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Environmental Improvement Potentials of Residential Buildings (IMPRO-Building)

Françoise Nemry, Andreas Uihlein (IPTS - JRC)

Cecilia Makishi Colodel, Bastian Wittstock, Anna Braune
(Lehrstuhl für Bauphysik LBP, Universität Stuttgart)
Christian Wetzel, Ivana Hasan, Sigrid Niemeier, Yosrea Frech
(CalCon Holding GmbH)
Johannes Kreißig, Nicole Gallon (PE INTERNATIONAL GmbH)

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European Commission
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Contact information
Address: Edificio Expo. c/ Inca Garcilaso, s/n. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

http://ipts.jrc.ec.europa.eu
http://www.jrc.ec.europa.eu

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Preface

This report on “Environmental improvement potential of residential buildings” is a scientific contribution of the JRC to the European Commission’s Integrated Product Policy framework which seeks to minimise the environmental degradation caused the life cycle of products. A previous study coordinated by the JRC (EIPRO study) had shown that building occupancy and structure all together make up 20 to 35% of the impacts of all products for most impact categories.

This report presents a systematic overview of the environmental life cycle impacts of residential buildings in EU-25. It also provides an analysis of the technical improvement options that could be help reducing these environmental impacts, with a special focus to their main source, namely energy use for space heating. The report assesses the environmental benefits and the costs associated with these improvement options.

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Nomenclature

Abbreviations

AP	Acidification Potential
BAT	Best Available Technique
EOL	End-of-Life
EP	Eutrophication Potential
EPBD	Energy Performance of Buildings Directive
EPD	Environmental Product Declaration
EPS	Expanded Polystyrene
ETICS	Exterior Thermal Insulation Composite System
EuP	Energy using Products Directive
GWP	Global Warming Potential
HDD	Heating Degree Days
HVAC	Heating, Ventilating, and Air Conditioning
IPP	Integrated Product Policy
IRR	Internal Rate of Return
ISO	International Organization for Standardization
IPTS	Institute for Prospective Technological Studies
JRC	Joint Research Centre
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
NPV	Net Present Value
ODP	Ozone Layer Depletion Potential
OSB	Oriented Strand Board
POCP	Photochemical Ozone Creation Potential
PUR	Polyurethane
PVC	Polyvinyl chloride
XPS	Extruded Polystyrene

Nomenclature of denotation of building types

Z1	Geographical zone 1 (south European countries)
Z2	Geographical zone 2 (middle European countries)
Z3	Geographical zone 3 (north European countries)
SI	Single-, two-family and terrace house types
MF	Multi-family house types
HR	High-rise building types
_ex	“existing” version of building type, where “new” building type also exists

Executive summary

Introduction

In June 2003, the European Commission adopted the Communication on Integrated Product Policy (IPP) [COM(2003) 302 FINAL] with the aim of reducing the environmental impacts from products and services throughout their life cycle. In this context, the EIPRO study was carried out and was concluded in May 2006 [EIPRO 2006]. The study showed that products from only three areas of consumption – food and drink, private transportation, and housing – are responsible for 70-80% of environmental impacts of private consumption and account for some 60% of consumption expenditure altogether.

The conclusions of the EIPRO study thus suggested initiating a more in-depth analysis of these three groups of products. To this end, three parallel projects were launched and coordinated by the IPTS in order to analyse the environmental IMprovement of PROducts (IMPRO, respectively IMPRO-Car, IMPRO-Meat, and IMPRO-Building projects).

This report, which presents the IMPRO-Building project results, is based on a research carried out by the JRC (IPTS) and supported by a study conducted by Lehrstuhl für Bauphysik LBP, CalCon Holding GmbH, and PE International GmbH.

Objectives and general approach

The overall goal of the IMPRO-Building project was the analysis of the environmental improvement potentials of residential buildings, including all relevant types of buildings used as household dwellings, from single-family houses to multi-apartment buildings, including existing and new dwellings in the EU-25. This has been achieved through:

- the estimation and the comparison of the life cycle environmental impacts of residential buildings
- the identification of the main environmental improvement options and their analysis in terms of their environmental benefits and of their costs.

The environmental impacts were analysed both for building structures and building occupancy. As concerns the improvement options, only those affecting the building structure and design[1] changes were considered.

The research was structured along three steps:

1. Define an appropriate building stock typology and provide its characterization regarding several aspects (e.g. population and residential area, building type, age, structure) and define building models that are the most "representative" buildings for the EU-25.
2. Analyse the life cycle impacts of the different building models and identify the environmental hotspots.
3. Identify the improvement options and analyse their environmental effects and their costs.

[1] This term indicates the general and common layout of residential buildings with common building elements.

Overview of residential buildings in the EU-25

The first step was primarily based on existing data and information taken from previous EU-funded projects and expertise in various EU countries regarding the most relevant aspects of buildings (e.g. structure, age, energy efficiency). The approach used to derive a list of relevant building models was guided by the need to reach sufficient representativeness of the building stock at EU-25 level while also keeping a reasonable level of study feasibility.

In order to ensure a sufficient level of representativeness, several criteria were considered, including population, total construction area per building type, common building structures, and weather conditions. The available country specific data on buildings and dwellings, including the segmentation into building types and age have been thoroughly reviewed.

This led to building models distributed into three building types: single-family houses (including two-family houses and terraced houses), multi-family houses, and high-rise buildings. These three building types represent 53%, 37% and 10% respectively of the existing EU-25 building stock. The buildings were also defined in such a way as to be distributed into three main zones in Europe that roughly represent three climate zones according to heating degree days (HDD).

The 72 selected building models (53 existing buildings and 19 new building types), were assessed to be representative of about 80% of the residential building stock in the EU-25. They were described in terms of their building stock representativity, geographical distribution, size, age, design, residual lifespan, and thermal insulation. The description also covered the material composition of the different building elements (roofs, external and interior walls, basement/foundation, floors, windows/doors).

Table A Number of buildings types in each zone

Climatic zones	Single-family house	Multi-family house	High-rise building
Zone 1: South Europe *564 to 2500 HDD*	11 (3)[a]	11 (3)	3 (1)
Zone 2: Middle Europe *2501 to 4000 HDD*	11 (3)	11 (3)	3 (1)
Zone 3: North Europe *4000 to 5823 HDD*	9 (2)	10 (2)	3 (1)

a) Numbers in bracket indicate new building types

Life cycle environmental impacts

The process chain approach was implemented in order to quantify the life cycle impacts of the different building models. The functional unit of the LCA is the use of 1 m² of the building's living area over a 1 year period.

The general system boundary was set similar for all new building types, including respectively the production and transport of building materials, the building refurbishment, building space heating, and cooling and waste management (demolition and refurbishment).

Regarding buildings, the life cycle phase "production and transport of building materials" was disregarded as it had occurred and cannot therefore be subjected to any improvement.

The considered environmental impact categories were selected based on scientific robustness, relevance and practicability. These are acidification, eutrophication, climate change, ozone layer depletion, and photochemical pollution. The primary energy consumption was also quantified.

For each impact category, the corresponding cumulated substance flows were quantified and aggregated to the so-called "mid-point" indicators (e.g. carbon dioxide, methane, N_2O and other greenhouse gas emissions were aggregated into CO_2 equivalent emissions in accordance with the respective global warming potentials).

For each existing building, a residual service lifespan was estimated by expert judgement, and limited to a maximum of 40 years. For new building types, this limit was also applied in order to take into account the uncertainties inherent to the long term and to keep the time horizon consistent with what policy measures can cover.

The background datasets were taken from two main sources of data:

- the GaBi 4 database [LBP & PE 2007] provided data on the construction, refurbishment and waste treatment processes
- the software programme epiqr® was used to calculate the energy demand for space heating, applying a calculation method based on the European standard EN 832.

A first finding from the life cycle assessment as implemented to the different building models is the similarity of trends shown over the different impact categories when the different building types according to zones are compared. This reflects the important role of energy use in most of the environmental impacts quantified, first as a result of fuel combustion for space heating, and, second, as a result of the industry processes involved in the manufacturing of building products. Consequently, both primary energy use and greenhouse gas (GHG) emissions are good proxy indicators to assess the environmental performance of the buildings.

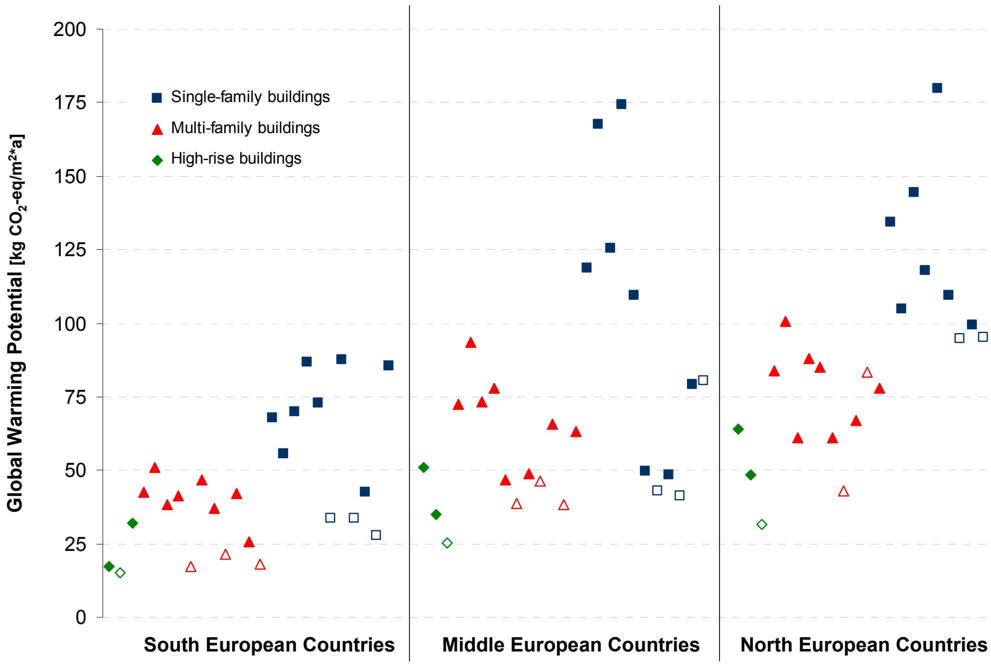


Figure A Life cycle impacts of all building types for the environmental impact category “Global Warming Potential”
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

The results also show that new buildings, as currently erected, generally show better environmental performance when compared to existing ones. This is due to the better energy performances achieved as long as the best available practices are applied, especially in terms of building insulation.

Weather conditions obviously entail higher space heating demands, which results in higher energy demands for buildings in northern regions. However, when normalised to similar weather conditions (based on heating degree days), buildings in these zones tend to have the best energy performances. The effect of the buildings geometry was also reflected in the general trend of higher energy demand in single-family houses when compared to the others. Cooling demand was estimated to be currently negligible in the total buildings energy demand.

The use phase of buildings, as dominated by the energy demand for heating is by far the highest for all buildings. For new buildings, the construction phase is also significant and its relative importance varies from one impact category to the other. The end-of-life phase is of much lower importance.

Regarding the use phase, the associated environmental impacts were broken down into the different building elements based on the respective heat losses. This showed that heat losses resulting from ventilation and infiltration have a significant importance for all buildings. This also holds true for external walls, particularly for high-rise buildings. Heat losses through roofs are important for a majority of single-family and multi-family houses. Windows were suggested to be of lower importance. This is partly because the retrofitting of windows was assumed to be part of autonomous improvement, which may, to some extent, provide a too optimistic picture. In general, the variations observed from one building type to another are explained by the geometry and current insulation levels of the buildings.

The use phase was also shown to be most important for new buildings with, however, a lower relative importance as a result of the better energy performance of these buildings. Regarding the new building construction phase, the impacts primarily stem from the construction of the exterior walls, the basement, and floors/ceilings. Interior walls, roof and windows only play a minor role.

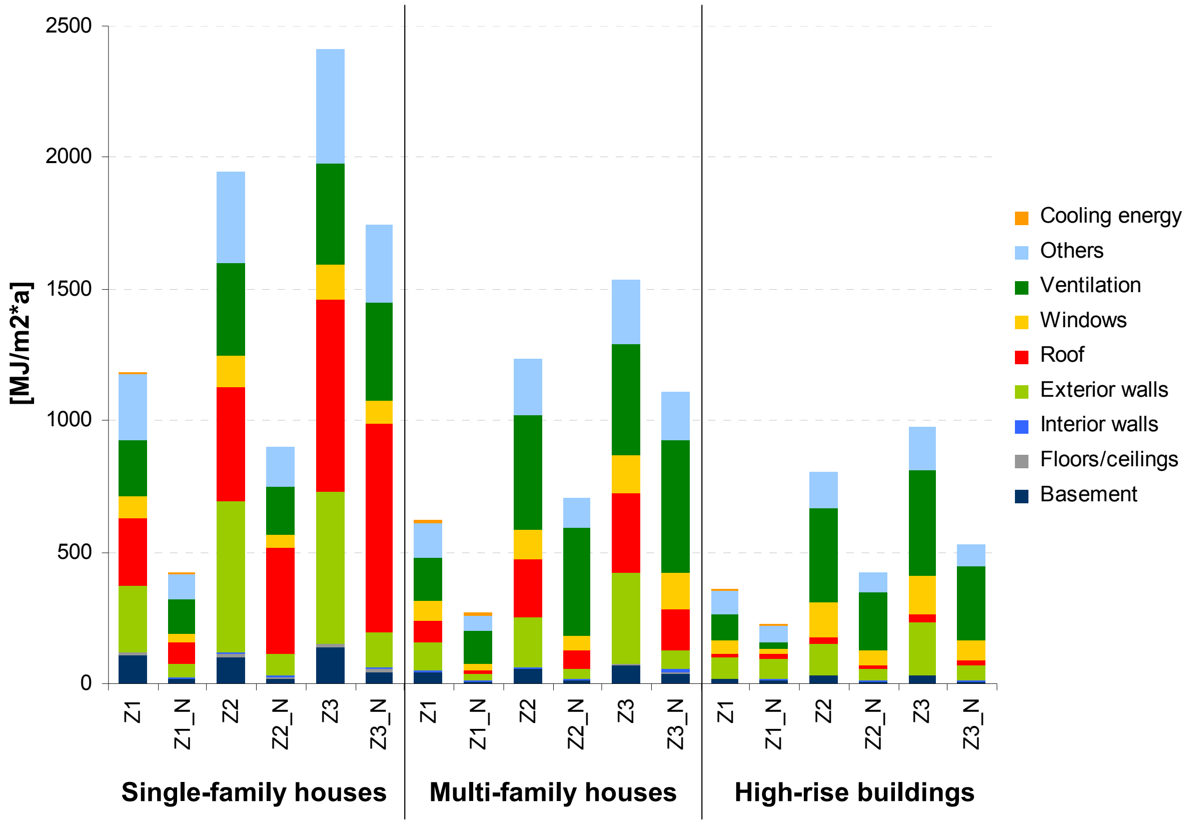


Figure B **Contribution of the individual construction elements to the environmental impacts of the Use Phase (total Primary Energy) according to zone and building group (weighted average) _N denotes new buildings**

Improvement options

Improvement options for relevant building types were identified, focusing on the environmental hotspots (use phase and construction phase). These were analysed against the initially defined base cases.

For **new building types**, the quantification of environmental benefits was limited to the options that primarily reduce the impacts from the construction phase, which is feasible by changing the material composition of buildings.

The results showed that, amongst the alternatives considered, significant environmental improvements can be expected only when the substitution leads to the use of wood products instead of more "conventional" products (concrete, reinforced concrete, bricks).

Besides these construction alternatives, improvement measures should also be considered with a view to reduce future GHG emissions from the building stock. This includes the new concepts of passive housing and so-called "zero CO_2 emissions buildings" for which the space heating demand is in a range 10 to 20 kWh/m^2*a . Their analysis was, however, beyond the scope of this IMPRO-Building project.

For **existing buildings**, consistently with the dominant role of the use phase, the measures address this life cycle part, and particularly space heating, covering "additional roof insulation", "additional façade insulation" and "new sealings to reduce ventilation" whenever the corresponding building element was shown to be an environmental hotspot.

The three measures considered were shown to yield a significant environmental improvement potential, which, for a majority of the buildings types analysed, represented at least 20% greenhouse gas emissions compared to the respective base case. When rescaled to the EU-25 level, the resulting improvement potentials, when measured in terms of CO_2 emissions reduction are high.

For each measure, the highest improvement potentials from the European perspective were derived for zone 2. This is partly due to the larger building stock in use and to the colder climate conditions. The major improvement potentials lie with single-, two-family and terraced houses, followed by multi-family buildings. Despite important percentage reductions potentials for high-rise buildings, smaller emissions reductions are expected in absolute terms due to the smaller share of these buildings in the overall building stock.

When combining and totalling the building types included in the analysis and relevant retrofit measures, the derived total life cycle emission reduction potential reaches 360 Mt CO_2-eq/a. This corresponded to about 7% of the total direct greenhouse gas emissions in the EU-25 in 2005 (without land use, land use change and forestry) [EEA 2007]. This high estimated emissions reduction potential can be achieved provided that all barriers (e.g. social, economic) are overcome. The initial investment costs may represent one of these barriers. These life cycle costs of the retrofit measures were analysed through the calculated internal return rates and the net present values associated with these retrofit measures.

Table B Summary of environmental improvement potential and abatement costs

Improvement measure	Building group	Zone	Abatement cost Euro/t CO_2-eq.	Total improvement potential Mt CO_2-eq./a
Additional roof insulation	Single-family houses	Zone 1	-89.84	47.67
		Zone 2	-92.64	83.50
Additional façade insulation	Single-family houses	Zone 1	54.51	29.46
		Zone 2	-18.56	64.21
	Multi-family houses	Zone 1	12.35	8.67
		Zone 2	na	na
	High-rise buildings	Zone 1	-55.69	6.81
		Zone 2	na	na
New sealings to reduce ventilation	Single-family houses	Zone 1	-60.35	29.71
		Zone 2	na	na
	Multi-family houses	Zone 1	-64.78	14.48
		Zone 2	-52.80	82.39
	High-rise buildings	Zone 1	-53.92	6.39
		Zone 2	-54.85	6.06

For both roof insulation and reduced ventilation, the measures were shown to be economically profitable (positive net present value and a high internal rate of return) for a majority of buildings. For external wall insulation, the economic profitability is less systematic as, in some cases, the subsequent fuel costs savings do not compensate the higher initial investments. Compared to the two other measures, the application of new sealings in order to reduce ventilation bears smaller improvement potentials but has a higher economic profitability as a result of very low initial investments. It should also be noted that the economically profitability only holds true if the energy savings are granted to the investor.

It was also shown that most of the improvement options are economically viable with costs being smaller than the benefit from energy savings. In total, 80% of the total GHG reduction potential in zone 1 and 95% of the potential in zone 2 can be reached at negative CO_2 abatement costs.

These results provide elements to guide policy making aimed to support the implementation of these measures with instruments such as subsidies, consumer awareness. However the decision on which measures to take for an individual building should be based on a prior assessment which takes into account the individual situation of the building.

Conclusion

Summarizing, it can be stated that the current situation of the European residential buildings stock in terms of environmental performance is far from the currently discussed low-energy standards and there lies a tremendous potential for improvements. If the measures examined are carried out on the buildings considered, the emissions of greenhouse gases from these buildings may be cut by around 30% to 50% over the next 40 years. Therefore, active promotion and strong actions from all stakeholders have to be undertaken in order to seize this environmental opportunity. The information this study provides the basis for discussions on measures and steps that can taken in that direction.

1 Introduction

1.1 Background

In June 2003, the European Commission adopted the Communication on Integrated Product Policy (IPP) [COM(2003) 302 FINAL] with the aim of reducing the environmental impacts from products and services throughout their life-cycle. In this context, the EIPRO study was carried out and was concluded in May 2006 [EIPRO 2006]. The study showed that products from only three areas of consumption – food and drink, private transportation, and housing – together are responsible for 70-80% of environmental impacts of private consumption. These products also account for some 60% of consumption expenditure altogether.

Buildings and construction products have a significant socio-economic relevance. The activities in the building and construction sector have high initial and follow-up expenditures, long life-cycles and require a large amount of materials and energy.

These are already subject to several activities in policy areas and in research. The Energy Performance of Buildings Directive [EPBD] is now being implemented and is beginning to show effects in the construction sector. The Energy using Products Directive [EUP DIRECTIVE] also provides the legal framework for improving the eco-design of energy-related building elements, including e.g. heating and cooling systems used in buildings. It should also be noted that the manufacturers of building materials are increasingly providing life cycle based environmental information on their products as, e.g. environmental product declaration (EPD).

Following the conclusions from the EIPRO study, the project 'Environmental Improvement Potentials of Buildings (IMPRO-Building)' was launched by the JRC (IPTS, Seville), with a view to analyse the life cycle impacts of residential building in the EU-25 and to assess the potentials to improve their environmental performance. The project was supported by a study conducted by Lehrstuhl für Bauphysik LBP, CalCon Holding GmbH, and PE International GmbH.

This report presents the approach followed throughout the IMPRO-Building project, its results and the conclusions drawn.

1.2 Objectives and scope of the IMPRO-Building project

The overall goal of the IMPRO-Building project is the analysis of the environmental improvement potentials of residential buildings. This has been achieved through:

- the estimation and comparison of the environmental life cycle impacts of buildings used as household dwellings
- the identification of the main environmental improvement options related to buildings addressing the different life cycle stages and estimation of the size of the environmental improvement potentials
- the assessment of the feasibility as well as the socio-economic impacts of the identified improvement options.

The overall scope of the work involved the environmental impact of the relevant types of buildings used as household dwellings, from single-family houses to multi-apartment buildings, including existing and new dwellings in the EU-25.

Environmental impacts were analysed both for building structures and building occupancy. Regarding the improvement options, only those affecting the building structure and design[2] changes were considered. Improvement options entailing changes in the heating and cooling system are disregarded[3].

For the analysis, a life-cycle approach was applied and all the relevant environmental impact categories for the selected structures were taken into account.

1.3 Report structure

Chapter 2 provides the methodology adopted in the project. An overview of the general approach is first given, followed by a more detailed description of the method used for assessing the environmental impacts of the buildings.

A general overview of the residential buildings in the EU-25 is given in Chapter 3. This explains how the building types modelled in the project were defined and grouped according to zones, size and age in order to identify the main typical and relevant building types.

Chapter 4 contains all relevant information on the life cycle assessment methodology. Based on the environmental impact assessment, the life cycle assessment results are described and discussed in Chapter 5. The environmental hotspots are also identified.

Chapter 6 includes the identification and the description of the improvement options to increase the environmental performance of both existing and new buildings. In Chapter 7, the improvement potentials for the identified measures on a building level and on European level are calculated. The cost efficiency of the improvement options is assessed.

Conclusions for the project are drawn in Chapter 8.

[2] This term indicates the general and common layout of residential buildings with common building elements.

[3] This choice was made to avoid overlapping with studies that were undertaken during the course of the IMPRO-Building project in the framework of the EuP Directive [EuP Directive].

2 General approach for the IMPRO-Building project

The research has been structured along the following steps (see Figure 2.1):

I General overview of residential buildings in the EU-25, definition of the appropriate geographical resolution and selection of representative building types.

II Detailed analysis of the life cycle impacts of the selected building types.

III Identification and analysis of the main environmental improvement options.

