0,21
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

58,94 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**

**Construction class F**

**1969-1978**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Masonry	1,1
Roof	Flat roof with 7cm insulation	0,61
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

117,16 kWh/m<sup>2</sup>

**Refurbishment concept:**

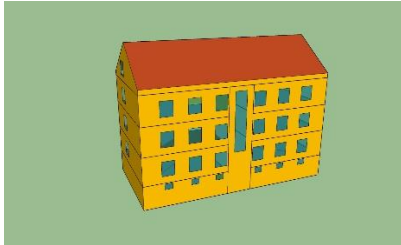
**KfW70**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,36
Roof	Insulation between rafters, 14cm	0,27
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

64,53 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-family House,  
Germany**  
**Construction class F**  
**1969-1978**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Masonry	1,1
Roof	Flat roof with 6cm insulation	0,61
Window	Wooden window, double-glazed insulation	2,80

**Heating demand before refurbishment:**

117,16 kWh/m<sup>2</sup>

**Refurbishment concept:**

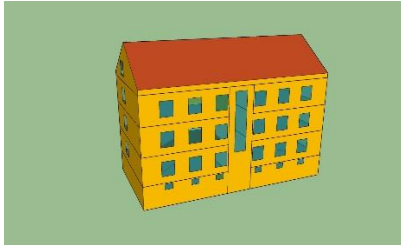
**KfW55**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 18cm	0,28
Roof	Insulation between rafters, 14cm	0,21
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

59,06 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class G**  
**1979-1983**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Masonry with light perforated brick / light mortar	0,9
Roof	pitched roof with 8cm insulation	0,64
Window	Metall frame window, double-glazed insulation	4,30

**Heating demand before refurbishment:**

121,88 kWh/m<sup>2</sup>

**Refurbishment concept:**

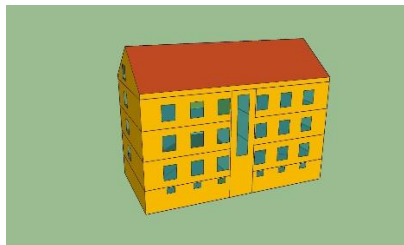
**KfW70**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,34
Roof	Insulation between rafters, 14cm	0,27
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

63,53 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class G**  
**1979-1983**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Masonry with light perforated brick / light mortar	0,9
Roof	pitched roof with 8cm insulation	0,64
Window	Metall frame window, double-glazed insulation	4,30

**Heating demand before refurbishment:**

121,88 kWh/m<sup>2</sup>

**Refurbishment concept:**

**KfW55**

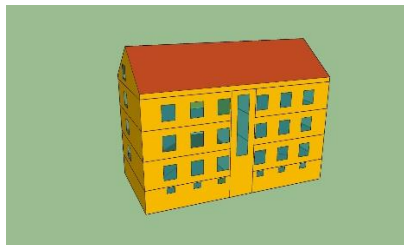
Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 14cm	0,29
Roof	Insulation between rafters, 14cm Above-rafter insulation, 14cm	0,2
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

59,07 kWh/m<sup>2</sup>



## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class H**  
**1984-1994**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Masonry with aerated concrete block	0,6
Roof	pitched roof with 12cm insulation	0,52
Window	Aluminum windows with thermal break, double-glazed insulation	3,20

**Heating demand before refurbishment:**

95,51 kWh/m<sup>2</sup>

**Refurbishment concept:**

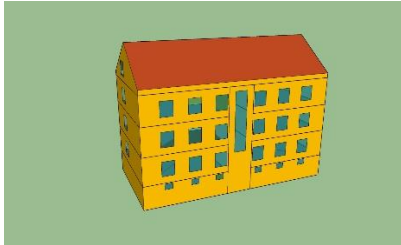
**KfW70**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,31
Roof	Insulation between rafters, 14cm	0,26
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

61,22 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class H**  
**1984-1994**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Masonry with aerated concrete block	0,6
Roof	pitched roof with 12cm insulation	0,52
Window	Aluminum windows with thermal break, double-glazed insulation	3,20