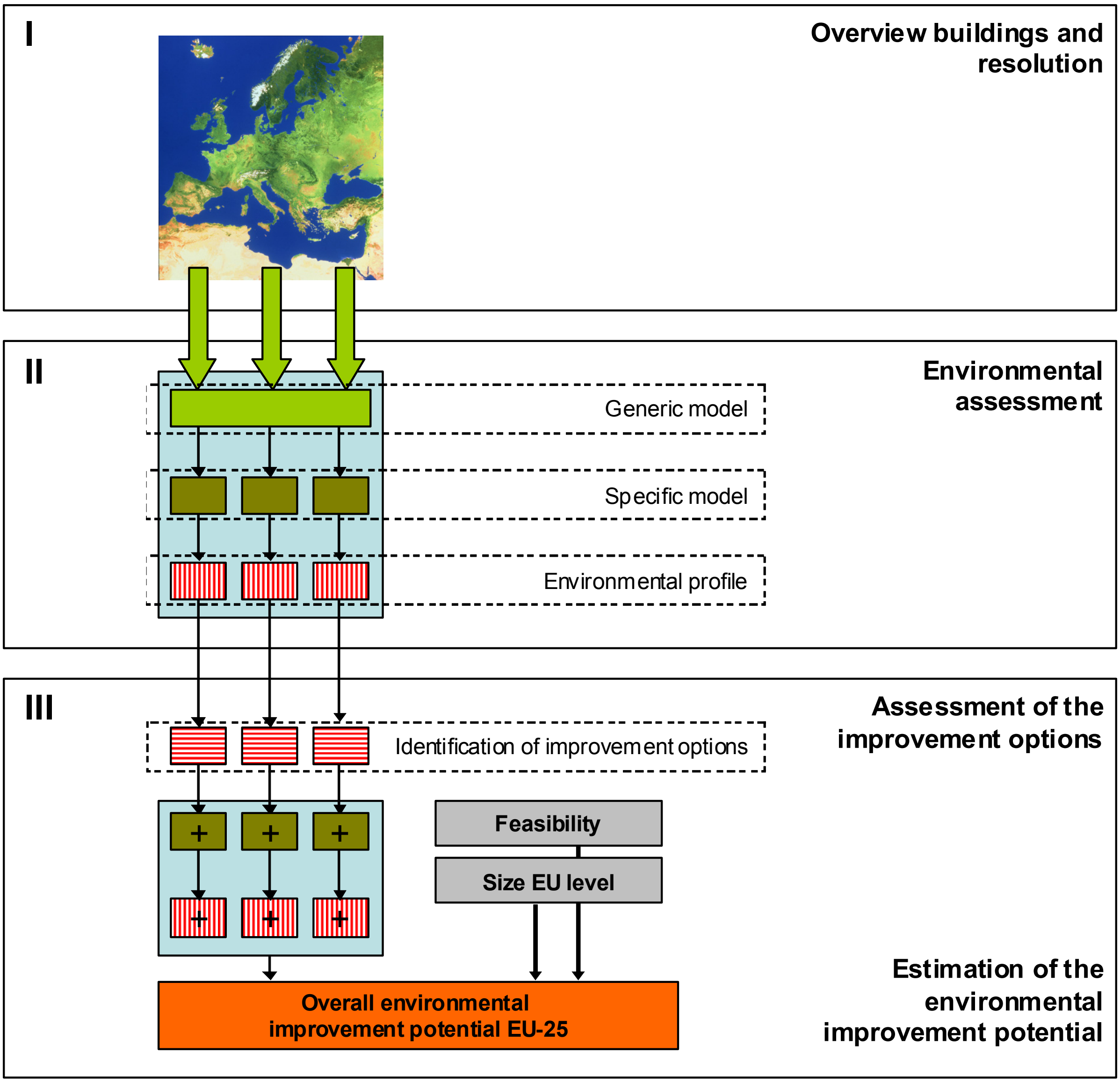


Figure 2.1 Project structure

The first step was built upon existing information, statistical reviews, literature analysis and expert interviews. Several former EU projects represented the main basis used to establish a list of building types representing altogether 80% of the EU-25's residential areas.

The second step started with the definition of the functional unit and system boundaries considered when implementing the life cycle assessment of the different building types which were described according to a common generic model with all relevant necessary parameters and interrelations. The environmental assessment was made in accordance to the ISO standards 14040 and 14044 [EN ISO 14040, EN ISO 14044].

This was the basis for the third step which consisted of the identification of the main environmental improvement options and their assessment and, the cost efficiency of these measures.

3 Overview of residential buildings in the EU-25

The overview of residential buildings in the EU-25 served to define a list of the most representative building types, considering an appropriate geographical resolution. Residential buildings are defined as buildings primarily constructed for residential occupancy. Data were mainly gathered from already accomplished European projects like the COST action C16 [WETZEL & VOGDT 2005], EPIQR [EPIQR 1996] and INVESTIMMO [BAUER ET AL. 2004], that all focused on residential buildings in Europe.

The objectives of all the research work were to provide an overview of impacts and improvement options of residential buildings in Europe. This required a description of the EU-25 building stock and the definition of "typical" residential buildings in order to build a representative set of building models for the project.

Detailed data about country level population and residential buildings stock were the basis for a first definition of buildings according to age and size, and to order these buildings according to their relevance. As an intermediate result, a representative set of building types was derived for each country. These building types were also clustered at a more aggregated level.

For these building types, materials and dimensions were defined. Furthermore, the reference service life of the different construction elements was analysed. In order to allow an analysis of the use phase of the building types, an overview of the different refurbishment and maintenance actions that are conducted, was also elaborated. After some iterations, it was possible to retrieve groups of transnational building types that give a sound overview of the residential stock in the EU-25.

3.1 Definition of the model and database

Each residential building type is based on a specific construction model and a specific material composition. The building types cover the EU-25 residential buildings stock as much as possible. Data have been collected according to the template shown in Table 3.1.

Table 3.1 Building type input table

Construction elements	Material	Density	Thickness	Area	Volume	Piece	Mass
	-	kg/m³	m	m²	m³	-	kg
Exterior walls							
Interior walls							
Roof							
Floors/Ceilings							
Windows/Doors							
Basement/Foundation							

The analysis of the use phase implied using data referring to the heating and cooling energy demand. Since the focus was on the analysis of improvement potentials of building design rather than HVAC (Heating, Ventilating, and Air Conditioning) systems, a standard heating system was defined for all building types. The differences of the space heating demand of the different building types only result from each building's design, construction material composition and from the climatic region. This was calculated with the European software epiqr® (see detailed description in Section 4.5.3.1).

3.2 Population and building stock

Both population and building stock data sources are Eurostat, some publications from the construction sector and construction product industries, and statistics from financial institutions. The used references are given in Annex E. It has to be noted that some deviations exist between the different data sources, including amongst the official ones. Table 3.2 lists the population of the EU-25 in the descending order.

Table 3.2 Population in million residents in the EU-25 ordered by population size

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
EU-25	446.39	447.38	448.32	449.11	449.97	451.08	452.02	452.64	454.58	456.86
EU-15	371.19	372.23	373.22	374.07	375.02	376.20	377.65	378.36	380.38	382.72
Germany	81.54	81.82	82.01	82.06	82.04	82.16	82.26	82.44	82.54	82.53
France	57.75	57.94	58.12	58.30	58.50	58.75	59.04	59.34	59.64	59.90
United Kingdom	58.50	58.70	58.91	59.09	59.39	59.62	59.86	59.14	59.33	59.67
Italy	56.85	56.85	56.88	56.91	56.91	56.93	56.97	56.99	57.32	57.89
Spain	39.31	39.38	39.47	39.57	39.72	39.96	40.38	40.85	41.55	42.35
Poland	38.58	38.61	38.64	38.66	38.67	38.65	38.25	38.24	38.22	38.19
The Netherlands	15.42	15.49	15.57	15.65	15.76	15.86	15.99	16.11	16.19	16.26
Greece	10.60	10.67	10.74	10.81	10.86	10.90	10.93	10.97	11.01	11.04
Portugal	10.02	10.04	10.07	10.11	10.15	10.20	10.26	10.33	10.41	10.47
Belgium	10.13	10.14	10.17	10.19	10.21	10.24	10.26	10.31	10.36	10.40
Czech Republic	10.33	10.32	10.31	10.30	10.29	10.28	10.23	10.21	10.20	10.21
Hungary	10.34	10.32	10.30	10.28	10.25	10.22	10.20	10.17	10.14	10.12
Sweden	8.82	8.84	8.84	8.85	8.85	8.86	8.88	8.91	8.94	8.98
Austria	7.94	7.95	7.97	7.97	7.98	8.00	8.02	8.07	8.10	8.14
Denmark	5.22	5.25	5.28	5.29	5.31	5.33	5.35	5.37	5.38	5.40
Slovakia	5.36	5.37	5.38	5.39	5.39	5.40	5.38	5.38	5.38	5.38
Finland	5.10	5.12	5.13	5.15	5.16	5.17	5.18	5.19	5.21	5.22
Ireland	3.60	3.62	3.66	3.69	3.73	3.78	3.83	3.90	3.96	4.03
Lithuania	3.64	3.62	3.59	3.56	3.54	3.51	3.49	3.48	3.46	3.45
Latvia	2.50	2.47	2.44	2.42	2.40	2.38	2.36	2.35	2.33	2.32
Slovenia	1.99	1.99	1.99	1.98	1.98	1.99	1.99	1.99	2.00	2.00
Estonia	1.45	1.43	1.41	1.39	1.38	1.37	1.37	1.36	1.36	1.35
Cyprus	0.65	0.66	0.67	0.68	0.68	0.69	0.70	0.71	0.72	0.73
Luxembourg	0.41	0.41	0.42	0.42	0.43	0.43	0.44	0.44	0.45	0.45
Malta	0.37	0.37	0.37	0.38	0.38	0.38	0.39	0.39	0.40	0.40

Source: [EUROSTAT 2005a]

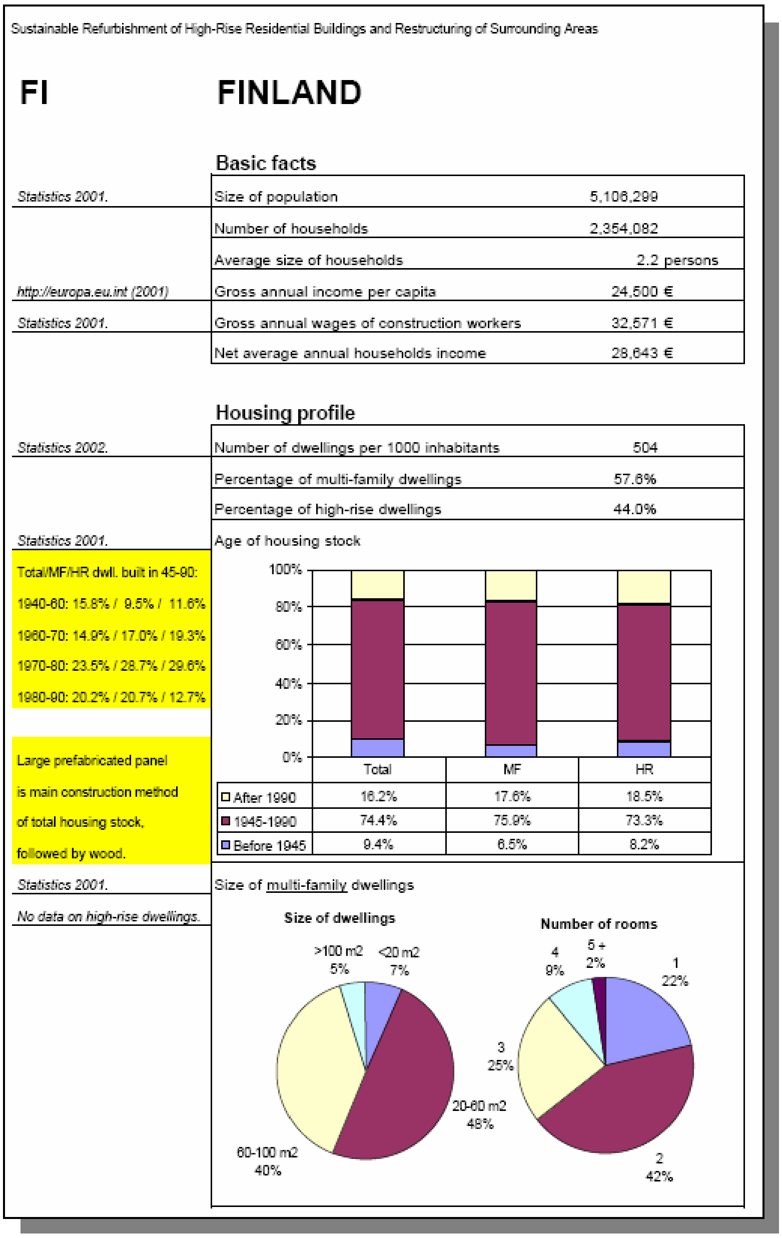
The available country specific data on buildings and dwellings, including the segmentation into building types and age have been thoroughly reviewed. Examples from the research are shown in Figure 3.1 and Figure 3.2.

Housing stock, 2003

	Number of dwellings (thousand) (1)	Dwellings per thousand inhabitants	Type of tenancy (%) (2) Rented	Owner occupied	Coop-erative	Other
BE (3)	4 820	462	31	68	:	2
CZ	4 366	:	:	:	:	:
DK	2 561	484	40	53	7	0
DE (4)	38 925	472	55	45	:	0
EE	624	460	:	:	:	:
EL	5 465	:	20	74	:	6
ES (5)	20 947	513	11	82	:	7
FR	29 495	503	38	56	:	6
IE (3) (6)	1 554	391	18	77	:	5
IT	26 526	:	:	:	:	:
CY	299	421	:	:	:	:
LV	967	417	21	79	0	0
LT	1 292	375	:	:	:	:
LU	176	394	26	67	:	7
HU	4 134	402	7	92	:	1
MT	127	:	26	70	:	4
NL	6 811	419	45	55	:	0
AT (7)	3 280	404	39	58	:	3
PL (8)	11 764	330	24	58	18	0
PT	5 318	508	:	:	:	:
SI	785	:	9	84	:	7
SK (9)	1 885	:	:	:	:	:
FI	2 574	499	34	63	0	3
SE (10)	4 351	485	39	46	15	0
UK	25 617	:	31	69	:	0

(1) Belgium, 2004; Czech Republic, Germany, Greece, France, Cyprus, Poland, Slovenia, Finland and the United Kingdom, 2002; Spain, Italy, Luxembourg and Slovakia, 2001; Malta, 2000. (2) Belgium, France, Germany, Ireland, Luxembourg and Malta, 2002; Greece, Sweden and the United Kingdom, 2001. (3) Tenancy: occupied dwellings. (4) Dwellings: dwelling units in buildings with housing space. Tenancy: excluding former East Germany. (5) Dwellings: estimates. (6) Dwellings: total number of conventional (permanent) habitable residential buildings whether occupied or not. (7) Dwellings: occupied dwellings in main residence only. Tenancy: annual average, principal dwellings only. (8) Tenancy: rental includes the housing stock of municipalities, social housing associations, co-operatives and employers; owner occupied includes dwellings owned by natural persons; cooperatives includes the housing stock of co-operatives. (9) Dwellings: including vacant dwellings. (10) Tenancy: cooperative includes housing co-operatives based on tenants-owning and a small fraction of the dwelling stock consists of co-operative rental dwellings.
Source: National statistical institutes and Government departments, in 'Housing statistics in the European Union, 2004', National board of Housing, Building and Planning, Sweden and Ministry for Regional Development of the Czech Republic

Figure 3.1 Example for a statistical overview of the EU-25 countries
Source: [EUROSTAT 2006]



Sustainable Refurbishment of High-Rise Residential Buildings and Restructuring of Surrounding Areas

FI **FINLAND**

Basic facts

Statistics 2001.	Size of population	5,106,299
	Number of households	2,354,082
	Average size of households	2.2 persons
http://europa.eu.int (2001)	Gross annual income per capita	24,500 €
Statistics 2001.	Gross annual wages of construction workers	32,571 €
	Net average annual households income	28,643 €

Housing profile

Statistics 2002.	Number of dwellings per 1000 inhabitants	504
	Percentage of multi-family dwellings	57.6%
	Percentage of high-rise dwellings	44.0%

Statistics 2001. Age of housing stock

Total/MF/HR dwll. built in 45-90:
1940-60: 15.8% / 9.5% / 11.6%
1960-70: 14.9% / 17.0% / 19.3%
1970-80: 23.5% / 28.7% / 29.6%
1980-90: 20.2% / 20.7% / 12.7%

Large prefabricated panel is main construction method of total housing stock, followed by wood.

	Total	MF	HR
After 1990	16.2%	17.6%	18.5%
1945-1990	74.4%	75.9%	73.3%
Before 1945	9.4%	6.5%	8.2%

Statistics 2001. Size of multi-family dwellings

No data on high-rise dwellings.

Figure 3.2 Example of national statistical data [VROM 2005]

Very few reports cover all EU-25 countries so different sources, including forecasts about future building production in some countries (see for instance Table 3.3) have been combined.

The analysis of the available statistical data showed some data inconsistencies, even regarding one same country and survey. This is partly explained by different building classifications. For example, commercial buildings also containing some dwellings are sometimes accounted for in the dwellings stock. Another problem is the fact that the definition of “high-rise building” differs from one country to another. In Estonia, for instance, a high-rise building has at least 14 storeys whereas, in south European countries, high-rise buildings are defined as having more than five storeys. In some other countries, the criterion is the height of guttering of the building (e.g. in Germany, a high-rise building is higher than 22 m, as the standardized ladders of the fire-brigades can only reach up to 22 m and therefore other fire protection rules hold).

Table 3.3 Datasets that were used to characterise the current buildings stock

Country	Population growth 1990 to 2004 in %	Dwellings stock in 2003	Dwellings per 1 000 inhabitants in 2003	Living space per person in 2004 in m^2	Completion per 1 000 inhabitant in 2003
Austria	5.8	3 904	477	38	5.2
Belgium	4.5	4 820	463	36	3.9
Denmark	5.1	2 541	471	51	4.4
Germany	4.3	38 935	472	40	3.2
Finland	4.9	2 574	492	36	5.4
France	5.9	29 495	490	38	2.6
Greece	9.1	5 465	494	30	11.6
United Kingdom	3.6	25 617	429	44	3.2
Ireland	14.8	1 554	385	35	17.4
Italy	1.4	26 526	461	32	3.1
Luxembourg	19.0	176	391	50	3.6
The Netherlands	9.2	6 811	418	41	3.7
Portugal	5.6	5 318	506	29	7.9
Sweden	5.3	4 329	482	44	2.7
Spain	5.5	20 823	488	31	11.3
Total EU-15	4.7	178 888	467	37	5.1
Poland	0.4	11 763	308	22	4.3
Slovakia	1.8	1 885	350	26	2.6
Slovenia	0.1	785	393	30	3.7
Czech Republic	-1.5	4 366	436	29	2.7
Hungary	-2.5	4 134	409	28	2.1
Total CEE5[a]	-0.2	22 933	349	25	3.5

a) CEE5 aggregates the five countries in Central and Eastern Europe: Czech Republic, Slovakia, Hungary, Poland, and Slovenia.
Source: [AMANN 2006]

Whenever different sources provided different values, the preference was given to the most elaborated and/or recent one. In some cases, the average value was taken into account.

3.3 Definition of group of buildings according to size

In order to group the European buildings stock into clusters that could subsequently be described in accordance with the datasheets in Table 3.3, the statistical data were further aggregated into three major groups:

- single-family houses (including two-family houses and terraced houses)
- multi-family houses
- high-rise buildings.

Single-family houses include individual houses that are inhabited by one or two families. Also terraced houses are assigned to this group.

Multi-family houses contain more than two dwellings in the house. The separation to the next group – the high-rise buildings – is either not made or made differently from one country to another. It is considered that buildings with fewer than 9 storeys are regarded as multi-family buildings.

High-rise buildings were defined as buildings that are higher than 8 storeys.

One special building type, the panelised structure buildings, is found in most (especially eastern European) countries. In literature and statistics, they are either accounted for amongst high-rise building or multi-family buildings (Figure 3.3).

Figure 3.3 Panel buildings especially erected in the eastern European states
Source: [Wetzel & Vogdt 2005]

In the EU-25, altogether 34 million dwellings or 17% of the whole buildings stock are included in panel buildings. In each country where these buildings exist, one to three different building types were defined.

3.4 Definition of groups of buildings according to age

Most of the statistical data considered are produced by Eurostat, covering building types and construction period disaggregation. The "Housing Statistics" report [Boverket & MMR 2005] is another important statistical source. The last issue from 2004 is the 10th edition in a series of publications dating back to 1991 and the first to cover 25 Member States.

The data provide building age groupings for all EU-25 countries (Figure 3.4). The data were taken into account for cross-checking the national individual age groups and also were used for defining age groups where no other data were available.

Three age categories for buildings are set as the highest aggregated level for each country:

- until 1945 (old buildings)
- between 1946 until 1990 (post war buildings)
- after 1991 (current and new buildings).

It is possible to identify typical construction systems in some countries or zones and for certain periods. It has to be noted that besides some factors such as population and economic growth, the building activities are also heavily influenced by the national housing policy and the funding policy.

The grouping into the three age categories can be seen as a way to simplify the overview but may mask such specificities. Some of the identified building types especially show an overlapping of these age groups, meaning that one building type represents buildings from the other groups, e.g. the group of the "post war buildings" (1945 – 1990) and the "current and new buildings" (after 1990).

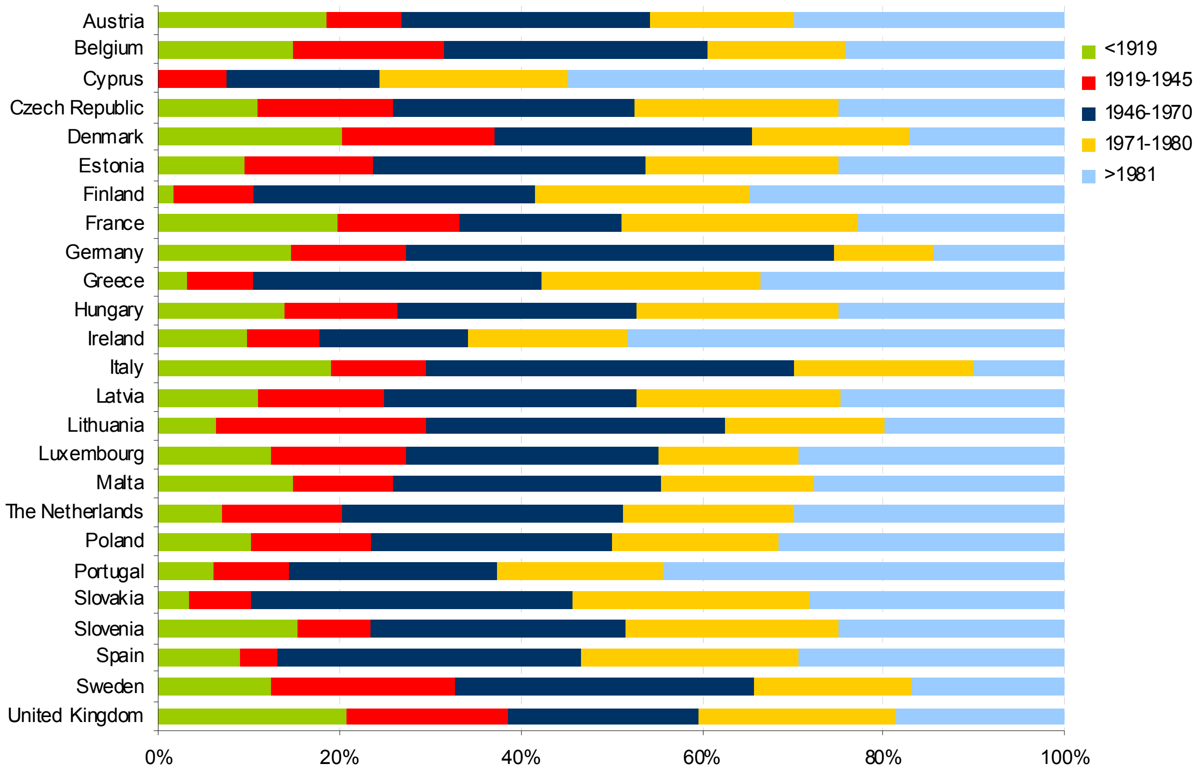


Figure 3.4 Age distribution of the housing stock
Source: [BOVERKET & MMR 2005]

3.5 Derived building age and building size typology

The major groups of buildings – single-family houses, multi-family houses and high rise buildings – in each country have been grouped according to age categories. Table 3.4 provides, as an example, the information gathered for multi-family houses in France. Annex A contains the data for all countries and building groups.

Table 3.4 Country specific table of dwellings grouped according to age and size for multi-family houses in France

Dwelling stock age category	Number of multi-family houses	Proportion of total dwelling stock in%	Proportion of multi-family dwellings in %
Until 1945	3 451 500	12	39
1945-1990	4 690 500	16	53
Since 1990	708 000	2	8
Total	8 850 000	30	100

Sources: [EUROSTAT 2006; VROM 2005; BOVERKET & MMR 2005]

The overall grouping of the EU-25 housing stock according to size is shown in Figure 3.5. As already highlighted above, there is a different national distinction between high-rise buildings and multi-family buildings. Therefore, it would be more accurate to say that about 53% of the EU-25 building stock is composed of single-family houses while the remainder are "bigger" buildings like multi-family houses and high-rise buildings.

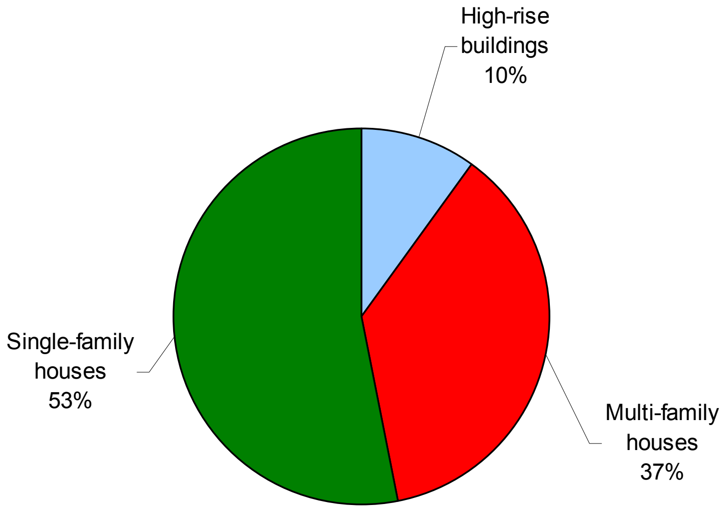


Figure 3.5 Distribution of the entire housing stock in the EU-25
Source: [EUROSTAT 2005b]

3.6 Material and building design typology

As an example, the process followed to identify the material and masses for each building type is described here. In France, for instance, multi-family houses built between 1945 and 1990 cover 16% of the entire French building stock and represent a total of 4 690 500 dwellings (see Table 3.4). An iterative process started from these preliminary building types. For each building type a typical representative building model with corresponding construction procedures and material used along with masses had to be derived.

Sometimes average building types were assumed. For example, in one country, mainly multi-family buildings with four and six storeys were found. The materials used in these two different building types were comparable, so in this case it was decided to regard these building types as a building with five storeys (average). For this approach, expert knowledge as well as a sound research in literature about typical construction in certain time periods in particular countries for specific building types have been used.

Table 3.5 Result from the expert poll performed within the COST C16 action (ESF-COST-C16)

Façade	GR	I	F	S	P	DE	DK	MT	NL	Mk	SI	CY	PL
Description of the current STATE (post II-WW apartment buildings)													
Type of external covering													
Rendering	C	C	C	C	C	C	S	C	C	C	C	C	C
Exposed masonry (natural stone, brick)	S	S	N	C	S	C	C	C	C	S	S	N	S
Exposed concrete	S	C	S	C	S	C	C	N	C	S	S	S	
Prefabricated concrete elements	S	C	C	C	N	C	C	S	C	C	S	N	C
Artificial stone veneer	S	S	N	C	N	S	S	N	S		S	N	
Curtain-wall façade	S	N	S	S	S	S	S	S	S		S	S	S
Light (concrete) elements	S	C	N	C	N	C	S	N	C	S	S	N	
Wooden elements	S	N	N	C	N	C	S	N	S	S	N	N	
Metal elements	S	N	N	S	N	S	S	N	S	S	N	N	

"C" stands for "commonly used (x > 20%), "S" stands for seldom used (1% < x < 20%) and "N" stands for not used (x < 1%)
Source: [WETZEL ET AL. 2005]

The construction details for all climatic regions in the EU-25 collected in the EPIQR has also been used in this project [EPIQR 1996]. The EU-project INVESTIMMO [BAUER ET AL. 2004], provided relevant data on the lifespan of the used materials and the European COST action C16 detailed the actual state of theses buildings today. The literature sources for these EU-projects are given in Annex E.

Nevertheless, the data derived from these references were too rough to really build detailed construction plans for each of the major building groups. Therefore, design and construction characteristics of these building types were defined taking into account literature research and experts knowledge on typically used material for each of the considered zones.

The result is a construction description with detailed descriptions of used material and masses as shown in Table 3.6 below which is an example for a multi-family house in France.

Table 3.6 Material and masses for a typical multi-family house in France (between 1945 and 1990)

Multi-family house	Brick masonry, reinforced concrete flooring, pitched roof 20°
Year of construction	1945 - 1990
Building type	Multi-family house
Dimension	32 m x 12 m
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
External wall	Brick masonry 30 cm
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

The dimensions used in the example shown in Table 3.6 are a representative average for the used materials that are common for the construction in the specific country for the specific age and building type.

Further investigation of the used materials showed that this building type is also found in the following age category (after 1990) and altogether represents around 10% of the whole building stock. The remaining multi-family buildings between 1945 and 1990 were built with concrete, light concrete, limestone and also brick with insulation. These materials and their respective constructions are described in other building types and can be found in Annex B.

Not only did the different materials and structures of the façade cause the creation of additional building types for one selected national group of buildings at a certain age and size, but also the structure and materials of floors and roofs. Flat roofs and pitched roofs, for instance, with their different constructions were to be split into two groups. Concerning masses and materials, it was possible to assemble at least buildings with mansard roofs, pitched roofs and hipped roofs in one group. For floors, there are two different groups: wooden floors and massive floors of stone and/or concrete that created a different grouping.

3.7 Grouping building types from different countries

In general, there were sufficient data for the building types in available country level data. For some countries (e.g. Estonia), data were not available with sufficient accuracy. However, sound data could be derived from neighbouring countries with comparable climatic conditions and with comparable historic economic and political backgrounds.

When similar data were available for similar building types defined in two different countries, those were merged into one building type. This was done under the following conditions:

- comparable climatic boundary conditions
- comparable techniques and materials used for the building which is only possible, if comparable economic and political boundary conditions are found.

To ensure comparable climatic boundary conditions, the heating degree days of each country were a suitable indicator for comparison. This indicator is the best way to represent similar zones for heating in the EU-25. The long term average of the heating degree days (HDD), based on the period 1980-2004, are used. A relatively long term base period is desirable to avoid the influence of short term changes in mean temperatures. Thereby, three different categories, shown in Table 3.7, have been set.

Table 3.7 Grouping of heating degree days

Range of heating degree days [HDD]	Corresponding countries			
	Country	**HDD**	**Population in 2003 [Mio.]**	**Building stock [Mio. m²]**
Zone 1: South European countries	Malta	564	0.40	11
564 to 2 500 HDD (1 269 HDD)[a]	Cyprus	787	0.72	40
	Portugal	1 302	10.41	337
	Greece	1 698	11.01	351
	Spain	1 856	41.55	1 454
	Italy	2 085	57.32	2 076
	France	2 494	59.64	2 109
Zone 2: Central European countries	Belgium	2 882	10.36	359
2 501 to 4 000 HDD (3 272 HDD)	The Netherlands	2 905	16.19	561
	Ireland	2 916	3.96	125
	Hungary	2 917	10.14	221
	Slovenia	3 044	2.00	45
	Luxembourg	3 216	0.45	21
	Germany	3 244	82.54	3 463
	United Kingdom	3 354	59.33	1 567
	Slovakia	3 440	5.38	82
	Denmark	3 479	5.38	230
	Czech Republic	3 559	10.20	237
	Austria	3 569	8.10	292
	Poland	3 605	38.22	706
Zone 3: North European countries	Lithuania	4 071	3.46	62
4 000 to 5 823 HDD (4 513 HDD)	Latvia	4 243	2.33	45
	Estonia	4 420	1.36	28
	Sweden	5 423	8.94	338
	Finland	5 823	5.21	151

a) Numbers in brackets indicate average weighted HDD
Sources: [EUROSTAT 2005a, GIKAS & KEENAN 2006]

Besides heating degree days, political and economic boundary conditions were also taken into account when defining geographical zones and building types. For instance, the political system in eastern European countries until 1990, characterized by a centralized planning process which included building strategies, sometimes resulted in raw materials shortages. This is reflected in typical apartment buildings in all Eastern European countries.

By applying the transnational clustering of building types (Table 3.8), it was possible to reduce the number of building types tremendously without increasing the risk of error.

Table 3.8 Transnational clustering of similar national building types (example for a single-family house in zone 1)

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings	2 950 000	1 325 000	275 000	106 000	418 000	6 500	15 000
Number of buildings	1 966 670	883 330	183 330	70 670	278 670	4 330	10 000
Stock in Mio. m^2	264	120	23	9	38	1	3
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	3.6	3.9	4.2	4.4	4.4	5.0	5.0

Source: [GIKAS & KEENAN 2006]

3.8 Typology of residential buildings in the EU-25

The variety of special buildings, e.g. historical buildings with straw roofs would lead to a huge number of building types. Therefore, a cut-off was defined that at least 70% of the whole building stock in each country as well as in the EU-25 building stock are covered by specific building types.

The European residential buildings sector is separated into 53 typical building types. Of these 53 building types, 19 types were each subdivided into one group representing the existing building stock, and one group representing the current typical practice of residential building construction (new buildings), respectively. Thus, in total 72 building types were identified that altogether represent 80% of the whole building stock in the EU-25 in terms of residential area. The grouping according to size and to climatic region is highlighted in Table 3.9.

Table 3.9 Number of building types in each zone

Climatic zones	Single-family house	Multi-family house	High-rise building
Zone 1: South European countries	11 (3)[a]	11 (3)	3 (1)
Zone 2: Central European countries	11 (3)	11 (3)	3 (1)
Zone 3: North European countries	9 (2)	10 (2)	3 (1)

a) Numbers in bracket indicate new building types

The building types are listed in Table 3.10. In the second column of this table, the climatic zone is given (Z1 stands for southern European countries, Z2 stands for middle European countries and Z3 stands for northern European countries). The short name for each construction is given in the third column. The notation is “Building type (XX)_Number(3 digits)” with “SI” standing for single-family houses, “MF” for multi-family houses and “HR” for high-rise buildings.

Table 3.10 Short description of the building types

No.	Zone	Type	Description of Building Type
1	Z1	SI_001	Brick masonry with wooden flooring
2	Z1	SI_002	Limestone/fieldstone masonry with wooden flooring
3	Z1	SI_003	Limestone/fieldstone masonry, wooden flooring, flat roof
4	Z1	SI_004	Brick masonry, hollow brick flooring, pitched roof
5	Z1	SI_005_ex[a]	Brick cavity wall, reinforced concrete flooring, pitched roof 20°
6	Z1	SI_005	Brick cavity wall, reinforced concrete flooring, pitched roof 20° with ins. (new building)
7	Z1	SI_006_ex	Brick cavity wall, reinforced concrete flooring, flat roof
8	Z1	SI_006	Brick cavity wall, reinforced concrete flooring, flat roof with insulation (new building)
9	Z1	SI_007_ex	Brick masonry insulated, reinforced concrete flooring, pitched roof 20° with insulation
10	Z1	SI_007	Brick masonry insulated, reinforced concrete flooring, pitched roof 20° (new building)

No.	Zone	Type	Description of Building Type
11	Z1	SI_008	Wooden frame with stone filler, reinforced concrete flooring, pitched roof
12	Z1	MF_001	Brick masonry with wooden flooring
13	Z1	MF_002	Limestone/fieldstone masonry with wooden flooring
14	Z1	MF_003	Brick cavity wall, reinforced concrete flooring, pitched roof 20°
15	Z1	MF_004_ex	Breeze concrete, reinforced concrete flooring, pitched roof
16	Z1	MF_004	Breeze concrete, reinforced concrete flooring, pitched roof with insulation (new building)
17	Z1	MF_005	Concrete wall, reinforced concrete flooring, flat roof
18	Z1	MF_006_ex	Brick cavity wall insulated, reinforced concrete flooring, flat roof
19	Z1	MF_006	Brick cavity wall ins., reinforced concrete flooring, flat roof with ins. (new building)
20	Z1	MF_007	Concrete wall, reinforced concrete flooring, flat roof
21	Z1	MF_008_ex	Brick cavity wall insulated, reinforced concrete flooring, flat roof
22	Z1	MF_008	Brick cavity wall ins., reinforced concrete flooring, flat roof with ins. (new building)
23	Z1	HR_001_ex	Brick cavity wall insulated, reinforced concrete flooring, flat roof
24	Z1	HR_001	Brick cavity wall ins., reinforced concrete flooring, flat roof with ins. (new building)
25	Z1	HR_002	Concrete wall, reinforced concrete flooring, flat roof
26	Z2	SI_001	Brick masonry with wooden flooring and pitched roof
27	Z2	SI_002	Rubble masonry with wooden flooring and pitched roof
28	Z2	SI_003	Wooden frame with stone filler, reinforced concrete flooring, pitched roof
29	Z2	SI_004	Brick masonry, hollow brick flooring, pitched roof
30	Z2	SI_005	Brick wall, reinforced concrete flooring, pitched roof
31	Z2	SI_006_ex	Brick wall, reinforced concrete flooring, pitched roof
32	Z2	SI_006	Brick wall, reinforced concrete flooring, pitched roof with insulation (new building)
33	Z2	SI_007_ex	Sand lime wall, reinforced concrete flooring, pitched roof
34	Z2	SI_007	Sand lime wall, reinforced concrete flooring, pitched roof with ins. (new building)
35	Z2	SI_008_ex	Wooden frame insulated, wooden flooring, pitched roof
36	Z2	SI_008	Wooden frame insulated, wooden flooring, pitched roof with insulation (new building)
37	Z2	MF_001	Brick masonry with wooden flooring
38	Z2	MF_002	Rubble stone masonry with wooden flooring
39	Z2	MF_003	Wooden frame with stone filler, wooden flooring, pitched roof
40	Z2	MF_004	Brick masonry, reinforced concrete flooring, pitched roof
41	Z2	MF_005_ex	Breeze concrete insulated, reinforced concrete flooring, pitched roof
42	Z2	MF_005	Breeze concrete ins., reinforced concrete flooring, pitched roof with ins. (new building)
43	Z2	MF_006_ex	Brick masonry insulated, reinforced concrete flooring, pitched roof
44	Z2	MF_006	Brick masonry ins., reinforced concrete flooring, pitched roof with ins. (new building)
45	Z2	MF_007_ex	Sand lime wall insulated, reinforced concrete flooring, pitched roof
46	Z2	MF_007	Sand lime wall ins., reinforced concrete flooring, pitched roof with ins. (new building)
47	Z2	MF_008	Concrete wall, reinforced concrete flooring, pitched roof
48	Z2	HR_001	Concrete wall, reinforced concrete flooring, flat roof
49	Z2	HR_002_ex	Brick cavity wall insulated, reinforced concrete flooring, flat roof
50	Z2	HR_002	Brick cavity wall ins., reinforced concrete flooring, flat roof with ins. (new building)
51	Z3	SI_001	Brick masonry with wooden flooring and pitched roof
52	Z3	SI_002	Brick wall, reinforced concrete flooring, pitched roof
53	Z3	SI_003	Wooden wall, wooden flooring, pitched roof
54	Z3	SI_004	Wooden wall and brick facade, reinforced concrete flooring, pitched roof
55	Z3	SI_005	Breeze concrete wall, breeze concrete block flooring, pitched roof
56	Z3	SI_006_ex	Brick wall, reinforced concrete flooring, pitched roof
57	Z3	SI_006	Brick wall, reinforced concrete flooring, pitched roof with insulation (new building)
58	Z3	SI_007_ex	Wooden frame insulated, wooden flooring, pitched roof
59	Z3	SI_007	Wooden frame insulated, wooden flooring, pitched roof with insulation (new building)
60	Z3	MF_001	Brick masonry with wooden flooring
61	Z3	MF_002	Breeze concrete insulated, reinforced concrete flooring, pitched roof
62	Z3	MF_003	Wooden wall brick façade, reinforced concrete flooring, pitched roof
63	Z3	MF_004	Brick masonry, reinforced concrete flooring, pitched roof
64	Z3	MF_005	Breeze and reinforced concrete wall, reinforced concrete flooring, pitched roof
65	Z3	MF_006_ex	Wooden wall insulated, wooden flooring, pitched roof

No.	Zone	Type	Description of Building Type
66	Z3	MF_006	Wooden wall insulated, wooden flooring, pitched roof with insulation (new building)
67	Z3	MF_007_ex	Brick masonry insulated, reinforced concrete flooring, pitched roof
68	Z3	MF_007	Brick masonry insulated, reinforced concrete flooring, pitched roof with ins. (new building)
69	Z3	MF_008	Concrete wall insulated, reinforced concrete flooring, flat roof
70	Z3	HR_001	Concrete wall, reinforced concrete flooring, flat roof
71	Z3	HR_002_ex	Brick cavity wall insulated, reinforced concrete flooring, flat roof
72	Z3	HR_002	Brick cavity wall insulated, reinforced concrete flooring, flat roof with ins. (new building)

a) ex stands for existing building
inc. stands for insulation

Table 3.11 presents the total number of covered dwellings by the defined building types in each country. The coverage level ranges from 67% of the building stock (in terms of number of dwellings) in Luxembourg to 89% of the building stock in Poland.

Table 3.11 Percentage coverage of existing dwellings per country

Country	Single-family houses	Multi-family houses	High-rise building	Total	Not covered
Austria	41	46	1	88	12
Belgium	63	20	2	85	15
Cyprus	50	20	0	70	30
Czech Republic	28	30	18	76	24
Denmark	40	33	6	79	21
Estonia	27	32	25	84	16
Finland	38	47	0	85	15
France	40	28	10	78	22
Germany	41	42	4	87	13
Greece	44	31	0	75	25
Hungary	42	20	14	76	24
Ireland	70	4	0	74	26
Italy	34	39	12	85	15
Latvia	24	65	0	89	11
Lithuania	31	56	0	87	13
Luxembourg	42	17	8	67	33
Malta	50	30	0	80	20
Poland	35	36	18	89	11
Portugal	44	16	14	74	26
Slovakia	43	23	16	82	18
Slovenia	47	23	8	78	22
Spain	26	27	22	75	25
Sweden	40	45	0	85	15
The Netherlands	50	28	5	83	17
United Kingdom	53	18	1	72	28
Total	**42**	**31**	**7**	**80**	**20**

For each of the 72 building types a datasheet providing information on the number and size of dwellings and their average occupancy, the main construction characteristics of the building type and the energy balance was compiled. An example datasheet is shown in Figure 3.6. The datasheets for each building type are found in Annex C.

Annex C 1 Building type Z1_SI_001

Single-family house
Brick masonry, wooden flooring, pitched roof

Statistics Proportion of Z1_SI_001 in the EU-25: 2.5 %

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	2950.0	1325.0	275.0	106.0	418.0	6.5	15.0
Number of buildings [1 000]	1966.7	883.3	183.3	70.7	278.7	4.3	10.0
Stock in Mio. m^2	264	120	23	9	38	1	3
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	3.6	3.9	4.2	4.4	4.4	5.0	5.0

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	001
Year of construction	Until 1900
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Solid brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Solid brick
Window	Wooden frame and single-glazing

Energy balance

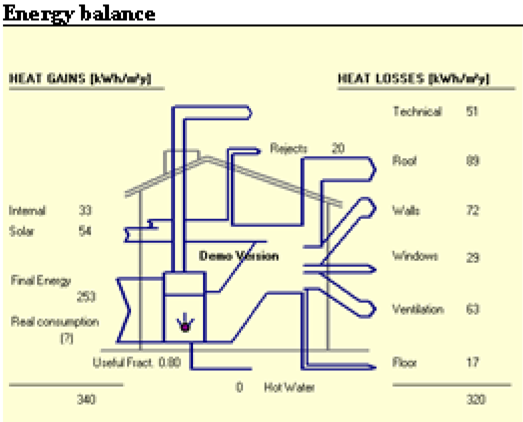


Figure 3.6 Example of a datasheet per building type
In this example, “Z1_SI_001“ stands for the single-family house 001 in Zone 1 (Southern European countries)

Each datasheet contains a list of statistical country data such as the number of dwellings that are covered by this building type in each country. A short description of the typical material, dimensions and structure, as well as the residual lifespan (in three rough estimates of 20, 30 and 40 years) is also given. The energy balance of the building from the epiqr® software is shown at the bottom of the datasheet (see Section 4.5.3.1).

A second datasheet per building type provides the detailed composition of building elements, masses, volumes and densities (see the example in Table 3.12). The complete set of datasheets for all evaluated building types can be found in Annex B.

Table 3.12 Detailed information about the building type
In this example, "Z1_SI_001" stands for the single-family house 001 in Zone 1 (Southern European countries)

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_001**	**Brick masonry with wooden flooring and pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1 300.0	0.0	220.0	4.4		5 720.0	5.7
40			brick	80	0.0	1 800.0	0.5	220.0	110.0		198 000.0	198.0
			interior plaster (lime-gypsum)	30	0.3	1 000.0	0.0	220.0	4.4		4 400.0	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	60.0	1.2		1 200.0	1.2
			brick	80	0.0	1 800.0	0.3	60.0	18.0		32 400.0	32.4
			interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	60.0	1.2		1 200.0	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	100.0	2.0		2 000.0	2.0
			wooden construction	20	1.0	500.0	0.1	10.0	0.8		400.0	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	100.0	2.0		2 000.0	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500.0	0.2	21.9	3.5		1 750.0	1.8
			roof battening (timber spruce 12%)	25	0.6	500.0	0.0	12.5	0.5		250.0	0.3
			roof tile	25	0.6	2 000.0	0.0	120.0	2.4		4 800.0	4.8
			REFURBISHMENT: insulation	40	0.6	80.0	0.1	100.0	12.0			0.0
		Floor	floor timber spruce	20	1.0	500.0	0.0	90.0	2.7	2.0	2 700.0	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	20	1.0	500.0	0.2	15.6	2.5	2.0	2 500.0	2.5
			wooden boarding	20	1.0	690.0	0.0	90.0	1.8	2.0	2 484.0	2.5
			interior plaster (lime-gypsum)	20	1.0	1 000.0	0.0	90.0	1.8	2.0	3 600.0	3.6
		Basement wall	brick	80	0.0	1 800.0	0.8	80.0	64.0		115 200.0	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1 800.0	0.1	120.0	8.4		15 120.0	15.1
			wooden construction	20	1.0	500.0	0.1	31.3	2.5		1 250.0	1.3
			filling sand and grit	30	0.3	2 000.0	0.1	90.0	7.2		14 400.0	14.4
			wooden boarding	20	1.0	690.0	0.0	90.0	1.8		1 242.0	1.2
		Basement ground Floor	brick	80	0.0	1 800.0	0.1	90.0	9.0		16 200.0	16.2
		Foundation	brick	80	0.0	1 800.0	0.5	25.0	12.5		22 500.0	22.5
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22.0	**451 316.0**	**451.3**
			REFURBISHMENT: window	25						26.4		

4 Life cycle assessment methodology

This chapter describes the methodology, the assumptions and the data used to implement the Life Cycle Assessment (LCA) of the buildings types defined in the previous chapter.

4.1 Environmental impact categories

The life cycle impacts assessed for the different building types were aggregated in terms of several impact categories which were selected on the basis of scientific robustness, relevance and practicability. These are:

- Acidification Potential (AP)
- Eutrophication Potential (EP)
- Global Warming Potential (GWP100)
- Ozone Layer Depletion Potential (ODP)
- Photochemical Ozone Creation Potential (POCP).

The environmental indicators “Primary Energy from renewable sources” and “Primary Energy from non-renewable sources” are also quantified.

The incorporated greenhouse gases (related to the carbon content of the used renewable resources like wood) was also quantified, together with the greenhouse gas emissions resulting from fuel combustion and industry processes (‘Output GWP’).

Due to missing scientific robustness of the underlying methods, environmental impact categories related to human and eco-toxicity, abiotic resource depletion, as well as to land use were not addressed.

For the characterisation of the above listed environmental impacts, the CML (Centre of Environmental Science) characterisation model version 2001 was used [CML 2001].

4.2 Functional unit

The selected primary functional unit of the life cycle model is the ‘use’ of one square metre living area over the period of one year. To calculate life cycle impacts for this functional unit, one specific building type was analysed over its entire life span. The life span corresponds to the years of living in the building with all refurbishment actions considered and the consumption of energy for heating and cooling. This functional unit relates to all life cycle phases, i.e. construction, use phase and recycling.

These functional units permit the direct comparison of differently sized building types or of building types with different residual service lives (see Section 4.3.2 for information about the service lives of buildings).

4.3 Product system and system boundaries

Once the list of buildings types in their respective geographical surroundings had been prepared with their main technical aspects and influencing surrounding conditions, the system boundaries for the life cycle models were defined.

With regard to the building's layout, the life cycle model integrates six main construction elements:

- basement (including the building's foundation)
- exterior walls (including plaster & exterior paint)
- interior walls (including plaster)
- floors/ceilings
- roof
- windows.

The interior construction, fittings and finish, and heating and cooling systems (e.g. HVAC, heating systems and cooling equipment/services, mechanical ventilation systems and building automation) are not considered as they are not relevant for the identification of improvement options. The exterior area surrounding the building and the infrastructure services are also not considered.