**Heating demand before refurbishment:**

95,51 kWh/m<sup>2</sup>

**Refurbishment concept:**

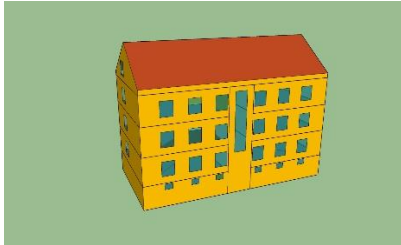
**KfW55**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 12cm	0,28
Roof	Insulation between rafters, 14cm Above-rafter insulation, 10cm	0,21
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

58,87 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**  
**Construction class I**  
**1995-2001**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Bivalve masonry with 10cm insulation	1,36
Roof	pitched roof with 14cm insulation	0,46
Window	Aluminum windows with thermal break, double-glazed insulation	1,90

**Heating demand before refurbishment:**

71,02 kWh/m<sup>2</sup>

**Refurbishment concept:**

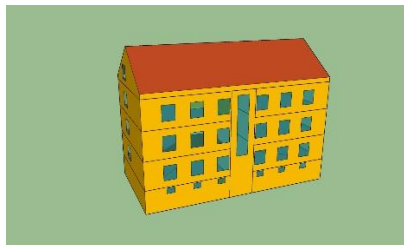
**KfW70**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,37
Roof	no measures	0,46
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

63,61 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Germany**

**Construction class I**

**1995-2001**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Bivalve masonry with 10cm insulation	1,36
Roof	pitched roof with 14cm insulation	0,46
Window	Aluminum windows with thermal break, double-glazed insulation	1,90

**Heating demand before refurbishment:**

71,02 kWh/m<sup>2</sup>

**Refurbishment concept:**

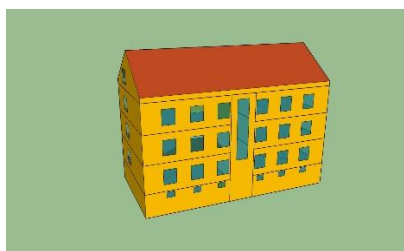
**KfW55**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,37
Roof	Insulation between rafters, 14cm	0,25
Window	Windows, triple-glazed, thermal insulation	0,7

**Heating demand after refurbishment:**

58,15 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
France**  
**Construction class C**  
**1949-1967**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Brick wall	1,95
Roof	pitched roof with wooden rafters	1,48
Window	Wooden windows, double-glazed insulation	2,80

Heating demand before refurbishment:

204,01 kWh/m<sup>2</sup>

**Refurbishment concept:**

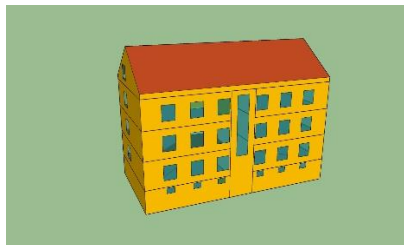
**Minimum Requirements**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,39
Roof	Insulation between rafters, 14cm	0,32
Window	Windows, double-glazed, insulating glazing	1,4

Heating demand after refurbishment:

77,47 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
France**  
**Construction class D**  
**1968-1974**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Cavity block wall	2,49
Roof	Gabled roof with wooden rafters	1,08
Window	Wooden windows, double-glazed insulation	2,80

**Heating demand before refurbishment:**

215,41 kWh/m<sup>2</sup>

**Refurbishment concept:**

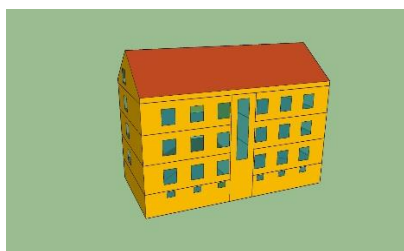
**Minimum Requirements**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,41
Roof	Insulation between rafters, 14cm	0,30
Window	Windows, double-glazed, insulating glazing	1,4

**Heating demand after refurbishment:**

77,46 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
France**

**Construction class E**

**1975-1981**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Cavity block wall with 4cm Insulation	0,71
Roof	Gabled roof with wooden rafters and 4cm Insulation	0,89
Window	Wooden windows, double-glazed insulation	2,80