For the sake of consistency, the general system boundary is similar for all building types to be assessed and includes all life cycle stages:

- production and transport of building materials
- refurbishment
- heating and cooling
- waste management (demolition and refurbishment).

4.3.1 Omission of processes

Some building parts, other processes and aspects are excluded from the system due to minor relevance: the operation of the construction (site), and the entrance doors.

The minor relevance of the construction operation has been justified in several studies. [LÜSNER 1996], for instance, shows (for infrastructure building projects) that the operation of construction generally does not exceed 2% (in some rare cases, the construction operation may sum up to approx. 9%) of the life cycle impacts for bridges or roads. These examples, however, include the transport of construction materials and products to the construction site. The impact of transport has been attributed to each individual building element. On this basis, and since the major environmental impacts lie in the use phase (especially heating energy uptake), the construction operation can reasonably be neglected.

Compared to the rest of the building, entrance doors have small masses and are generally made of the same materials as windows. The analysis of windows shows that they do not bear the most relevant environmental impacts within the building's life. Therefore, the minor relevance of doors can reasonably be assumed.

4.3.2 Service lives of buildings and building types

For any manufactured product, the service life or life span can be fairly accurately estimated from experience (and similar products). Conversely, the residual life span of a building is not as easy to estimate due to non-technical factors that can limit the actual building's residual service. This holds especially true for long term predictions. The profile of the building owner/occupant (social status), the building's surrounding, e.g. nearby mining or underground transportation or the occurrence of earthquakes) are two examples that can affect the residual life of the building.

The residual service life of each building is determined by both non-technical decisions and by the technical state of the building [BAUER ET AL. 2004]. For analytical purposes the maximum residual service life of a building has been established at 40 years. For some building types, the residual service life is assumed to be below 40 years, but, in no cases fewer than 20 years.

For new building types, the reference service life is generally estimated to reach or exceed 40 years. However, whenever the residual service life was estimated to be 40 or more years, the analysis of the impact of the use phase was limited to 40 years. This upper limit was established due to the uncertainties inherent to the long term and because it provides a reasonable framework in the definition of policy measures which generally do not consider long term goals beyond 2050.

Improvement options concern both existing and new building stock. Therefore, in order to perform life cycle assessments and to highlight the most environmentally relevant processes, a differentiation was made between "new buildings" (buildings assumed to be currently built and to represent state-of-the-art construction practice in Europe) and "existing buildings".

4.3.3 New buildings

The building type "new building" is defined as a new construction, where the most common current practices over the last few years until today are considered. The generic life cycle model for a new building includes three phases, the "Construction Phase", the "Use Phase" and the "End-of-Life Phase". These phases are divided into several sections, containing all relevant processes (see Figure 4.1).

The "Construction Phase" divides into "Production of Construction Materials" and "Transport of Materials". The process of construction and its related processes are not considered.

The "Use Phase" contains the relevant processes throughout the building's reference service life in particular "Refurbishment", and "Heating & Cooling", and "Refurbishment" being all actions that are required to maintain the function of the building throughout its service life, without altering the building's environmental performance. "Heating & Cooling" considers the total heating energy demand and the total cooling energy demand as average energy consumption throughout the building's reference service life. The respective mix of energy carriers is considered and specifically built up for this analysis.

The life cycle phase "End-of-Life" divides into the sections "End-of-Life Construction" and "End-of-Life Refurbishment". These sections consider the handling of the wastes which accumulate during the demolition of the original construction materials and the wastes which accumulate during the refurbishment of the building.

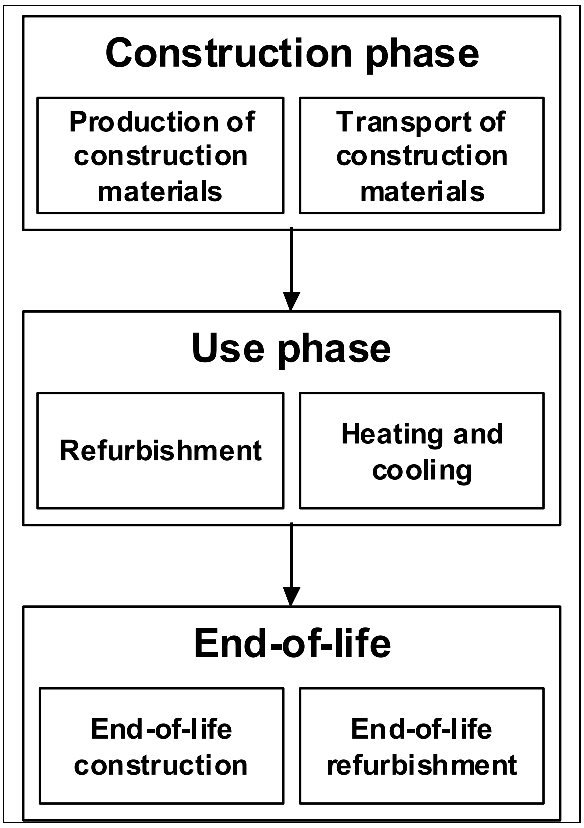


Figure 4.1 Life cycle phases and system boundaries of the life cycle model for a new building including "Construction Phase", "Use Phase" and "End-of-Life"

The life cycle inventory data use average European data, e.g. for the production of construction materials and mixes of energy carriers. Parameters like 'heating energy demand', however considers the geographical resolution of the respective building type.

4.3.4 Existing buildings

While the "new building" scenario considered the construction phase of the building, the "existing building" scenario is limited to the "Use Phase" and the "End-of-Life Phase", since the construction phase of existing buildings is not relevant for the identification of improvement options (see Figure 4.2).

The "Use Phase" and the "End-of-Life Phase" are similar to the new building scenario. The only difference is the service life time within the "Use Phase". In the new building scenario, the service life corresponds to the total time span between construction and end-of-life of the building and is referred to as the "reference service life". Within the existing building scenario, the service life represents the time span between the time of assessment ('today') and the End-of-Life of the building. This time span is referred to as the "residual service life".

The "End-of-Life" phase is divided into "End-of-Life Construction" and "End-of-Life Refurbishment". These sections consider the handling of the wastes which accumulate during the demolition of the original construction materials and the wastes which accumulate during the refurbishment of the building.

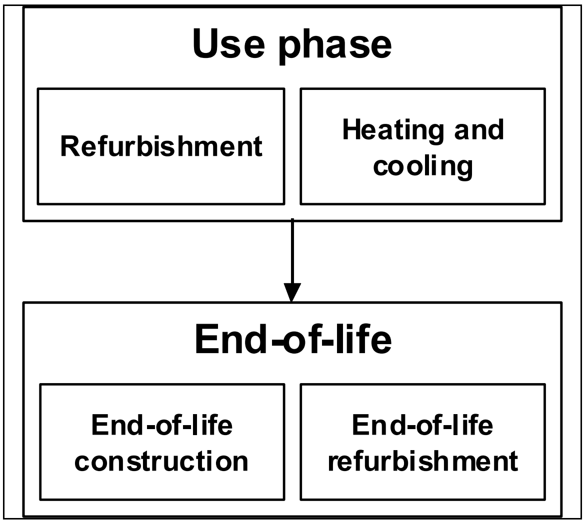


Figure 4.2 Life cycle phases and system boundaries of the life cycle model for an existing building including the "Use Phase" and "End-of-Life"

4.4 Background data

The term "background data" refers to life cycle inventories of construction materials and energy as well as of transportation processes and waste management processes.

In order to assure consistency for the life cycle models of all building types, all background data used except heating energy were from European average datasets. This means that for construction materials, the datasets represent technologies on average levels for the EU-25. These construction materials also contain European (EU-25) boundary conditions such as EU-25 datasets for electric or thermal energy or intermediate products and represent a common European market for construction materials. Using such European average datasets does not show the variability, for instance of the industry producing construction materials industry in Europe and thus has the advantage not to bias the analysis of the life cycle models by accounting for differences in different production techniques. This bias would reduce the significance of the results as the clear denotation of environmental hotspots in the structure and design of buildings would contain higher uncertainties on the origin of environmental impacts.

Based on previous research on the life cycle impacts of buildings, as well as on other LCA studies of buildings, the use phase, particularly the energy demand for heating, is the most likely phase to bear the majority of the life cycle impacts. The composition of the heating energy mix that is used within the model is not related to any constructional questions, but has a significant impact on the overall life cycle impacts of a building type. Therefore, the heating energy mix varies according to the geographical zones adopted (see Section 4.4.1).

Background datasets were taken from the GaBi 4 database as far as possible [LBP & PE 2007]. Additional datasets were modelled with the same boundary conditions and by applying the same modelling methodology as for existing datasets. Existing, as well as newly modelled background datasets are generally based on information from industry and were generally cross-checked with literature data. Where applicable, the information was used to model technology mixes for the production of the respective construction material. In order to assure the data quality of the background datasets, the background data models were validated through completeness checks, sensitivity checks and consistency checks.

4.4.1 Heating energy

The consumption of heating energy is given for every building type individually (see Annex C) and the composition of the heating energy mix is aggregated for each zone separately. [EUROSTAT 2007] provided a mix of primary energies for the total consumption of energy in households. Additionally, [KEMNA ET AL. 2006] provided a table containing the EU residential heat load assessment. By combining both tables, the country-specific mixes of energy carriers were calculated. For each zone, the energy carrier mix was calculated from the weighted energy mixes of the individual countries. The total number of dwellings, given in Annex A, serves as the weighting factor for these data (see Table 4.1). The final zone mix was calculated by multiplying the "share of zone energy" with the respective share for each energy carrier.

The heating energy mixes for each country contain heat as an energy carrier for residential building heating. The life cycle information for the provision of heat was put together on a country-wise level. Information on the composition of primary energy mixes for thermal energy from heat was taken from [IEA 2004]. An efficiency of 90% was assumed for heat as energy carrier, in order to take distribution losses into account.

Table 4.1 Heating energy carrier mix per country and weighting factors to produce zone-specific mixes

Zone and country	Solid fuels	Oil	Gas	Electricity	Heat	Renewable energy sources	Number of households	Share of zone
	%	%	%	%	%	%	Mio.	%
Zone 1	**0.7**	**32.6**	**36.8**	**11.8**	**0.1**	**17.9**		
Malta	0.0	55.0	0.0	44.7	0.0	0.0	0.13	0.1
Cyprus	0.0	23.0	0.0	52.2	0.0	24.4	0.30	0.3
Portugal	0.0	25.3	3.3	22.2	0.0	49.1	5.30	6.0
Greece	0.1	74.0	0.0	5.4	0.8	19.9	5.50	6.2
Spain	1.2	35.5	22.2	23.4	0.0	17.6	20.90	23.7
Italy	0.0	24.7	67.2	3.0	0.0	5.0	26.50	30.1
France	1.3	31.4	33.1	10.4	0.0	23.8	29.50	33.5
Zone 2	**4.7**	**17.0**	**51.3**	**5.1**	**14.9**	**6.9**		
Belgium	1.7	39.9	40.7	15.3	0.4	2.1	4.80	4.5
The Netherlands	0.1	0.8	92.9	0.5	2.8	2.9	6.80	6.4
Ireland	16.6	41.8	21.8	18.1	0.0	1.7	1.60	1.5
Hungary	4.0	4.4	65.4	0.7	15.9	9.5	4.10	3.8
Slovenia	0.0	40.5	6.2	7.8	16.2	29.3	0.80	0.7
Luxembourg	0.0	47.8	43.7	0.0	5.9	2.6	0.20	0.2
Germany	1.1	27.8	44.5	3.0	15.6	7.9	38.90	36.4
United Kingdom	2.7	7.5	79.7	9.5	0.0	0.6	25.60	24.0
Slovakia	4.3	0.2	57.2	0.0	36.7	1.3	1.90	1.8
Denmark	0.0	14.2	14.5	1.1	59.3	10.8	2.60	2.4
Czech Republic	9.5	1.0	38.9	10.4	31.7	8.4	4.40	4.1
Austria	2.3	29.6	24.1	6.1	11.0	26.8	3.30	3.1
Poland	23.9	6.6	13.6	0.3	41.6	14.0	11.80	11.0
Zone 3	**0.6**	**6.8**	**1.0**	**25.5**	**50.7**	**15.4**		
Lithuania	2.4	4.3	4.0	2.2	57.7	29.0	1.30	13.1
Latvia	1.2	3.8	2.9	0.3	46.5	45.1	1.00	10.1
Estonia	1.4	13.0	0.0	12.1	56.7	17.3	0.60	6.1
Sweden	0.0	2.4	0.2	43.2	51.3	2.8	4.40	44.4
Finland	0.3	15.0	0.5	20.0	46.4	17.8	2.60	26.3

4.4.2 Cooling energy

No EU standard method to calculate the cooling energy demand for residential buildings is yet agreed upon and little information and literature is available for its calculation. [DALIN ET AL. 2006] presented a calculation method for the specific cooling demand that is based on a newly introduced European Cooling Index related to the climatic conditions throughout Europe. This specific cooling demand represents a potential energy demand that is not met today and will not necessarily be met in the future (see Table 4.2).

Table 4.2 Specific cooling energy consumption factors per country and weighting factors for the calculation of average cooling energy factors per zone

Zone/ Country	Specific cooling energy potential [DALIN ET AL. 2006]	Expert judgement on the fraction of actual consumption of the cooling energy potential	Specific cooling energy consumption	Weighting factor[a]	Zone average cooling energy consumption
	kWh/m^2*a	%	kWh/m^2*a	Mio. m^2	kWh/m^2*a
Zone 1				**6 232**	**0.773**
Malta	53	3.00	1.590	11	
Cyprus	53	3.00	1.590	40	
Portugal	38	1.00	0.380	326	
Greece	59	3.00	1.770	342	
Spain	54	3.00	1.620	1 414	
Italy	49	1.50	0.735	2 037	
France	35	0.30	0.105	2 062	
Zone 2				**8 037**	**0.032**
Belgium	28	0.10	0.028	351	
The Netherlands	24	0.10	0.024	551	
Ireland	12	0.00	0.000	122	
Hungary	45	0.30	0.135	231	
Slovenia	47	0.30	0.141	44	
Luxembourg	30	0.10	0.030	20	
Germany	35	0.10	0.035	3 489	
United Kingdom	27	0.05	0.014	1 600	
Slovakia	43	0.15	0.065	85	
Denmark	22	0.05	0.011	225	
Czech Republic	33	0.10	0.033	257	
Austria	39	0.10	0.039	292	
Poland	35	0.10	0.035	770	
Zone 3				**661**	**0.000**
Lithuania	37	0.00	0.000	70	
Latvia	29	0.00	0.000	50	
Estonia	24	0.00	0.000	31	
Sweden	27	0.00	0.000	340	
Finland	27	0.00	0.000	170	

a) Living area in Mio. m^2 per country

This demand would be met, if the total living area was cooled throughout the entire cooling season. This might hold true for office buildings but not for residential buildings, where the actual cooling energy demand per living surface unit is likely to be lower because a smaller fraction of the building area is cooled. In addition, the cooling devices are switched on during shorter periods. Cooling demand is also lower in residential buildings than in office buildings as a result of more natural ventilation (e.g. opening the windows during the night).

Based on the calculated cooling energy potential according to [DALIN ET AL. 2006], expert judgement that give the actual used fraction of the theoretical potential are made. These expert judgements are made in each country. Using the total considered building stock per country in million m² as the weighting factor, zone-wide average values are calculated from these country-specific values (see Table 4.2).

The figures obtained were cross-checked with [ADNOT ET AL. 2003] who give information on the total cooling energy demand. They focus on the total cooled areas (residential and non-residential buildings). According to that study, the residential area amounted to 5.75% of the total cooled area within the EU-15 in 2005. Based on that project, the specific cooling energy consumption for that zone (Table 4.3) was derived assuming that:

- the European average share of 5.75% cooled area in the residential sector has a sufficiently low deviation and may be used to express this ratio in every considered country
- the consumption of cooling energy per cooled area is constant throughout all countries and all sectors.

One can derive that in the countries from zone 1 (except for France), the cooling energy consumption from [ADNOT ET AL. 2003] is lower than the expert estimation. For zone 2 and zone 3, the values from [ADNOT ET AL. 2003] are higher than the expert estimation based on [DALIN ET AL. 2006] for all countries.

The deviations can be explained as for the calculations according to [ADNOT ET AL. 2003], a European average of 5.75% for the share of cooled residential areas and a constant cooling energy demand per cooled area was assumed. Thus, the value in southern European countries with greater cooling load should be higher. Accordingly, the values for the middle and northern countries should be lower. Nevertheless, the comparison of the conclusions drawn from the expert judgment based on [DALIN ET AL. 2006] with the values derived from [ADNOT ET AL. 2003] show good consistency, namely respectively 4 490 GWh/a and 4 818 GWh/a cooling demand for the EU-15 (7% gap).

Table 4.3 Calculation of cooling energy consumption based on [ADNOT ET AL. 2003]

Zone/Country	Cooling energy demand for all sectors in 2005 [ADNOT ET AL. 2003]	Cooling energy demand for residential buildings in 2005[a]	Total residential area	Calculated specific cooling energy demand	Specific cooling energy consumption (see Table 4.2)
	GWh/a	GWh/a	Mio. m^2	kWh/m^2*a	kWh/m^2*a
Zone 1			**6232**		
Malta	na[b]	na	11	na	1.590
Cyprus	na	na	40	na	1.590
Portugal	na	na	326	na	0.380
Greece	5 365	308.49	342	0.902	1.770
Spain	28 333	1629.15	1414	1.152	1.620
Italy	24 336	1399.32	2037	0.687	0.735
France	8 213	472.25	2062	0.229	0.105
Zone 2			**8037**		
Belgium	422	24.27	351	0.069	0.028
The Netherlands	690	39.68	551	0.072	0.024
Ireland	180	10.35	122	0.085	0.000
Hungary	na	na	231	na	0.135
Slovenia	na	na	44	na	0.141
Luxembourg	18	1.04	20	0.052	0.030
Germany	4 012	230.69	3489	0.066	0.035
United Kingdom	3 227	185.55	1600	0.116	0.014
Slovakia	na	na	85	na	0.065
Denmark	122	7.02	225	0.031	0.011
Czech Republic	na	na	257	na	0.033
Austria	549	31.57	292	0.108	0.039
Poland	2 049	117.82	770	0.153	0.035
Zone 3			**661**		
Lithuania	na	na	70	na	0.000
Latvia	na	na	50	na	0.000
Estonia	na	na	31	na	0.000
Sweden	378	21.74	340	0.064	0.000
Finland	210	12.08	170	0.071	0.000

a) According to [ADNOT ET AL. 2003], on average in the EU-15, 5.75% of the total cooled areas are residential areas;
b) No values available from [ADNOT ET AL. 2003]

4.4.3 Life cycle inventories of construction materials

On the basis of the detailed technical descriptions of all building types (see Annex B), life cycle inventories (background datasets) for the required construction materials were created. Table 4.4 shows the full list of construction materials that were for the life cycle models of all building types.

The comprehensive list of construction materials used for each building type and the corresponding relevant technical parameters is given in Annex B. This table was revised for the modelling of the building type life cycle models. For all construction materials, two parameters that are required for the modelling were added:

- residual, respective reference service life of the entire building type, and of each construction material, specific to the respective building type and the respective construction element
- refurbishment factors.

These factors yield the number of refurbishment actions for each construction element over the building type's residual service life.

Besides these added parameters, the material densities given in this table were revised and matched to densities as given in GaBi 4 databases [LBP & PE 2007].

Table 4.4 Construction materials included in the life cycle models

Construction material	Comment
Aerated concrete element	Density 0.6 reinforced
Clay	
Clinker	
Concrete	C20/25
Concrete roof tiles	
Exterior plaster	Lime-cement scratch plaster
Façade paint	Mix of previous coat and emulsion paint, synthetic resin and silicate
Gravel	Grain size 2/32
Gypsum board	
Insulation materials mix	Containing: (default mass shares in brackets)[a] - Stone wool (36%) - Glass wool (24%) - Expanded Polystyrene EPS (28%) - Polyurethane PUR (7%) - Extruded Polystyrene XPS (5%)
Interior plaster	Lime-gypsum
Light-weight concrete	Pumice hollow block (density 0.8)
Light-weight concrete	Expanded clay block (density 0.6)
Limestone ($CaCO_3$)	
Oriented Strand Board (OSB)	OSB III (water content 8%)
Ready-mix concrete	C 20/25
Reinforced concrete	Mass of reinforcement wire may be adjusted (default: 160 kg/m^3)
Roof tiles	
Rubble stone masonry	Density 1.6
Sand	Grain size 0/2
Sand-lime brick	
Screed	Anhydrite
Screed	Cement
Timber spruce	Absolute dry
Vertically perforated brick	
Wood fibre board	P5 (water content 8.5%)
Wood paint	Inclusive application

a) Mass shares are estimations, based on [GDI 2005] and [MÉNDEZ nd].

4.5 Generic building models description

The approach of generic models adopted to model selected types of buildings is applied to manage complex product models and it gives the opportunity to provide transparent and summarized results. This is realized by forming flexible models with parameter variations, including previously modelled materials and parts. The parameter variation offers the possibility to adapt the models to specific product properties or modelling design scenarios without the need of forming entirely new models.

Generic models were used for the analysis of the complete manufacturing of a product. By variation of significant parameters, each single module of the product chain could be varied. By implementing the entire manufacturing process into a modelled life cycle, all the effects of each life cycle phase could be recognized depending on the different variations.

The modelling of the selected types of buildings within their various geographical settings imposed challenges is comparability, in modelling efficiency and in clarity of the results. In order to achieve sound, consistent and transparent results through efficient modelling of the selected building types, generic building models with a focus on the building structure were set up, so the three generic building models represent the groups: single-family buildings, multi-family buildings and high-rise buildings.

These generic models were then adapted to varying building types and different geographical settings by parameterizing key variables such as mass or energy fluxes. The generic models also provided the basis for the assessment of different building materials such as concrete, wood, bricks, etc. In order to identify all relevant effects of using specific building materials and constructional elements, all relevant processes, raw materials and operation processes were included in the models.

The generic models were built up within the LCA software system GaBi 4 [LBP & PE 2007]. This comprises a consistent and extensive up-to-date database of processes and materials used in the building industry and in the use phase of the buildings. Regional differences are taken into account in the building's use phase in terms of zone specific heating energy mixes and zone-specific potential cooling energy demand factors. All used material, auxiliary materials and energy datasets are modelled within European boundary conditions.

4.5.1 Modelling of the selected building types in their geographical resolution

The generic life cycle models for new and existing buildings for each group of residential dwellings were used as the basis for the preparation for the new life cycle models of individual building types. Each building type within the three groups of residential dwellings was modelled within its respective geographical areas. This yielded 72 life cycle models for a variety of building types, each modelled within its respective geographical area. The data sets used for materials and energies were taken from the GaBi 4 software and represented respective European system boundaries for the specific energy mixes for the three different geographical regions [LBP & PE 2007].

The generic life cycle models included the three life cycle phases of each building type: the Construction Phase, Use Phase, and End-of-Life.

All life cycle models share a common building structure, consisting of six construction elements or assemblies thereof (see Figure 4.3). These construction elements included the roof, exterior walls, interior walls, windows & entrance doors, floors & ceilings and the basement & foundations.

The construction elements contained all relevant assemblies, sub-assemblies, construction materials and processes required to model the respective building types within their geographic area in a representative way. This included, e.g. for the roof, the roof truss, roofing tiles, vapour barrier and the roof insulation. Consequently, the level of detail and the processes and materials included may vary between different construction materials, depending on the relevance of the individual process or material.

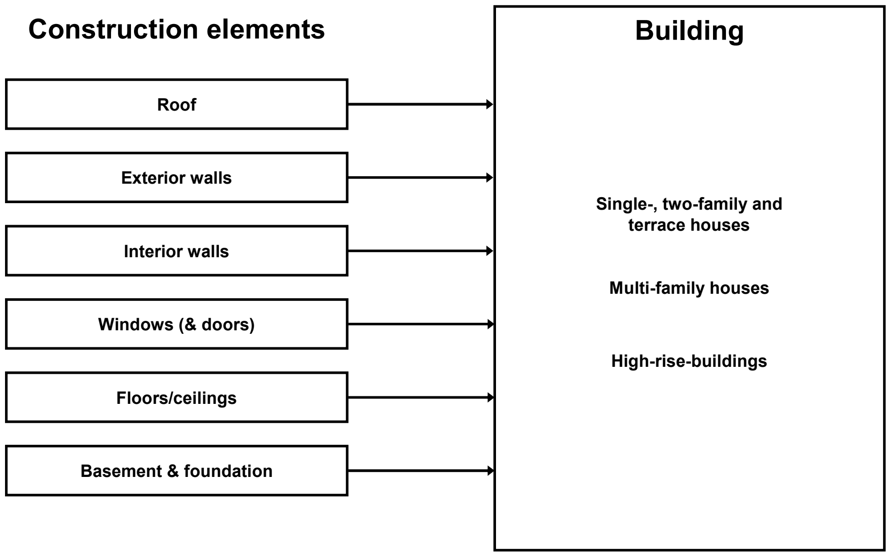


Figure 4.3 Common building structures,, including all relevant and considered construction elements, for all building types within all groups of residential dwellings

This common structure was used to assess improvement potentials by improving the environmental performance of individual construction elements by applying specific refurbishment measures.

In the following sections, the modelling of the different construction elements for the “Construction Phase” is described (Section 4.5.2). The modelling of the “Use Phase” (Section 4.5.3) and the “End-of-Life Phase” (Section 4.5.4) is also explained in the next sections.

The validation of the models in terms of their calculation routines, and their outcome was done with completeness checks, sensitivity checks and consistency checks to ensure the validity of the life cycle inventories.

All relevant processes were considered and modelled to represent the specific model as far as possible. Background processes were taken from the publicly available professional GaBi 4 databases [LBP & PE 2007] as far as was available. New data sets were also modelled, using the same system boundaries and levels of detail as existing data sets. The data sets use European boundary conditions. To ensure consistency, individual data, foreground data and background data were modelled tp the same degree and quality level as applied by [LBP & PE 2007].

For the later analysis of the different building type models, it was necessary to group the used construction materials. By this grouping, a detailed analysis of the environmental impacts of the construction materials was possible. Table 4.5 gives an overview of all used construction materials and their respective grouping. This grouping was one of the bases of for the impact assessment.

Table 4.5 Grouping list for the construction materials

Process	Grouping
Aerated concrete element (density 0.6 reinforced)	Concrete
Concrete C20/25	Concrete
Concrete roof tile	Concrete
Ready mix concrete C20/25	Concrete
Clinker	Stones
Light weight concrete (pumice) hollow block (density 0.8)	Stones
Light weight concrete (expanded clay) block (density 0.6)	Stones
Limestone ($CaCO_3$)	Stones
Rubble stone masonry (density 1.6)	Stones
Sand – lime brick	Stones
Vertically perforated brick	Stones
Clay	Other materials
Exterior plaster (lime cement scratch plaster)	Other minerals
Glass wool (core insulation board)	Other minerals
Gravel (grain size 2/32)	Other minerals
Gypsum board	Other minerals
Interior plaster (lime gypsum)	Other minerals
Roof tile	Other minerals
Sand (grain size 0/2)	Other minerals
Screed (anhydride)	Other minerals
Screed (cement)	Other minerals
Stone wool (flat roof insulation board, 180)	Other minerals
Reinforced steel (wire)	Steel
EPS manufacturing (expanded polystyrene foam, PS 20)	Foam plastics
Polyurethane rigid foam (PU)	Foam plastics
XPS manufacturing (extruded polystyrene foam)	Foam plastics
Bitumen at refinery	Non foamed plastics
Oriented strand board (OSB) III	Wood
Timber spruce abs. dry	Wood
Wood fibre board (P5)	Wood
Wood-aluminium window (0.8 x 1.2) with single glazing	Wood-aluminium window
Wood-aluminium window (1.0 x 1.5) with single glazing	Wood-aluminium window
Wood-aluminium window (1.0 x 2.1) with single glazing	Wood-aluminium window
Wooden window (0.8 x 1.2) with single glazing	Wooden window
Wooden window (1.0 x 1.5) with double glazing	Wooden window
Wooden window (1.0 x 1.5) with single glazing	Wooden window
Wooden window (1.0 x 2.1) with single glazing	Wooden window
Plastic (PVC) window (1.0 x 1.5) with double glazing	PVC window
Plastic (PVC) window (1.0 x 1.5) with single glazing	PVC window
Plastic (PVC) window (1.0 x 1.5) with triple glazing	PVC window
Emulsion paint (synthetic resin)	Coating and sealing material
Wood paint inclusive application	Coating and sealing material

4.5.2 Modelling of the Construction Phase

The modelling of the parameterised generic module of a building is explained by using a single-family house (building type Z1_SI_001) as an example. All parameter settings are adapted to the specifics of this building type.

In the generic module, parameters are used to change the thickness and area (roof, floors and walls); number of pieces (windows) for each material. Fixed or calculated parameters are used to calculate the mass as well as to define the density of the respective material.

The construction phase is split into the modelling of the different construction elements. All construction element modules use a transport model. This transport model is necessary to build up the specific diesel consumption of the transport of the respective construction elements. The diesel consumption depends upon the weight of the transport cargo and the transport distance. The transport distance was estimated by a distribution model which was based on two parameters: the population density of Germany and the distance. For the calculation, the defined Nielsen-urban centres were taken into account. According to the average population density – distance relation, the resulting transport distance was 293 km (for detailed information on the method see [BAITZ 1995]).

4.5.2.1 Roof

Table 4.6 shows the list of parameters which can be selected to model the construction element roof. The variable material parameters are divided in two groups. For each material, the thickness and the area can be chosen to represent a specific roof for the selected building type.

In this specific case, the roof is represented by the following materials: wooden joist (timber spruce 12%), roof battening (timber spruce 12%), an insulation mix, reinforced concrete and exterior plaster. The materials insulation mix and reinforced concrete are also parameterised. The share of the different insulation materials can be specified for each construction element. In this example the insulation mix consists of 28% EPS material, 24% glass wool material, 7% PUR material, 5% XPS material and 36% stone wool material. The share of steel material in the reinforced concrete is 6.7%.

By changing the material parameters of the roof, the total weight of the construction element is adjusted accordingly.

Table 4.6 Parameter list for the roof parameter settings

Parameter	Value	Unit	Parameter description
Mat1_area	21.88	m²	Area of wooden joist (timber spruce 12%), distance 0.6mx0.1
Mat1_thickness	0.16	m	Thickness of wooden joist (timber spruce 12%), distance 0.6mx0.1
Mat2_area	12.5	m²	Area of roof battening (timber spruce 12%)
Mat2_thickness	0.04	m	Thickness of roof battening (timber spruce 12%)
Mat3_area	120	m²	Area of roof tile
Mat3_thickness	0.02	m	Thickness of roof tile
Mat4_area	0	m²	Area of wooden boarding
Mat4_thickness	0	m	Thickness of wooden boarding
Mat5_area	0	m²	Area of stone panel
Mat5_thickness	0	m	Thickness of stone panel
Mat6_area	0	m²	Area of bitumen
Mat6_thickness	0	m	Thickness of bitumen
Mat7_area	0	m²	Area of reinforced concrete
Mat7_thickness	0	m	Thickness of reinforced concrete
Mat8_area	0	m²	Area of interior plaster (lime-gypsum)
Mat8_thickness	0	m	Thickness of interior plaster (lime-gypsum)
Mat9_area	0	m²	Area of gravel
Mat9_thickness	0	m	Thickness of gravel
Mat10_area	0	m²	Area of insulation
Mat10_thickness	0	m	Thickness of insulation
Mat11_area	0	m²	Area of mineral insulation
Mat11_thickness	0	m	Thickness of mineral insulation
Mat12_area	0	m²	Area of prefabricated concrete joist
Mat12_thickness	0	m	Thickness of prefabricated concrete joist
Mat13_area	0	m²	Area of concrete tile
Mat13_thickness	0	m	Thickness of concrete tile
Mat14_area	0	m²	Area of exterior plaster (lime-cement)
Mat14_thickness	0	m	Thickness of interior plaster (lime-gypsum)
EPS	0.28	-	Share (mass) of EPS insulation
XPS	0.05	-	Share (mass) of XPS insulation
Glaswolle	0.24	-	Share (mass) of glass wool insulation
PUR	0.07	-	Share (mass) of PUR insulation
Stonewool	0.36	-	Share (mass) of stone wool insulation
Anteil_stahl	160	kg/m³	Share reinforcement steel (kg steel/m³ concrete)
M3_stahlb	2 400	kg/m³	Density reinforced concrete, including Reinforcement

4.5.2.2 Windows

Table 4.7 shows the list of parameters which can be selected to model the construction element window. In this parameter list the type and the number of windows which should be used in the building type can be selected. These are differentiated in three window types:

- wooden frame
- wood-aluminium frame
- wlastic frame.

It is also possible to choose between single-, double- or triple-glazing. The parameter selection of triple-glazing windows is important for the refurbishment actions in the use phase. In this specific case the construction element window is represented by the window type wooden frame single-glazing (1 m x 1.5 m).

Table 4.7 Parameter list for the window parameter settings

Parameter	Value	Unit	Parameter description
Window1	0	piece	Window wooden frame 0.8 m x 1.2 m (with single-glazing)
Window2	22	piece	Window wooden frame 1 m x 1.5 m (with single-glazing)
Window3	0	piece	Window wooden frame 1 m x 2.1 m (with single-glazing)
Window4	0	piece	Window wood-aluminium frame 0.8 m x 1.2 m (with single-glazing)
Window5	0	piece	Window wood-aluminium frame 1 m x 1.5 m (with single-glazing)
Window6	0	piece	Window wood-aluminium frame 1 m x 2.1 m (with single-glazing)
Window7	0	piece	Window plastic frame 1 m x 1.5 m (with single-glazing)
Window8	0	piece	Window plastic frame 1 m x 1.5 m (with double-glazing)
Window9	0	piece	Window plastic frame 1 m x 1.5 m (with triple-glazing)
Window10	0	piece	Window wooden frame 1 m x 1.5 m (with double-glazing)
Window11	0	piece	Window wood-aluminium frame 0.8 m x 1.2 m (with triple-glazing)
Window12	0	piece	Window wood-aluminium frame 1 m x 1.5 m (with triple-glazing)
Window13	0	piece	Window wood-aluminium frame 1 m x 2.1 m (with triple-glazing)
Window14	0	piece	Window wooden frame 0.8 m x 1.2 m (with triple-glazing)
Window15	0	piece	Window wooden frame 1 m x 1.5 m (with triple-glazing)
Window16	0	piece	Window wooden frame 1 m x 2.1 m (with triple-glazing)

4.5.2.3 Floors and ceilings

Table 4.8 shows the list of parameters which can be selected to model the construction element floors and ceiling. The variable material parameters are divided in two groups. For each material, the thickness and the area can be chosen to represent specific floors for the selected building type. Also the number of floors for the considered building type can be changed.

In this specific case the floor is represented by the material: floor timber spruce, wooden joist (timber spruce 12%), wooden boarding, interior plaster (lime-gypsum), insulation mix and reinforced concrete. The materials insulation mix and reinforced concrete are also parameterised. The share of the different insulation materials can be specified for each construction element. In this example the insulation mix consists of 28% EPS material, 24% glass wool material, 7% PUR material, 5% XPS material and 36% stone wool material. The share of steel material in the reinforced concrete is 6.7%. The number of floors is given as two.

By changing the material parameters and the number of floors and ceilings, the total weight of this construction element were automatically calculated.

Table 4.8 Parameter list for the floors/ceilings parameter settings

Parameter	Value	Unit	Parameter description
Floor_number	2	pieces	Number of floors
Mat1_area	90	m^2	Area of floor timber spruce
Mat1_thickness	0.03	m	Thickness of floor timber spruce
Mat10_area	0	m^2	Area of anhydrite screed
Mat10_thickness	0	m	Thickness of anhydrite screed
Mat11_area	0	m^2	Area of breeze concrete block
Mat11_thickness	0	m	Thickness of breeze concrete block
Mat2_area	15.63	m^2	Area of wooden joist (timber spruce 12%), distance 0.6 m x 0.1 m
Mat2_thickness	0.16	m	Thickness of wooden joist (timber spruce 12%), distance 0.6 m x 0.1 m
Mat3_area	90	m^2	Area of wooden boarding
Mat3_thickness	0.02	m	Thickness of wooden boarding
Mat4_area	90	m^2	Area of interior plaster (lime-gypsum)
Mat4_thickness	0.02	m	Thickness of interior plaster (lime-gypsum)
Mat5_area	0	m^2	Area of cement floor, screed topping
Mat5_thickness	0	m	Thickness of cement floor, screed topping
Mat6_area	0	m^2	Area of reinforced concrete filling
Mat6_thickness	0	m	Thickness of reinforced concrete filling
Mat7_area	0	m^2	Area of ceramic block
Mat7_thickness	0	m	Thickness of ceramic block
Mat8_area	0	m^2	Area of interior plaster (lime-gypsum)
Mat8_thickness	0	m	Thickness of interior plaster (lime-gypsum)
Mat9_area	0	m^2	Area of insulation
Mat9_thickness	0	m	Thickness of insulation
EPS	0.28		Share (mass) of EPS insulation
XPS	0.05	-	Share (mass) of XPS insulation
Glaswolle	0.24		Share (mass) of glass wool insulation
PUR	0.07		Share (mass) of PUR insulation
Steinwolle	0.36		Share (mass) of stone wool insulation
Anteil_stahl	160	kg/m^3	Share reinforcement steel (kg steel/m^3 concrete)
M3_stahlb	2 400	kg/m^3	Density reinforced concrete, including reinforcement

4.5.2.4 Interior walls

Table 4.9 and Table 4.10 show the list of parameters which can be selected to model the construction element inner walls. This construction element is split up into interior load-bearing walls and interior walls.

For each of these elements material parameters are listed. Some materials are used for both elements and some materials are specified for one of the two. For both elements it can be stated that the variable material parameters are divided into two groups. For each material the thickness and the area can be chosen to represent a specific roof for the selected building type.

In this specific case the complete construction element inner walls is represented by the materials: interior plaster (lime-gypsum), wooden construction, reinforced concrete and solid brick. The material reinforced concrete is also parameterised. The share of steel material in the reinforced concrete is 6.7%. By changing the material parameters of the inner wall elements, the total weight of the construction element inner wall will automatically be calculated.

Table 4.9 Parameter list for the inner walls parameter settings (interior walls)

Parameter	Value	Unit	Parameter description
Mat1_area	100	m^2	Area of interior plaster (lime-gypsum) with straw
Mat1_thickness	0.04	m	Thickness of interior plaster (lime-gypsum) with straw
Mat2_area	100	m^2	Area of wooden construction
Mat2_thickness	0.08	m	Thickness of wooden construction
Mat3_area	0	m^2	Area of plaster board (gypsum)
Mat3_thickness	0	m	Thickness of plaster board (gypsum)
Mat4_area	0	m^2	Area of reinforced concrete
Mat4_thickness	0	m	Thickness of reinforced concrete
Mat5_area	0	m^2	Area of solid brick
Mat5_thickness	0	m	Thickness of solid brick
Anteil_stahl	160	kg/m^3	Share reinforcement steel (kg steel/m^3 concrete)
M3_stahlb	2 400	kg/m^3	Density reinforced concrete, incl. reinforcement

Table 4.10 Parameter list for the inner walls parameter settings (interior load bearing walls)

Parameter	Value	Unit	Parameter description
Mat13_area	0	m^2	Area of plaster board (gypsum)
Mat13_thickness	0	m	Thickness of plaster board (gypsum)
Anteil_stahl	160	kg/m^3	Share reinforcement steel (kg steel/m^3 concrete)
M3_stahlb	2 400	kg/m^3	Density reinforced concrete, incl. reinforcement
Mat1_area	60	m^2	Area of interior plaster (lime-gypsum) with straw
Mat1_thickness	0.04	m	Thickness of interior plaster (lime-gypsum) with straw
Mat2_area	60	m^2	Area of solid brick
Mat2_thickness	0.3	m	Thickness of solid brick
Mat3_area	0	m^2	Area of cored brick
Mat3_thickness	0	m	Thickness of cored brick
Mat4_area	0	m^2	Area of brick filling
Mat4_thickness	0	m	Thickness of brick filling
Mat5_area	0	m^2	Area of wooden construction
Mat5_thickness	0	m	Thickness of wooden construction
Mat6_area	0	m^2	Area of limestone/fieldstone
Mat6_thickness	0	m	Thickness of limestone/fieldstone
Mat7_area	0	m^2	Area of breeze concrete
Mat7_thickness	0	m	Thickness of breeze concrete
Mat8_area	0	m^2	Area of rubble stone masonry
Mat8_thickness	0	m	Thickness of rubble stone masonry
Mat9_area	0	m^2	Area of sandlime
Mat9_thickness	0	m	Thickness of sandlime
Mat10_area	0	m^2	Area of concrete
Mat10_thickness	0	m	Thickness of concrete
Mat11_area	0	m^2	Area of reinforced concrete
Mat11_thickness	0	m	Thickness of reinforced concrete
Mat12_area	0	m^2	Area of wooden wall
Mat12_thickness	0	m	Thickness of wooden wall

4.5.2.5 Exterior walls

Table 4.11 shows the list of parameters which can be selected to model the construction element exterior walls. The variable material parameters are divided into two groups. For each material the thickness and the area can be chosen to represent specific exterior walls for the selected building type.

In this specific case the exterior walls are represented by the materials: insulation mix, reinforced concrete, exterior plaster (lime-cement), solid brick and interior plaster (lime-gypsum). The materials insulation mix and reinforced concrete are also parameterised. The share of the different insulation materials can be specified for each construction element. In this example the insulation mix consists of 28% EPS material, 24% glass wool material, 7% PUR material, 5% XPS material and 36% stone wool material. The share of steel material in the reinforced concrete is 6.7%.

By changing the material parameters of the walls the total weight of the construction element exterior walls will automatically be calculated.

Table 4.11 Parameter list for the exterior walls parameter settings

Parameter	Value	Unit	Parameter description
EPS	0.28	-	Share (mass) of EPS insulation
XPS	0.05	-	Share (mass) of XPS insulation
Glaswolle	0.24	-	Share (mass) of glass wool insulation
PUR	0.07	-	Share (mass) of PUR insulation
Steinwolle	0.36	-	Share (mass) of stone wool insulation
Anteil_stahl	160	kg/m³	Share reinforcement steel (kg steel/m³ concrete)
M3_stahlb	2 400	kg/m³	Density reinforced concrete, incl. reinforcement
Mat1_area	220	m²	Area of exterior plaster (lime-cement)
Mat1_thickness	0.02	m	Thickness of exterior plaster (lime-cement)
Mat10_area	0	m²	Area of wooden construction
Mat10_thickness	0	m	Thickness of wooden construction
Mat11_area	0	m²	Area of breeze concrete
Mat11_thickness	0	m	Thickness of breeze concrete
Mat12_area	0	m²	Area of concrete
Mat12_thickness	0	m	Thickness of concrete
Mat13_area	0	m²	Area of sandlime
Mat13_thickness	0	m	Thickness of sandlime
Mat14_area	0	m²	Area of wooden wall
Mat14_thickness	0	m	Thickness of wooden wall
Mat15_area	0	m²	Area of rubble stone masonry
Mat15_thickness	0	m	Thickness of rubble stone masonry
Mat16_area	0	m²	Area of insulation
Mat16_thickness	0	m	Thickness of insulation
Mat17_area	0	m²	Area of mineral insulation
Mat17_thickness	0	m	Thickness of mineral insulation
Mat18_area	0	m²	Area of wooden facade
Mat18_thickness	0	m	Thickness of wooden facade
Mat2_area	220	m²	Area of solid brick
Mat2_thickness	0.5	m	Thickness of solid brick
Mat3_area	220	m²	Area of interior plaster (lime-gypsum)
Mat3_thickness	0.02	m	Thickness of interior plaster (lime-gypsum)
Mat4_area	0	m²	Area of limestone/fieldstone

Parameter	Value	Unit	Parameter description
Mat4_thickness	0	m	Thickness of limestone/fieldstone
Mat5_area	0	m²	Area of cored brick
Mat5_thickness	0	m	Thickness of cored brick
Mat6_area	0	m²	Area of core insulation
Mat6_thickness	0	m	Thickness of core insulation
Mat7_area	0	m²	Area of brick filling
Mat7_thickness	0	m	Thickness of brick filling
Mat8_area	0	m²	Area of plaster board (gypsum)
Mat8_thickness	0	m	Thickness of plaster board (gypsum)
Mat9_area	0	m²	Area of reinforced concrete
Mat9_thickness	0	m	Thickness of reinforced concrete

4.5.2.6 Basement and foundation

Table 4.12 to Table 4.15 show the list of parameters which can be selected to model the construction element basement and foundation. These construction elements are split up into four elements:

- basement ceiling
- basement ground floor
- basement wall
- foundation.

For each of these elements material parameters are listed. Some materials are used for all elements and some materials are specified for one of the four.

For all elements it can be stated that the variable material parameters are divided into two groups. For each material, the thickness and the area can be chosen to represent a specific basement for the selected building type.

Table 4.12 Parameter list for the basement and foundation parameters settings (basement ceiling)

Parameter	Value	Unit	Parameter description
Mat1_area	120	m²	Area of vaulted brick ceiling
Mat1_thickness	0.07	m	Thickness of vaulted brick ceiling
Mat2_area	31.25	m²	Area of wooden construction
Mat2_thickness	0.08	m	Thickness of wooden construction
Mat3_area	90	m²	Area of filling sand and grit
Mat3_thickness	0.08	m	Thickness of filling sand and grit
Mat4_area	90	m²	Area of wooden boarding
Mat4_thickness	0.02	m	Thickness of wooden boarding
Mat5_area	0	m²	Area of anhydrite screed
Mat5_thickness	0	m	Thickness of anhydrite screed
Mat6_area	0	m²	Area of insulation
Mat6_thickness	0	m	Thickness of insulation
Mat7_area	0	m²	Area of reinforced concrete
Mat7_thickness	0	m	Thickness of reinforced concrete
Anteil_stahl	160	kg/m³	Share reinforcement steel (kg steel/m³ concrete)
M3_stahlb	2 400	kg/m³	Density reinforced concrete, incl. reinforcement

In this specific case, the complete construction element basement and foundation is represented by the materials: vaulted brick ceiling, wooden construction, filling sand and grit, wooden boarding, reinforced concrete, brick and solid brick. The material reinforced concrete is also parameterised. The share of steel material in the reinforced concrete is 6.7%.

By changing the material parameters, the total weight of the construction element was automatically calculated.

Table 4.13 Parameter list for the basement/foundation parameter settings (basement ground floor)

Parameter	Value	Unit	Parameter description
Mat1_area	90	m²	Area of brick
Mat1_thickness	0.1	m	Thickness of brick
Mat2_area	0	m²	Area of compact loam
Mat2_thickness	0	m	Thickness of compact loam
Mat3_area	0	m²	Area of concrete
Mat3_thickness	0	m	Thickness of concrete

Table 4.14 Parameter list for the basement/foundation parameter settings (basement wall)

Parameter	Value	Unit	Parameter description
Mat1_area	80	m²	Area of solid brick
Mat1_thickness	0.8	m	Thickness of solid brick
Mat2_area	0	m²	Area of limestone/fieldstone
Mat2_thickness	0	m	Thickness of limestone/fieldstone
Mat3_area	0	m²	Area of reinforced concrete
Mat3_thickness	0	m	Thickness of reinforced concrete
Mat4_area	0	m²	Area of rubble stone masonry
Mat4_thickness	0	m	Thickness of rubble stone masonry
Anteil_stahl	160	kg/m³	Share reinforcement steel (kg steel/m³ concrete)
M3_stahlb	2 400	kg/m³	Density reinforced concrete, incl. reinforcement

Table 4.15 Parameter list for the basement/foundation parameter settings (foundation)

Parameter	Value	Unit	Parameter description
Mat1_area	25	m²	Area of brick
Mat1_thickness	0.5	m	Thickness of brick
Mat2_area	0	m²	Area of limestone/fieldstone
Mat2_thickness	0	m	Thickness of limestone/fieldstone
Mat3_area	0	m²	Area of concrete
Mat3_thickness	0	m	Thickness of concrete
Mat4_area	0	m²	Area of rubble stone masonry
Mat4_thickness	0	m	Thickness of rubble stone masonry

4.5.3 Modelling of the Use Phase

The modelling of the use phase of the considered building type is divided into two models. One model represents the overall heat losses (allocated to the construction elements) and the overall potential cooling energy demand over the complete considered life span of the building and the other model represents the masses of the construction elements which are exchanged during the considered life span of the building (refurbishment actions), including maintenance actions. The information on the heat losses are derived from the epiqr® software [EPIQR 1996]. The information on the cooling of residential buildings is calculated as detailed in Section 4.4.2. For each geographical region (Z1, Z2 and Z3) one specific average value is calculated and represented by a European power grid mix.

The maximum service life considered for all building types is 40 years. The life span of the building has an influence on refurbishment and maintenance actions. All actions refer to the residual service life which means that the amount of actions is calculated by this life span.