**Heating demand before refurbishment:**

119,40 kWh/m<sup>2</sup>

**Refurbishment concept:**

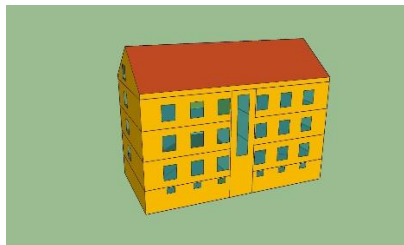
**Minimum Requirements**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,39
Roof	Insulation between rafters, 14cm	0,29
Window	Windows, double-glazed, insulating glazing	1,4

**Heating demand after refurbishment:**

73,30 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
France**  
**Construction class F**  
**1982-1989**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Cavity block wall with 8cm Insulation	0,52
Roof	Gabled roof with wooden rafters and 2cm Insulation	1,17
Window	Wooden windows, double-glazed insulation	2,80

**Heating demand before refurbishment:**

117,98 kWh/m<sup>2</sup>

**Refurbishment concept:**

**Minimum Requirements**

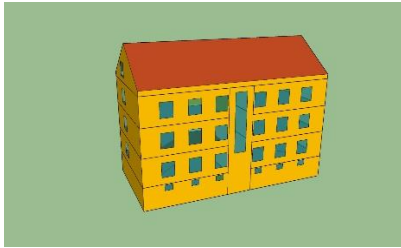
Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 10cm	0,41
Roof	Insulation between rafters, 14cm	0,32
Window	Windows, double-glazed, insulating glazing	1,4

**Heating demand after refurbishment:**

78,28 kWh/m<sup>2</sup>



## Refurbishment profile



**Multi-Family House,  
France**  
**Construction class G**  
**1990-1999**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Concrete wall with 8cm Insulation	0,48
Roof	Wooden roof with 14cm Insulation	0,33
Window	Metal frame window, double-glazed insulation	4,30

**Heating demand before refurbishment:**

109,25 kWh/m<sup>2</sup>

### Refurbishment concept:

### Minimum Requirements

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	No measures	0,48
Roof	No measures	0,33
Window	Windows, double-glazed, insulating glazing	1,4

**Heating demand after refurbishment:**

79,25 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Belgium**  
**Construction class B**  
**1946-1970**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Double-shell solid brick wall	1,69
Roof	Tile roof	2,12
Window	Single glazed wooden windows	5,00

Heating demand before refurbishment:

217,84 kWh/m<sup>2</sup>

### Refurbishment concept:

### Minimum Requirements

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 16cm	0,30
Roof	Insulation between rafters, 14cm Above-rafter insulation, 6cm	0,26
Window	Windows, double-glazed, insulating glazing	1,4

Heating demand after refurbishment:

82,72 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Belgium**  
**Construction class C**  
**1971-1990**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Double-shell solid brick wall	1,35
Roof	Tile roof, 4cm Insulation	1,13
Window	Metal frame window, double-glazed insulation	3,50

**Heating demand before refurbishment:**

167,05 kWh/m<sup>2</sup>

**Refurbishment concept:**

**Minimum Requirements**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 16cm	0,30
Roof	Insulation between rafters, 14cm	0,30
Window	Windows, double-glazed, insulating glazing	1,4

**Heating demand after refurbishment:**

83,15 kWh/m<sup>2</sup>

## Refurbishment profile



**Multi-Family House,  
Belgium**  
**Construction class D**  
**1991-2005**

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	Double-shell solid brick wall with 6cm Insulation	0,70
Roof	Tile roof, 8cm Insulation	0,76
Window	Metal frame window, double-glazed insulation	3,50

**Heating demand before refurbishment:**

121,87 kWh/m<sup>2</sup>

### Refurbishment concept:

### Minimum Requirements

Building component	Construction	U-value [W/(m <sup>2</sup> K)]
External walls	External thermal insulation composite system, 12cm	0,30
Roof	Insulation between rafters, 14cm	0,28
Window	Windows, double-glazed, insulating glazing	1,4

**Heating demand after refurbishment:**

80,20 kWh/m<sup>2</sup>