All construction materials of the construction element floor were assumed to be replaced and renewed after 20 years. Considering a life span of 40 years, the resulting refurbishment factor derived is one, meaning that the construction element have to be replaced once over the complete life span.

For all construction materials for the respective construction elements these refurbishment factors are calculated and used in the model. For detailed information see Section 4.5.3.3.

4.5.3.1 Heating

Calculating the heat losses of a building over its service life is done for each specific building type by using variable parameters. By changing these parameters, the specific heat loss for each construction element can be analysed. The required information for these parameters is:

- area (m^2) per building type. For this calculation, the heating area is assumed to equal the living area as given in Annex C. Minor deviations (due to, e.g. balconies) are neglected
- aeat loss in kWh per m^2 and year, per construction element, respectively building aspect (such as technical heat losses or rejects) in the current situation.

The software programme epiqr® was used to calculate the energy demand, applying a calculation method based on the one specified by the European standard EN 832 [EN 832:2003]. The methodology is based on a stationary approach with monthly temperature and radiation values. Non-stationary effects of heat flux and heat storage are regarded through a multi-zone approach as well as the thermal mass of the building by taking into account all interior masses (interior walls and floors). Compared to the European standard method, the following simplifications are made:

- the construction elements are predefined in a linked pan-European database which means that the user can select appropriate constructions from a database instead of calculating the U-values manually for all building components
- the thermal mass can be calculated according to the Swiss standard by accepting 4 different construction cases:
    - extra-light (e.g. wooden constructions);
    - medium light (e.g. concrete slabs, light concrete walls and wooden flooring);
    - medium heavy (e.g. brick walls with wooden flooring);
    - extra-heavy (e.g. concrete walls and floors)
- the calculation of the ventilation losses is based on proposed losses in 1/h, ranging from 0.3 1/h up to 1.5 1/h, thus covering realistic air changes in existing buildings in Europe (though in some European countries the minimum air change rate is limited to 0.5 1/h because of hygienic reasons).

The simplifications help to drastically reduce the necessary time for assessment and calculation while also slightly reducing the accuracy. Test evaluations performed through the EPIQR project showed a maximum possible error of ± 10% compared to standard method EN 832 [EN 832:2003].

One example of derived results with epiqr® results is given in Figure 4.4.

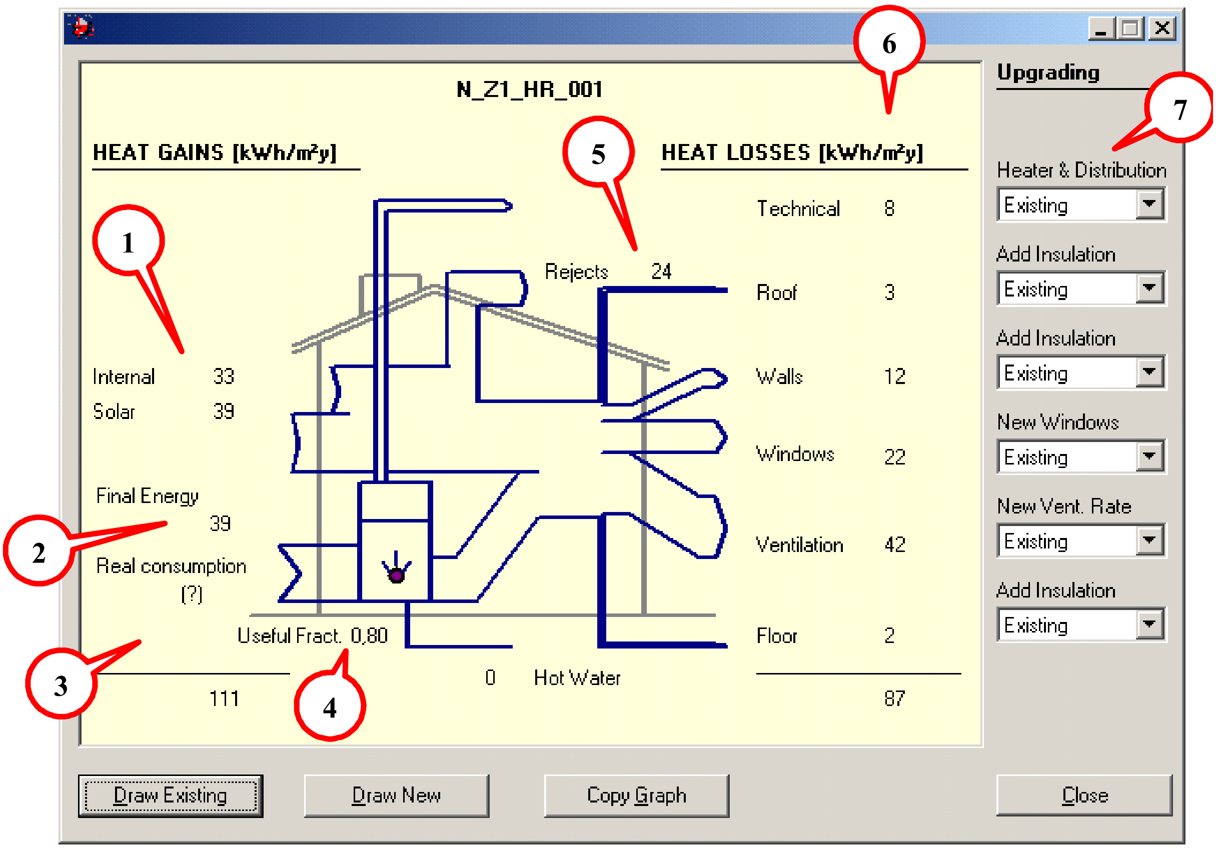


Figure 4.4 Screenshot of the software epiqr® showing as an example the results of the energy calculation

The results in Figure 4.4 are explained as follows:

1 Gains or energy that is available: internal gains from electrical equipment and from human beings and solar gains.

2 The final energy is the estimated energy consumption for space heating (note that hot water is not regarded in the calculation).

3 When available, this value shows the real consumption (derived from fuel consumption monitoring, e.g. in litres of fuel per year).

4 The useful fraction is the yield of the heating and distribution systems.

5 The rejects are the part of the energy that is produced by the heating system but is lost through pipe work and distribution to places where the energy is not needed.

6 The heat losses are the losses through the heating system, through opaque and transparent parts of the building envelope and through ventilation.

7 The user of the software can check the impact of an improvement measure of each or a combination of the losses. The improvements are related to the efficiency of the heat production. “Roof”, ”walls” and “floor” refer to the heat losses through the respective opaque parts of the building envelope. “Windows” refer to the heat losses through transparent parts and “ventilation” corresponds to the losses resulting from gaps in the envelope (e.g. window frames).

The thickness of the arrows represents the energy losses. The thicker the graph, the higher are the losses. From Figure 4.4 it can be seen that the ventilation losses are the highest, followed by the losses through the windows.

The different heat losses through the different building elements as shown in Figure 4.4 were calculated for each building. These values are provided with the energy balance in Annex C. The overall heat losses of the respective building types over their entire service lives are also taken into account any refurbishment – and possible energy retrofitting action over the residual life of the buildings. For this purpose, three additional key parameters are defined for each building:

- reference or residual service life in years for a new and existing building respectively
- years without reduced heat loss per construction element
- reducing factor for heat loss per construction element as a result of the refurbishment measure assumed to be implemented during the building element residual life.

The two last parameters ‘years with reduced heat loss per construction element’ and ‘reduced heat loss over the residual service life per construction element’ allow efficiency gains due to refurbishment actions to be incorporated in a variable way. The effect of improvement options, having an influence on the heating of the building, can be calculated accordingly. As an example, the variable parameter settings are listed for the building type Z1_SI_001 in Table 4.16.

Table 4.16 Parameter settings for heat loss (building type Z1_SI_001)

Parameter name	Construction element	Parameter Value
Heat loss per m^2 per year (kWh/m^2*a)	Roof	89
	Walls	72
	Windows	29
	Basement	17
	Ventilation	63
	Rejects	19
	Technical	51
Reducing factor for heat loss (%)	Roof	93
	Walls	0
	Windows	55
	Basement	0
	Ventilation	0
	Rejects	0
	Technical	0
Time without reduced heat loss (years)	Roof	25
	Walls	40
	Windows	10
	Basement	40
	Ventilation	40
	Rejects	40
	Technical	40
Area per building type (m2)	-	150
Reference service life (years)	-	40

4.5.3.2 Cooling

Section 4.4.2 described the approach necessary to derive the zone-dependent average cooling energy demand. These values are independent of the building type, thus ignoring factors such as shading or orientation of the building, which are known to have significant impacts on the cooling energy demand.

For the evaluation of the life cycle impacts from the cooling energy, the use of one cooling factor for the entire building and the fact that no allocation onto construction elements could be made, should be considered when comparing these results with allocated results for heating energy (see Section 4.5.3.1).

4.5.3.3 Refurbishment

The second model of the Use Phase represents the materials which are used during the life span of the respective building type. The life cycle models of the refurbishment of construction elements are identical to those models of the construction phase. Only the parameter settings have been varied to analyse the refurbishment actions.

The residual service life of the construction elements depend on the type of used materials they are composed of. This is captured through the so-called “refurbishment factor” which details on how often the construction materials have to be replaced. If the residual service life of a construction material is specified by 20 years, then the refurbishment factor is calculated as one (reference service life of the building minus 20 years divided by 20 years again).

The refurbishment factor is calculated individually for each construction material per building type (see Annex B).

4.5.4 Modelling of the End-of-Life

The life cycle phase “End-of-Life” divides into the sections “End-of-Life Construction” and “End-of-Life Refurbishment”. Those sections consider the handling of the wastes which accumulate during demolition of the original construction materials and of the wastes which accumulate during the refurbishment of the building.

For both the EOL phases related to the construction and to the refurbishment of the building type respectively, the mass weight of the used construction materials is automatically calculated in the GaBi 4 software [LBP & PE 2007]. Therefore, for each considered building type, the respective amount of materials can be specified in the End-of-Life phase.

The construction materials are grouped in the same construction elements as for the construction phase. Five groupings are thus defined for the End-of-Life phase (roof, exterior walls, interior walls, floors, basement, and windows).

According to these groups, material composition and the masses, the environmental burdens and credits are calculated assuming corresponding waste treatment plans including recycling and energy recovery (see Table 4.17).

Material recycling results in a credit corresponding to the fact that it enables a subsequent avoidance of the production of virgin material. Each material obtained in the End-of-Life is credited with the environmental burdens associated with the material the recovered fraction is substituting. Thermal energy recovery (incineration) results in credits for power and thermal energy. Natural gas is assumed to be used for this energy transformation.

Table 4.17 Overview of possible waste treatment plans

Construction material	Waste treatment plan	Recycling/ recovery credit	Collection rates
Glass waste	Landfill for inert matter (glass)	-	100%
Construction waste	Landfill for inert matter (construction waste unspecified)	-	100%
Aluminium waste	Aluminium recycling	Material credit	95%
Steel waste	Steel recycling	Material credit	98%
Foam plastics waste	Incineration	Credit for electricity and thermal energy	80%
PVC waste	Incineration	Credit for electricity and thermal energy	80%
Wood	Incineration	Credit for electricity and thermal energy	80%
Concrete	Minerals to inert landfill	-	100%
Other minerals	Minerals to inert landfill	-	100%
Stones	Minerals to inert landfill	-	100%
Coating and sealing	Coating and sealing recycling	Credit for electricity and thermal energy	100%
Waste (untreated)	Landfill for inert matter (construction waste unspecific)	-	Variable

4.5.4.1 Material credit for steel and aluminium waste

The dataset represents an EOL scenario assuming closed loop recycling with a collection rate of 98% (steel) and 95% (aluminium) and average losses during recycling. It includes the "avoided burden" of the recycling product calculated by system expansion. This dataset corresponds with the datasets for the production of galvanized steel sheet and the production of anodized aluminium sheet. It can be used in the supply chain situation of the respective commodity in a representative manner.

The recycling potential describes the ecological value of a material's accumulation in the technosphere. It states how many environmental burdens may be avoided in relation to a new production of the material (avoidance of primary steel or aluminium production). Taking into account this collection rate and today's technologies in metal recycling, an amount of 65% primary steel or aluminium for the production of one kg steel or aluminium sheet is assumed. Since the recycling potential when manufacturing the product represents a saving, it is composed of a complete dataset with full characteristics.

If the complete recycling potential is used, the characteristics for manufacturing the product are lowered by those for the recycling potential.

5 Life cycle assessment results

Having modelled the 72 building types by using the above described generic model, the life cycle impact assessments were performed. The evaluation of the LCA results is exemplarily presented in Section 5.1. The full results for each building type are given in Annex C. Section 5.2 presents a synopsis of all life cycle based results for the individual building types. For orientation purposes, relevant building type information, concerning the technical description of each building type, is given in Annex C. In Section 5.3, the environmental impacts at EU-level are presented.

The results for the conducted LCAs for all building types are the basis for identifying environmental hotspots (Section 5.4). These hotspots are then used to define improvement options and to finally calculate improvement potentials (see Chapter 6 and Chapter 7).

5.1 Detailed results at building level

Each of the 72 building types was evaluated separately and the detailed results are systematically presented in Annex C. The following information illustrates how these results are presented and how they should be interpreted. For each building type, the results of the Life Cycle Assessment are presented in one table and one figure (see Table 5.1 and Figure 5.1 as an example for the building type Z1_SI_001).

Table 5.1 Example of the LCIA results table for building type Z1_SI_001 (Annex C)

	PE* (total) MJ/m²*a	GWP (out)[a] kg/m²*a	GWP (incorp.)[b] kg/m²*a	GWP (net) kg/m²*a	AP kg/m²*a	EP kg/m²*a	POCP kg/m²*a	ODP kg/m²*a
Use Phase	**1 104**	**68.5**	**-19.5**	**49.0**	**1.9E-01**	**1.2E-02**	**6.3E-02**	**3.8E-06**
Refurbishment	72	3.2	-3.3	-0.1	1.2E-02	1.0E-03	1.9E-03	2.2E-07
Heating & cooling	1 032	65.3	-16.2	49.1	1.8E-01	1.1E-02	6.1E-02	3.6E-06
End-of-Life	**-43**	**4.6**	**0.0**	**4.6**	**-4.2E-04**	**2.4E-04**	**-2.1E-05**	**-1.3E-07**
Construction	-18	2.5	0.0	2.5	1.4E-03	3.0E-04	1.4E-04	-6.0E-08
Refurbishment	-25	2.0	0.0	2.0	-1.9E-03	-5.8E-05	-1.6E-04	-6.9E-08
Total**	**1 104**	**68.5**	**-19.5**	**49.0**	**1.9E-01**	**1.2E-02**	**6.3E-02**	**3.8E-06**
Heating & Cooling								
Basement	5.8%	5.8%	5.9%	5.8%	5.8%	5.8%	5.9%	5.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	24.8%	24.8%	24.9%	24.5%	24.6%	24.7%	24.9%	24.2%
Roof	19.9%	19.9%	20.1%	19.7%	19.8%	19.9%	20.0%	19.5%
Windows	5.9%	5.9%	5.9%	5.8%	5.8%	5.8%	5.9%	5.7%
Ventilation	21.7%	21.7%	21.8%	21.4%	21.5%	21.6%	21.7%	21.2%
Others	21.3%	21.3%	21.4%	21.1%	21.1%	21.2%	21.4%	20.8%
Cooling Energy	0.9%	0.7%	0.1%	0.8%	1.5%	0.9%	0.3%	2.9%

* PE: Primary Energy; GWP: Global Warming Potential; AP: Acidification Potential; EP: Eutrophication Potential; POCP: Photochemical Ozone Creation Potential; ODP: Ozone Depletion Potential
** Total = Use Phase
a) Greenhouse gas emissions resulting from fuel combustion and industry processes; b) incorporated greenhouse gases related to the carbon content of the used renewable resources like wood (see also Section 4.1)

Each result page contains a table which gives an overview of all considered environmental indicators and of the impacts from the different life cycle phases (see Table 5.1). The contributions are also given as relative shares. The sum of the Use Phase and the Construction Phase is considered to be 100% (for existing buildings, only the Use Phase is taken into account) and the End-of-Life impacts or credits are indicated as additional (positive or negative) impacts relative to 100%.

The table (Table 5.1) displays the absolute contributions from the life cycle phases (the Use Phase is separated into Heating & cooling, and Refurbishment) and the End-of-Life (EOL) is separated into EOL from construction and EOL from refurbishment.

The second element of the LCIA synopsis is a graph which displays the primary energy consumption associated with each building element and aspect, also showing the respective shares of the non-renewable and renewable primary energy (Figure 5.1).

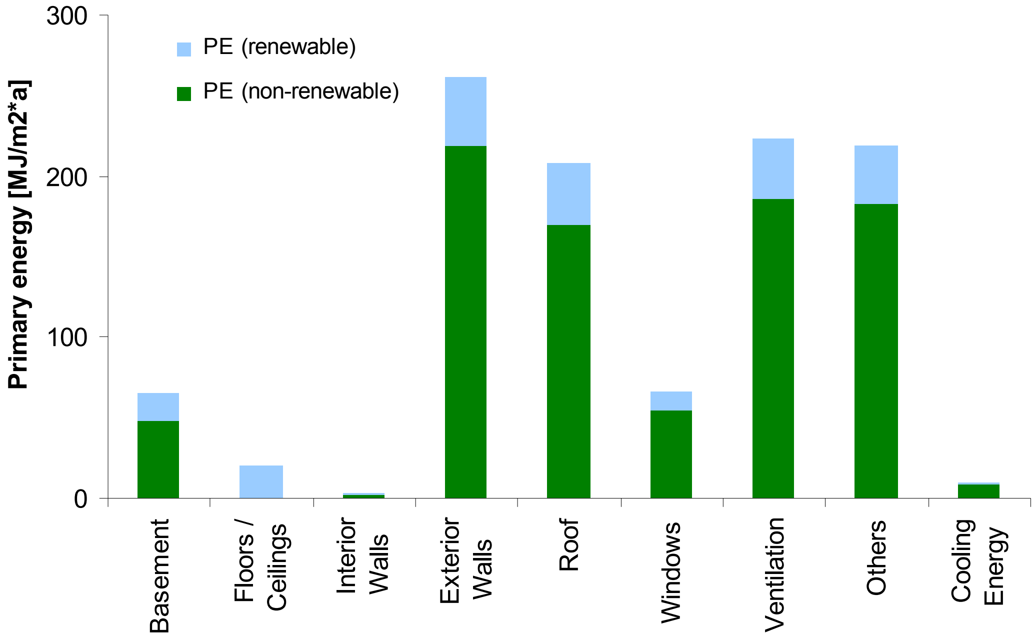


Figure 5.1 Example of the results of the LCA for one building type
The contributions of all life cycle phases from the building elements for the indicator "Primary Energy" are displayed

These detailed results are the basis for the next sections showing the influence of the different building parameters and zones, and highlighting the most important life cycle phases contributing to the environmental impacts.

5.2 Life cycle impacts of the individual building types

5.2.1 Life cycle impacts according to zones and building types

Figure 5.2 to Figure 5.8 display the synoptic results for all building types, separated into the geographical zones as well as into the groups of building types for the consumption of Primary Energy (non-renewable), Primary Energy (renewable), Global Warming Potential, Acidification Potential, Eutrophication Potential, Photochemical Ozone Creation Potential, and Ozone Layer Depletion Potential. The environmental impacts include Use Phase and End-of-Life for existing buildings and, for new buildings, Construction Phase, Use Phase and End-of-Life. New building types are indicated with blank symbols.

In each graph, the total life cycle impacts are represented by the midpoint indicators, expressed per m^2 and per year.

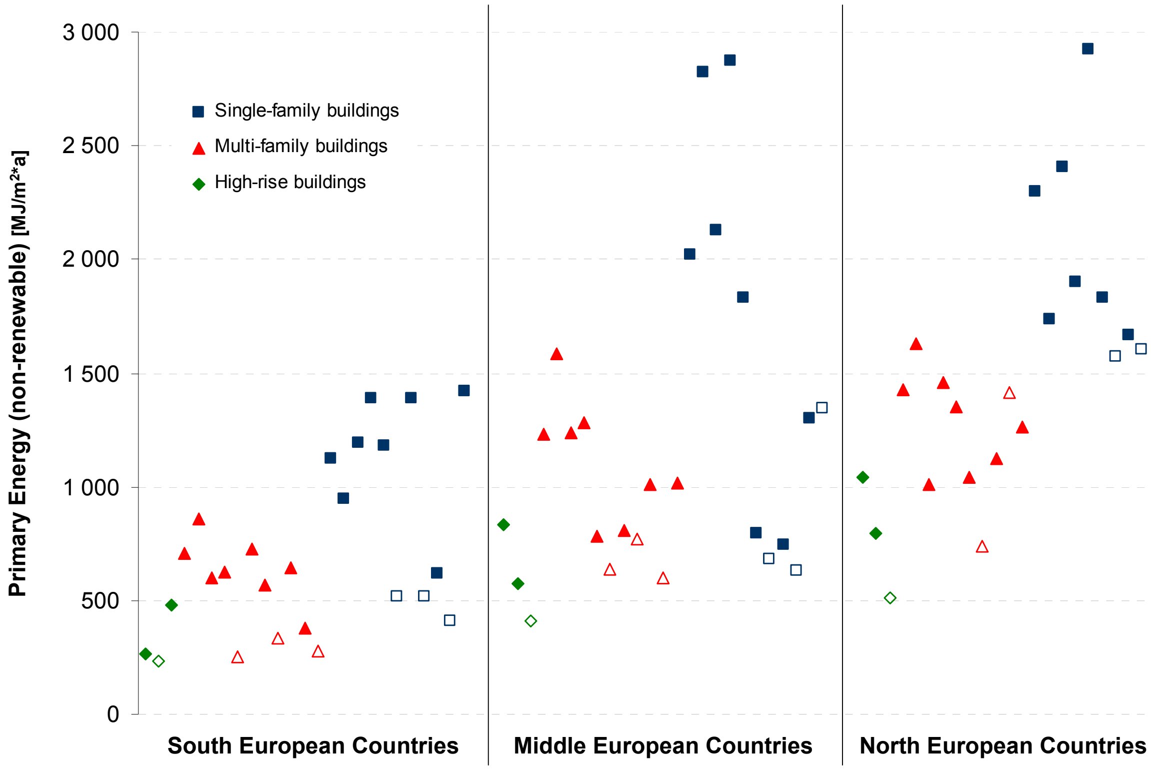


Figure 5.2 Life cycle impacts of all building types for the environmental indicator "Primary Energy (non-renewable)"
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

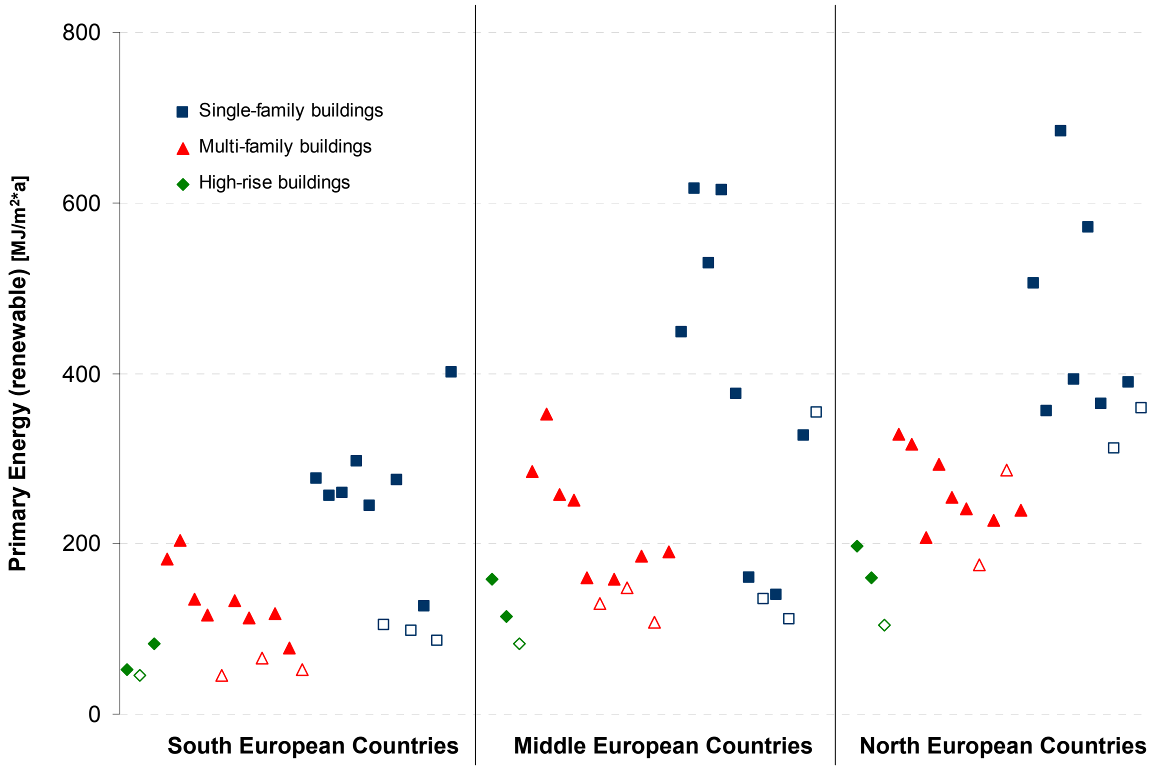


Figure 5.3 **Life cycle impacts of all building types for the environmental indicator "Primary Energy (renewable)"**
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

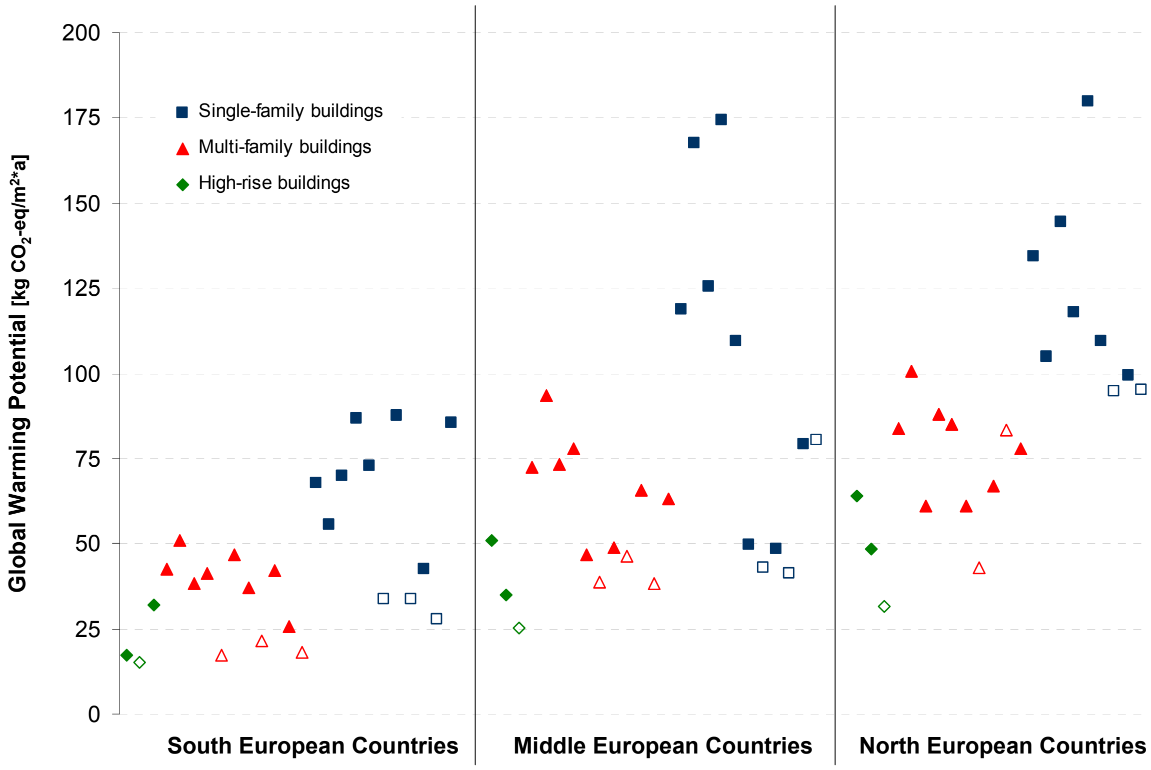


Figure 5.4 **Life cycle impacts of all building types for the environmental impact category "Global Warming Potential"**
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

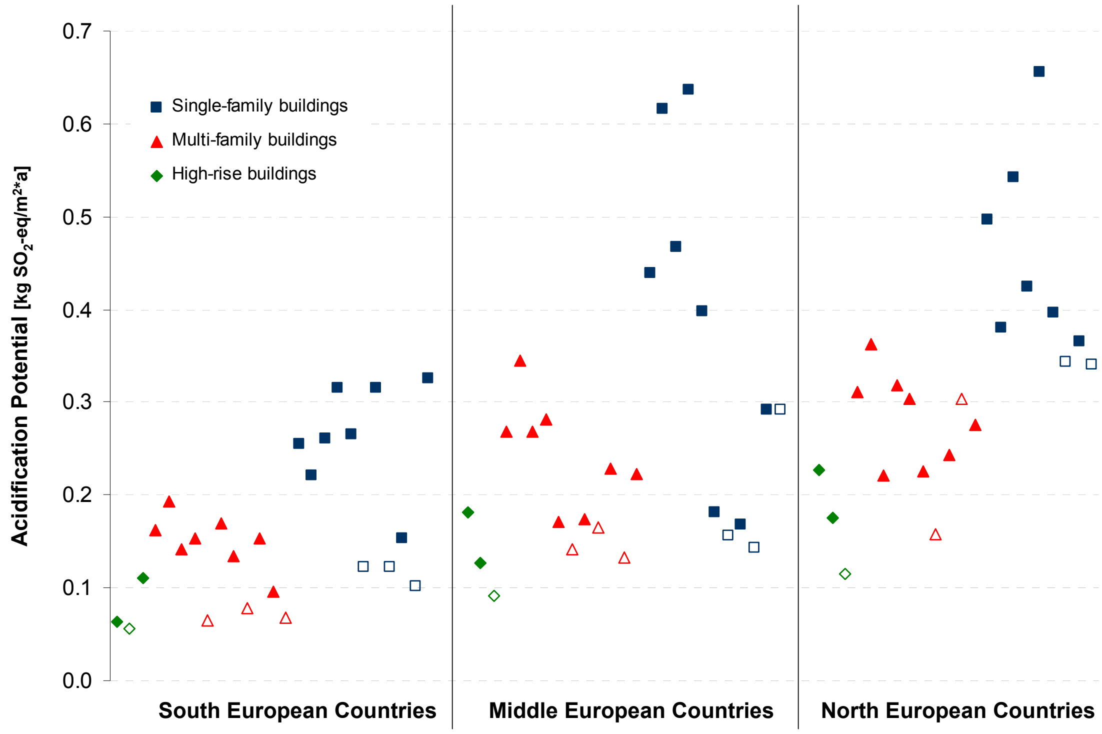


Figure 5.5 Life cycle impacts of all building types for the environmental impact category "Acidification Potential"
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

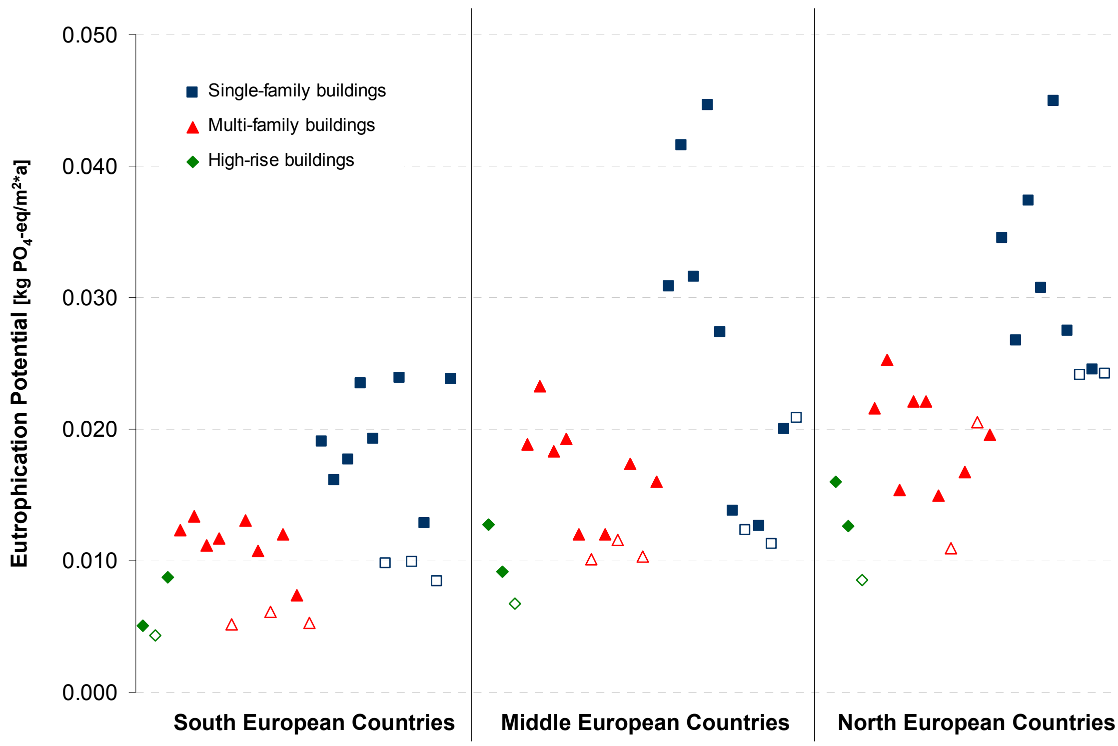


Figure 5.6 Life cycle impacts of all building types for the environmental impact category "Eutrophication Potential"
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

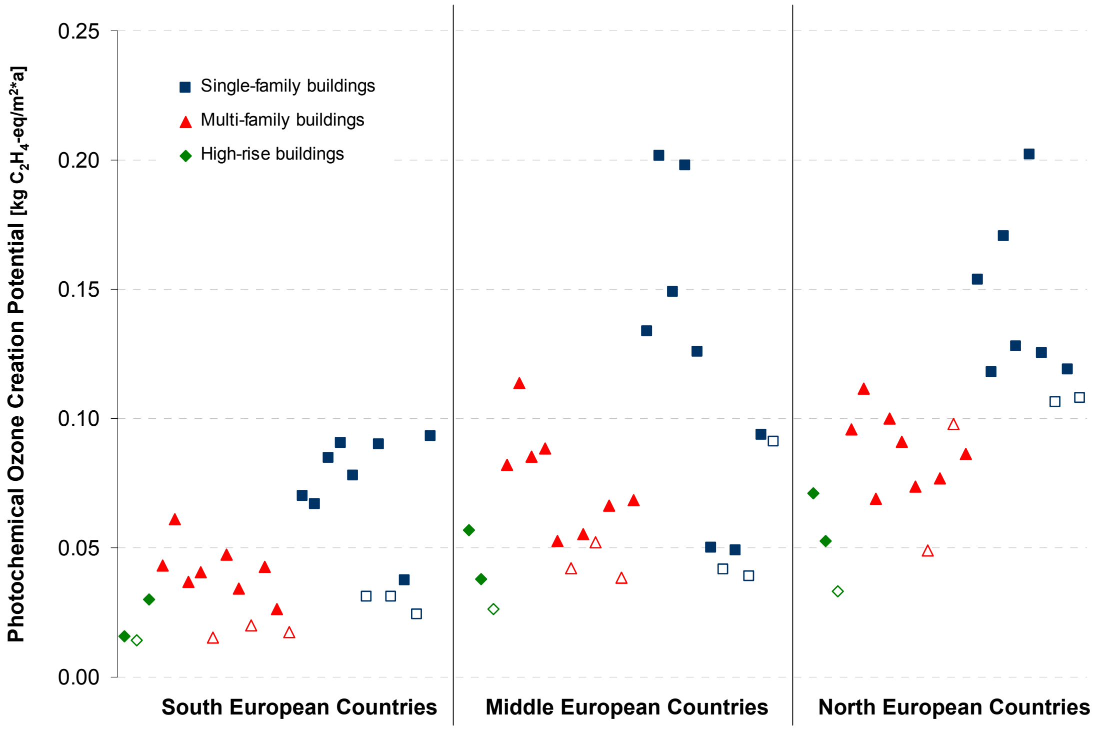


Figure 5.7 **Life cycle impacts of all building types for the environmental impact category "Photochemical Ozone Creation Potential"**
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

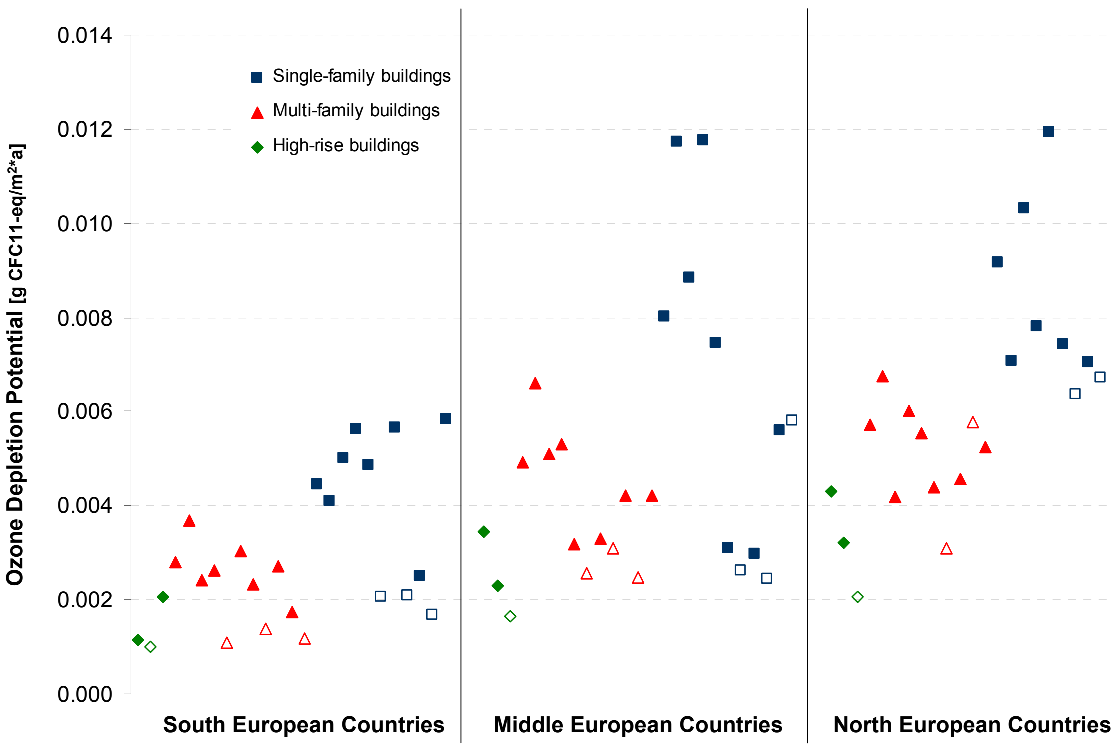


Figure 5.8 **Life cycle impacts of all building types for the environmental impact category "Ozone Depletion Potential"**
New building types are indicated with blank symbols and correspond to the existing building type to the left of them

The graphs (Figure 5.2 to Figure 5.8) show common patterns throughout most impact categories.

In general, high-rise buildings have very similar life cycle impacts while higher deviations in total impacts exist for multi-family houses. The deviations of the life cycle impacts within the single-family houses are even higher. The graphs also show that this finding holds true for all geographical zones.

They also clearly show that the life cycle impacts of buildings in zone 1 (southern European countries) are, on average, lower than those associated with buildings in the two other zones. This trend is clearly visible for high-rise buildings and, to a lesser extent, for multi-family buildings while the deviations between single-family houses are generally too high to identify such a trend.

Another visible trend in these graphs is that the high-rise buildings have the lowest life cycle impacts. On average, single-family houses have the highest impacts.

These three general trends all result from the influence of the climatic conditions, the building shape (area:volume ratio) and the insulation level on the energy demand for heating (see Section 5.4.2).

When new buildings and existing buildings are compared, it can be seen that new buildings generally have better environmental performances than the corresponding existing building.

5.2.2 Life cycle impacts according to life cycle phases

The environmental impacts according to life cycle phases are displayed in Table 5.2 (existing buildings) and Table 5.3 (new buildings). The ranges of the contributions of each life cycle phase grouped according to geographical zone and building type are displayed (minimum and maximum shares).

It should be noted that, as a definition, the Use Phase of existing buildings amounts to 100% of the impacts (see Section 5.1). For the End-of-Life phase, negative values can be observed, as a result of recycling credits (see Section 4.5.4).

In most cases, the End-of-Life does not exceed 5% (blank and pale yellow cells in Table 5.2) of the impacts from the use phase of existing buildings. For some impact categories (Acidification, Eutrophication, Photochemical Pollution, and Ozone Depletion), the End-of-Life contribution ranges from negative to positive values. For GWP (net emissions), and for Primary Energy in zone 1, the contribution of the EOL is up to +9.3% (single-family houses). To a lesser extent, this also holds true for Eutrophication Potential (up to 4.5%).

In general, the relative contribution of the End-of-Life is more important in zone 1 than it is in the other zones. This is explained by lower environmental impacts during the Use Phase (due to lower heating energy demand) as already shown in Section 5.2.1. The share of the End-of-Life in southern Europe thus is only greater in relative terms compared to the middle and northern European countries.

Table 5.2 Range of the share (%) of the contribution of the life cycle phases to the environmental impacts for each geographical zone and building type group (existing buildings)

Zone	Group	Life Cycle Phase	PE (total)	GWP (net)	AP	EP	POCP	ODP
1	SI	Use Phase	100	100	100	100	100	100
		End-of-Life	1.1 - 9.3	1.1 - 9.3	-0.7 - 2.2	1.3 - 4.5	-0.2 - 0.6	-3.7 - 0.1
	MF	Use Phase	100	100	100	100	100	100
		End-of-Life	0.5 - 9.1	0.5 - 9.1	-0.1 - 1.9	0.1 - 4.0	0.0 - 0.5	-3.2 - 0.1
	HR	Use Phase	100	100	100	100	100	100
		End-of-Life	0.5 - 2.3	0.5 - 2.3	0.3 - 1.0	0.6 - 2.2	0.1 - 0.2	-0.1 - 0.1
2	SI	Use Phase	100	100	100	100	100	100
		End-of-Life	0.9 - 6.4	0.9 - 6.4	-1.3 - 0.8	-0.5 - 1.7	-0.3 - 0.2	-2.9 - -0.2
	MF	Use Phase	100	100	100	100	100	100
		End-of-Life	0.3 - 4.0	0.3 - 4.0	-0.1 - 0.3	0.2 - 1.2	0.0 - 0.1	-1.5 - 0.1
	HR	Use Phase	100	100	100	100	100	100
		End-of-Life	0.3 - 1.1	0.3 - 1.1	0.1 - 0.5	0.2 - 1.0	0.0 - 0.1	0.0 - 0.1
3	SI	Use Phase	100	100	100	100	100	100
		End-of-Life	0.9 - 8.9	0.9 - 8.9	-1.7 - 0.4	-0.4 - 1.1	-0.4 - 0.1	-3.9 - -0.2
	MF	Use Phase	100	100	100	100	100	100
		End-of-Life	0.3 - 3.9	0.3 - 3.9	-1.0 - 0.5	-0.6 - 1.1	-0.3 - 0.1	-1.7 - 0.1
	HR	Use Phase	100	100	100	100	100	100
		End-of-Life	0.3 - 1.2	0.3 - 1.2	0.1 - 0.5	0.2 - 0.9	0.0 - 0.1	0.0 - 0.1

* Negative values indicate credits

> 2%	(absolute value)
> 5%	(absolute value)
> 20%	(absolute value)
> 80%	(absolute value)

For new buildings (Table 5.3), per definition, the sum of the Construction Phase and the Use Phase is considered to be 100% of the impacts (see Section 5.1). Again, for the End-of-Life phase, there can be negative values as a result of recycling credits (see Section 4.5.4).

In general, the Use Phase dominates the environmental impacts and contributes (for all building groups and zones) for more than 50% (in all cases). Its share can even reach 97%. The Construction Phase also contributes to the impacts and can reach considerable shares (up to 50% in the case of single-family houses in zone 1 and Eutrophication Potential). The End-of-Life phase is of minor relevance for all zones and building groups. The maximum levels reached are 8% for single-family houses in zone 2 and 6% for multi-family houses in zone 3. In most of the cases, the End-of-Life share does not exceed 5%.

Similar to the existing building types, there are some general trends for the new building types as well. Within each zone, the significance of the Use Phase usually increases from single-family houses to multi-family houses and then to high-rise buildings with an exception for the high-rise buildings in the northern European countries (zone 3). This again, is due to relatively fewer environmental impacts during the Use Phase (due to lower heating energy demand) for multi-family houses and high-rise buildings when compared to single-family houses. For all building groups, the importance of the Use Phase increases from zone 1 to zone 3 in general. The reason for this trend is the comparatively higher heating energy demand in middle and northern European countries compared to zone 1, which leads to a relatively higher share of the Use Phase when compared to the Construction Phase and the End-of-Life.

It should be borne in mind that the significance of the Use Phase also depends on the assumed residual service life for new buildings. The service life was estimated to be 40 years or longer but the Use Phase was restricted to 40 years (see Section 4.3.2). Thus, for some building types, the significance of the Use Phase could even be higher if the full residual service life of the building type is taken into account for the Use Phase.

Table 5.3 Range of the share (%) of the contribution of the life cycle phases to the environmental impacts for each geographical zone and building type group (new buildings)

Zone	Group	Life Cycle Phase	PE (total)	GWP (net)	AP	EP	POCP	ODP
1	SI	Constr. Phase	33.4 - 37.2	33.4 - 37.2	32.6 - 35.9	46.3 - 49.9	13.0 - 15.0	21.5 - 24.4
		Use Phase	62.8 - 66.6	62.8 - 66.6	64.1 - 67.4	50.1 - 53.7	85.0 - 87.0	75.6 - 78.5
		End-of-Life	1.5 - 3.2	1.5 - 3.2	0.8 - 1.1	1.5 - 1.7	0.3 - 0.4	-0.8 - -0.1
	MF	Constr. Phase	26.4 - 34.7	26.4 - 34.7	26 - 35.4	39.3 - 47.7	9.2 - 13.6	15.1 - 20.6
		Use Phase	65.3 - 73.6	65.3 - 73.6	64.6 - 74	52.3 - 60.7	86.4 - 90.8	79.4 - 84.9
		End-of-Life	1.9 - 2.9	1.9 - 2.9	0.5 - 0.8	1.1 - 1.3	0.1 - 0.2	-0.8 - -0.3
	HR	Constr. Phase	26.8	26.8	25.8	38.8	9.1	15.4
		Use Phase	73.2	73.2	74.2	61.2	90.9	84.6
		End-of-Life	1.7	1.7	0.8	1.3	0.2	-0.1
2	SI	Constr. Phase	9.1 - 29.3	9.1 - 29.3	13.9 - 29.1	22.2 - 41.6	5.7 - 11.3	15.4 - 19.2
		Use Phase	70.7 - 90.9	70.7 - 90.9	70.9 - 86.1	58.4 - 77.8	88.7 - 94.3	80.8 - 84.6
		End-of-Life	2.1 - 8.2	2.1 - 8.2	-1.8 - 0.7	-0.8 - 1.3	-0.5 - 0.2	-3.4 - -0.4
	MF	Constr. Phase	12.5 - 24.2	12.5 - 24.2	10.3 - 20.0	17.9 - 33.4	3.3 - 6.8	6.4 - 16.6
		Use Phase	75.8 - 87.5	75.8 - 87.5	80 - 89.7	66.6 - 82.1	93.2 - 96.7	83.4 - 93.6
		End-of-Life	1.1 - 1.4	1.1 - 1.4	0.3 - 1.1	0.6 - 1.9	0.1 - 0.6	-0.3 - 0.1
	HR	Constr. Phase	19.0	19.0	18.3	28.7	6.0	11.8
		Use Phase	81.0	81.0	81.7	71.3	94.0	88.2
		End-of-Life	1.2	1.2	0.5	0.8	0.1	0.0
3	SI	Constr. Phase	8.6 - 13.1	8.6 - 13.1	9.5 - 12.6	16.3 - 20.7	3.8 - 4.2	7.9 - 10.7
		Use Phase	86.9 - 91.4	86.9 - 91.4	87.4 - 90.5	79.3 - 83.7	95.8 - 96.2	89.3 - 92.1
		End-of-Life	0.9 - 3.9	0.9 - 3.9	-0.7 - 0.2	-0.2 - 0.5	-0.2 - 0	-1.7 - -0.2
	MF	Constr. Phase	8.2 - 8.3	8.2 - 8.3	8.3 - 10.8	13.8 - 17.5	2.6 - 3.9	5.1 - 11.5
		Use Phase	91.7 - 91.8	91.7 - 91.8	89.2 - 91.7	82.5 - 86.2	96.1 - 97.4	88.5 - 94.9
		End-of-Life	0.7 - 5.5	0.7 - 5.5	-1.3 - 0.1	-0.6 - 0.4	-0.4 - 0	-2.3 - -0.2
	HR	Constr. Phase	20.0	20.0	19.3	30.0	6.4	12.6
		Use Phase	80.0	80.0	80.7	70.0	93.6	87.4
		End-of-Life	1.3	1.3	0.5	0.8	0.1	-0.1

* Negative values indicate credits

> 5%	(absolute value)
> 20%	(absolute value)
> 50%	(absolute value)
> 80%	(absolute value)

5.3 Environmental impacts at EU level

The environmental impacts of the 72 single building types were aggregated at EU level by multiplication with the respective building stock (living area in Mio. m^2). Figure 5.9 displays the results of the aggregation for the impact category “Global Warming Potential”. The results for the other impact categories show similar patterns (this will be discussed in detail in Section 5.3.2 below).

First, the environmental impacts from new buildings can be seen to be negligible when compared to the impacts from existing buildings (share is 1.2%).

Second, the results show that zone 1 (23.6%) and zone 2 (69.6%) dominate the environmental impacts. Zone 3 is responsible for only 6.8% of the environmental impacts. This is primarily due to the low percentage share of living area in the north European countries (4.0%) when compared to zone 1 (42.9%) and zone 2 (53.1%) which completely outweighs the – generally – higher environmental impacts per m^2 in northern Europe as a result of colder weather conditions (see Section 5.2.1).

Third, the results suggest that single-family and multi-family houses dominate the environmental impacts at EU level. This finding will be discussed in greater detail in Section 5.3.2. Only five to ten building types dominate the environmental impacts (due to their high percentage share of living area).

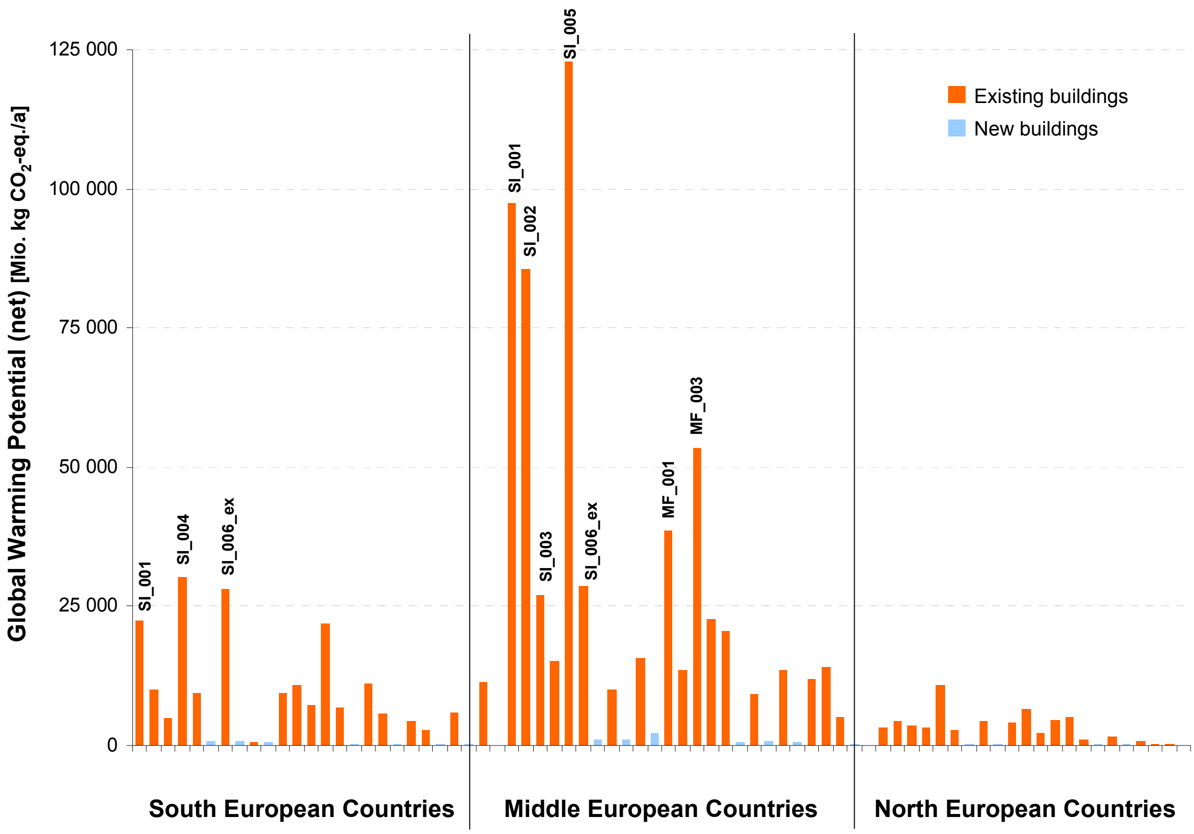


Figure 5.9 Total environmental impact of the building stock in the EU-25 for the environmental indicator ”Global Warming Potential”

5.3.1 Environmental impacts according to life cycle phase

Figure 5.10 illustrates, at aggregated EU level, the dominance of the Use Phase in the environmental impacts of the existing residential building stock in the EU-25. The End-of-Life accounts for only -1.3 to 2.7% of the environmental impacts. For Primary Energy (non-renewable and renewable), and Ozone Depletion Potential, the End-of-Life Phase contribution is negative, i.e. the End-of-Life comes with credits due to material recycling (-1.3 to -0.1%). For GWP, Acidification Potential, Eutrophication Potential and Photochemical Ozone Creation Potential, the End-of-Life exhibits positive environmental impacts (0.1 to 2.7% when compared to the impacts from the Use Phase).

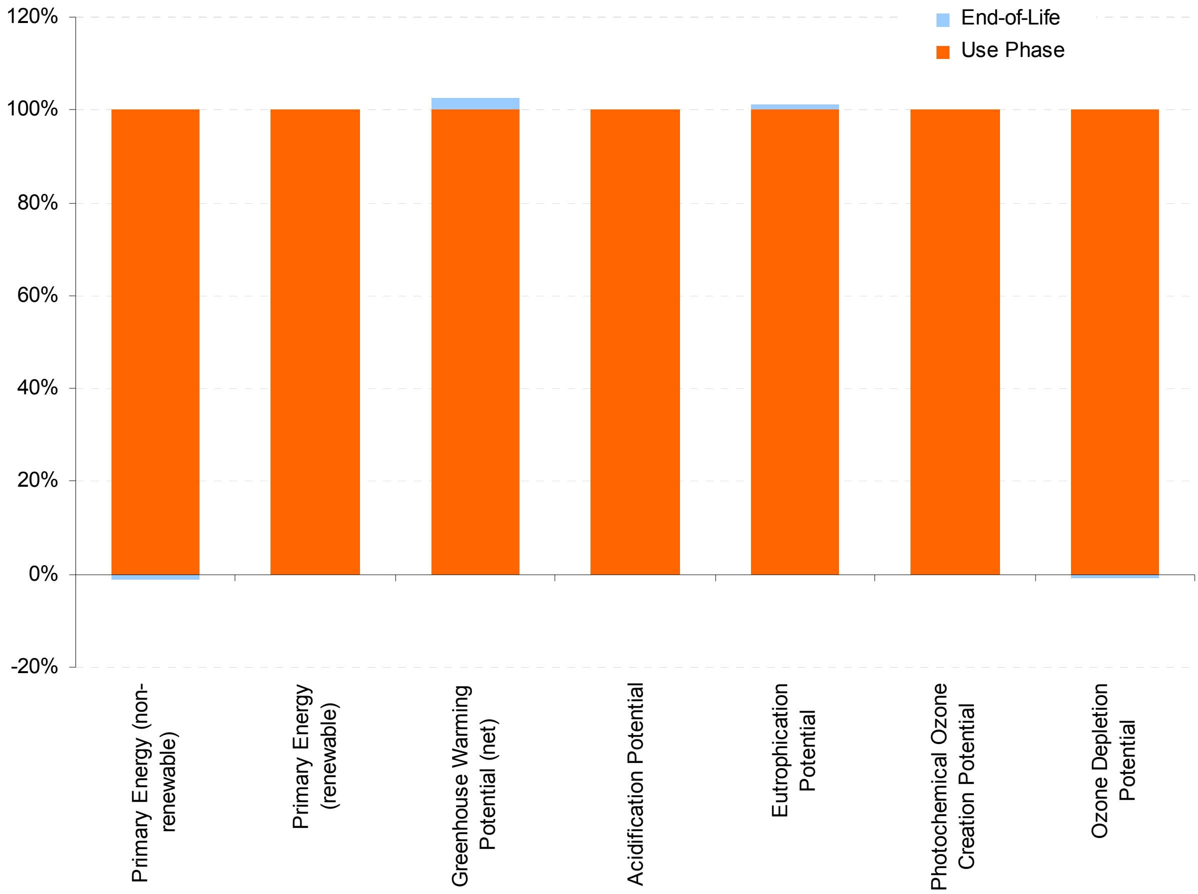


Figure 5.10 Total environmental impacts of the building stock in the EU-25 according to life cycle phases (existing buildings)

For new buildings, the Use Phase also dominates the total environmental impacts at EU level, but the Construction Phase also accounts for a great percentage share of the impacts (Figure 5.11). The Construction Phase is responsible for 8.3 to 34.3% of the environmental impacts. The percentage share is highest for Eutrophication Potential (34.3%) and lowest for POCP (8.3%).

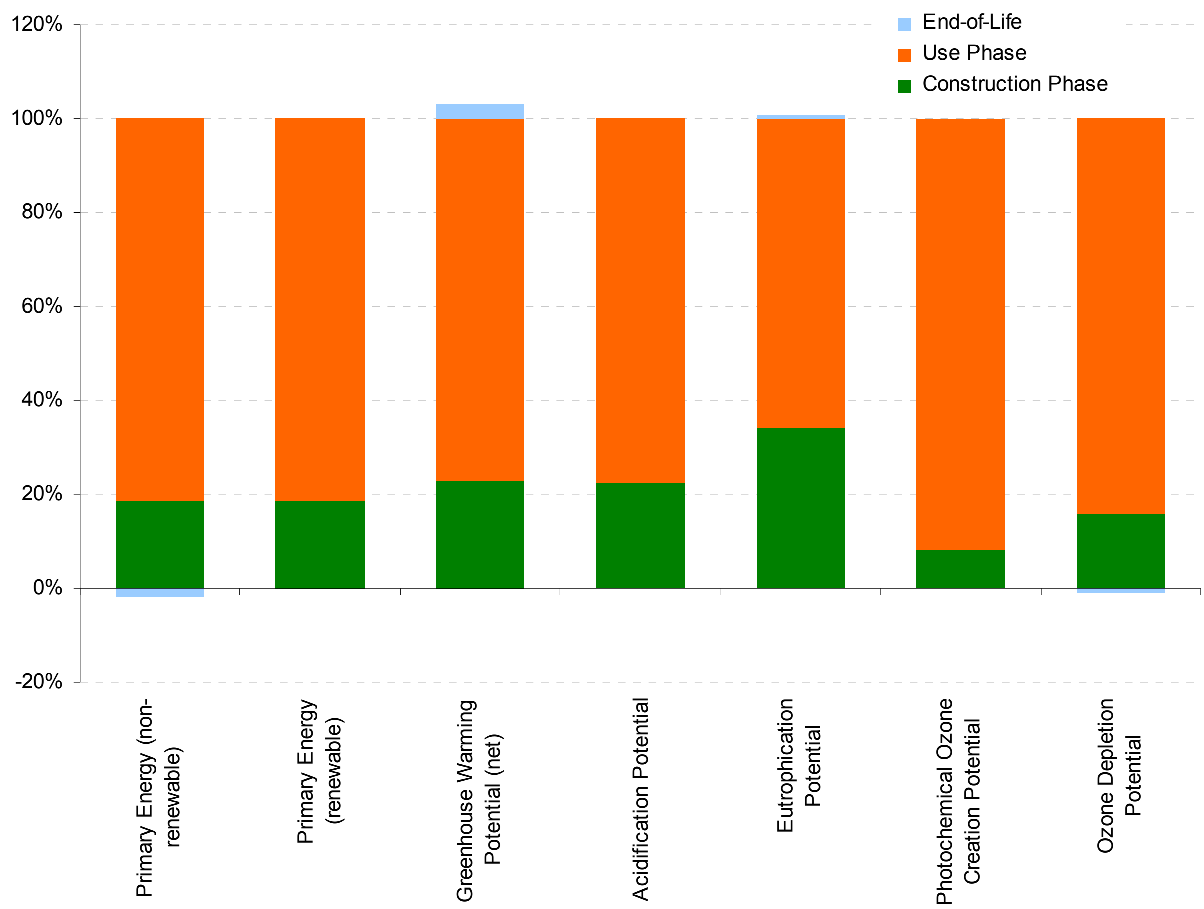


Figure 5.11 Total environmental impact of the building stock in the EU-25 according to life cycle phases (new buildings)

Again, the End-of-Life is of minor importance only (-1.7 to 3.2% of the environmental impacts). For Primary Energy (non-renewable and renewable), and Ozone Depletion Potential, the End-of-Life comes with credits while for GWP, AP, EP and POCP, the End-of-Life shows positive environmental impacts.

5.3.2 Environmental impacts according to geographical zone and building group

When grouped according to geographical zones, the majority of the environmental impacts can be seen to occur in zone 2 (middle European countries) with 69.2 to 69.7% of the environmental impacts at EU level (Figure 5.12). Zone 1 (southern European countries) is responsible for 23.5 to 24.1% of the impacts. Zone 3 only plays a minor role (6.7 to 6.8%). When compared to the living area, zone 2 represents a higher percentage share of the environmental impacts than the percentage share of living area would suggest (53.1%). The same holds true for zone 3 (4% of living area). For zone 1 (42.9%), the respective environmental impacts are smaller than the share in living area. This can be explained by lower environmental impacts generally of the building stock of zone 1 per m^2 when compared to the building types in the other zones (see Section 5.2.1).

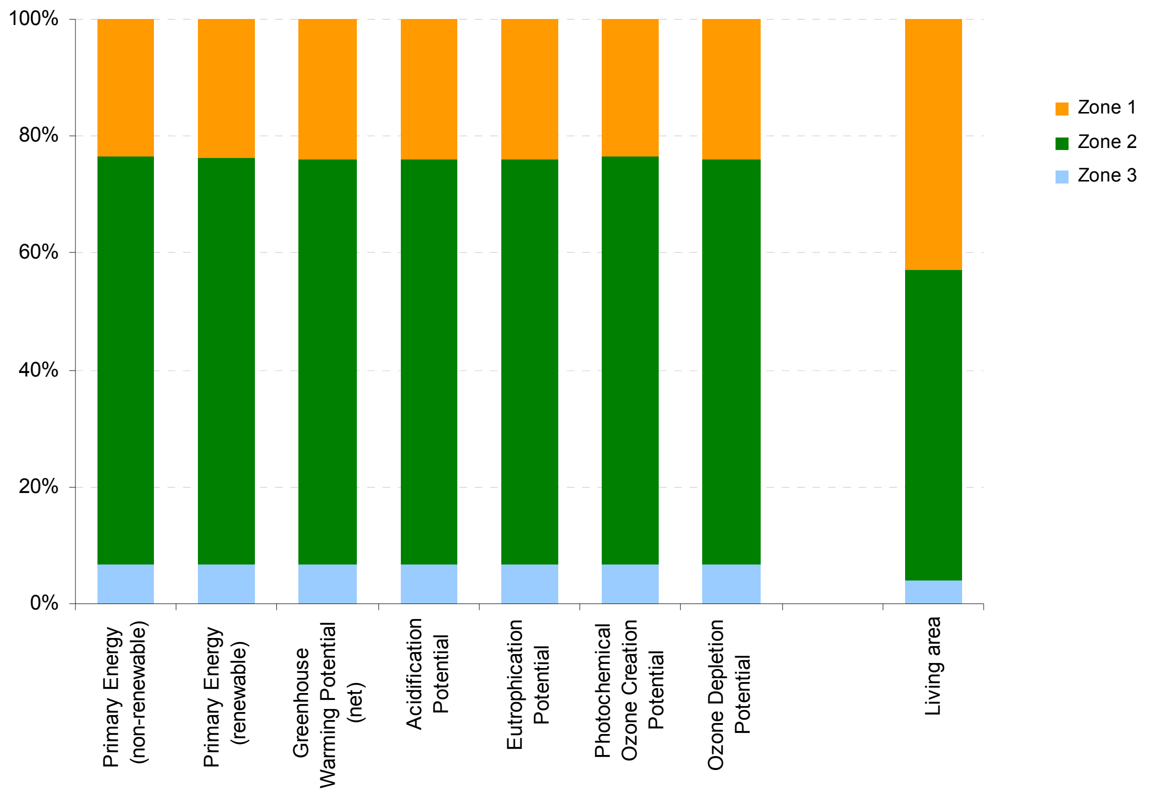


Figure 5.12 Relative contributions to the total environmental impacts of the building stock in the EU-25 according to geographical zones

Figure 5.13 displays the environmental impacts at EU level grouped according to building groups. The majority of the environmental impacts are due to single-family houses (63.3 to 64.0%), followed by multi-family houses (31.9 to 32.3%). High-rise buildings account for 4.1 to 4.4% of the environmental impacts only. Again, the shares in environmental impacts can be compared to the respective shares in living area. Single-family houses exhibit higher relative shares in environmental impacts than their share in living area would suggest. This is due to their relatively higher environmental burdens per m^2 living area as shown in Section 5.2.1. In contrast, for multi-family houses, and especially for high-rise buildings, their respective environmental impacts are smaller than their shares in living area.

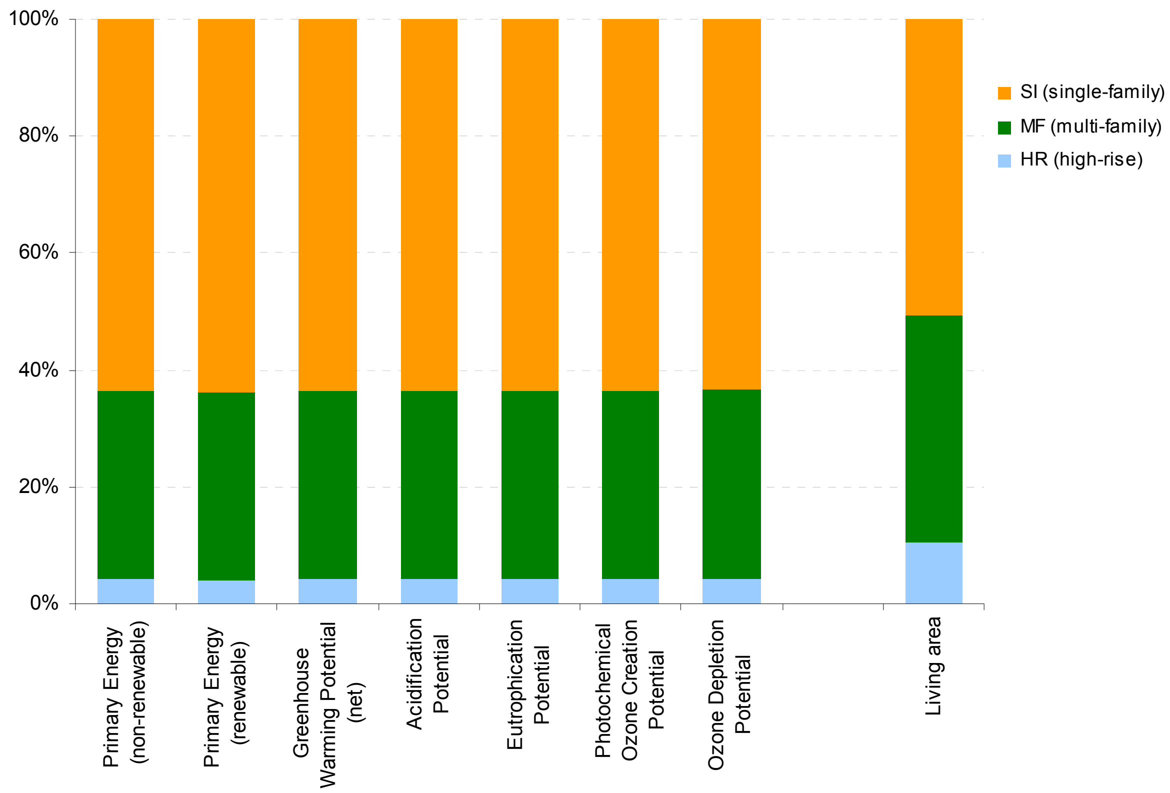


Figure 5.13 Relative contributions to the total environmental impacts of the building stock in the EU-25 according to building groups

The total environmental impacts show a similar pattern for all impact categories and impact indicators (see Figure 5.12 and Figure 5.13). To a large extent, this reflects the dominance of existing buildings in these impacts, where the use phase, and especially energy use for heating, is the greatest source of impacts.

5.4 Environmental hotspots

5.4.1 Introduction

The previous sections showed the large dominance of the Use Phase in the overall life cycle impacts of buildings (see Section 5.3.1). It also showed the respective importance of the geographical zones in terms of environmental impacts from residential buildings. In this section, the impacts from the Use Phase and of the Construction Phase (in the case of new buildings) are further detailed and analysed with a view to identifying the building components that generate the greatest impacts.

In both cases, the LCIA results given in Annex C for each building type are rescaled at zone/EU level and aggregated in order to highlight the average contribution of the different building elements.

5.4.2 Use phase

5.4.2.1 Energy performance of buildings

Building types differ from one to another in various ways. One of the most important differences which influence the (heating and cooling) energy demand is the envelope surface: volume ratio that is calculated as the quotient of the heat transferring envelope area to the volume of the building. A multi-family house generally shows a smaller envelope: volume ratio than, e.g. single-family houses. The values range between high-rise buildings with values of below 0.4 m^2/m^3, to multi-family houses with values from 0.4 to 0.8 m^2/m^3, up to single-family houses with values of between 0.8 and 1.2 m^2/m^3. This ratio has a significant influence on the heating energy consumption per m^2 living area and therefore affects the Use Phase of the building, yielding different outcomes of the Life Cycle Impact Assessments (see Section 5.2.1).

Between the different geographical zones, the major differences lie in the monthly average temperature, as well as in the monthly diffuse and global solar radiation, which vary significantly between the zones.

To a certain extent, the envelopes of buildings in Europe are already adapted to the local weather conditions. Buildings in Northern Europe are, for instance, generally designed with a higher level of thermal insulation to better reduce the heat transfers. This was taken into account when determining the boundary conditions of zone specific buildings.

All these three factors combined largely explain the energy and environmental profile of the buildings modelled in the project. The influence of these factors is shown in Figure 5.14 which displays the average primary energy demand per m^2 living area and per year in the different zones and for the different building types (including existing and new buildings). The impacts were aggregated for all building types (separately for existing and new buildings) belonging to the respective building group (SI, MF, HR) and zone and then the averages were calculated. In this case, Primary Energy (total) was used as an indicator, which is a good proxy for the environmental impacts (see Section 5.3.2).

It is worth emphasising that, despite the fact that the energy demand from buildings in zone 3 is the highest, this does not differ from the buildings in the other zones proportionally to the average heating degree days (1269, 3272, 4513 HDD in zone 1, zone 2 and zone 3 respectively). This is explained by the higher insulation level of these buildings when compared to those in the other zones.

5.4.2.2 Hotspots

The environmental impacts from the use phase were allocated to the different building elements according to their role regarding heat losses. Figure 5.14 displays the contribution of the individual building elements to the environmental impacts of the Use Phase. These heating losses (“others”)[4] will not be included into the hotspot analysis.

[4] The heating losses through technical and rejects (summarised as “others”) are due to non-steady temperature distribution, non-optimal room temperatures and heating control, heating losses of the heat distribution system, heat generation losses in operation and standby, and heat losses due to non-optimal control of the heating system. Rejects represent non-used heating gains.

As shown before, there is a clear pattern of increasing environmental impacts when travelling from southern to northern Europe and decreasing environmental impacts when moving from single-family houses to multi-family houses to high-rise buildings (see Section 5.2.1). It should be borne in mind that only a small percentage of the environmental impacts are due to the northern European countries (zone 3) because of the small percentage share in living area of this zone (see Figure 5.12).

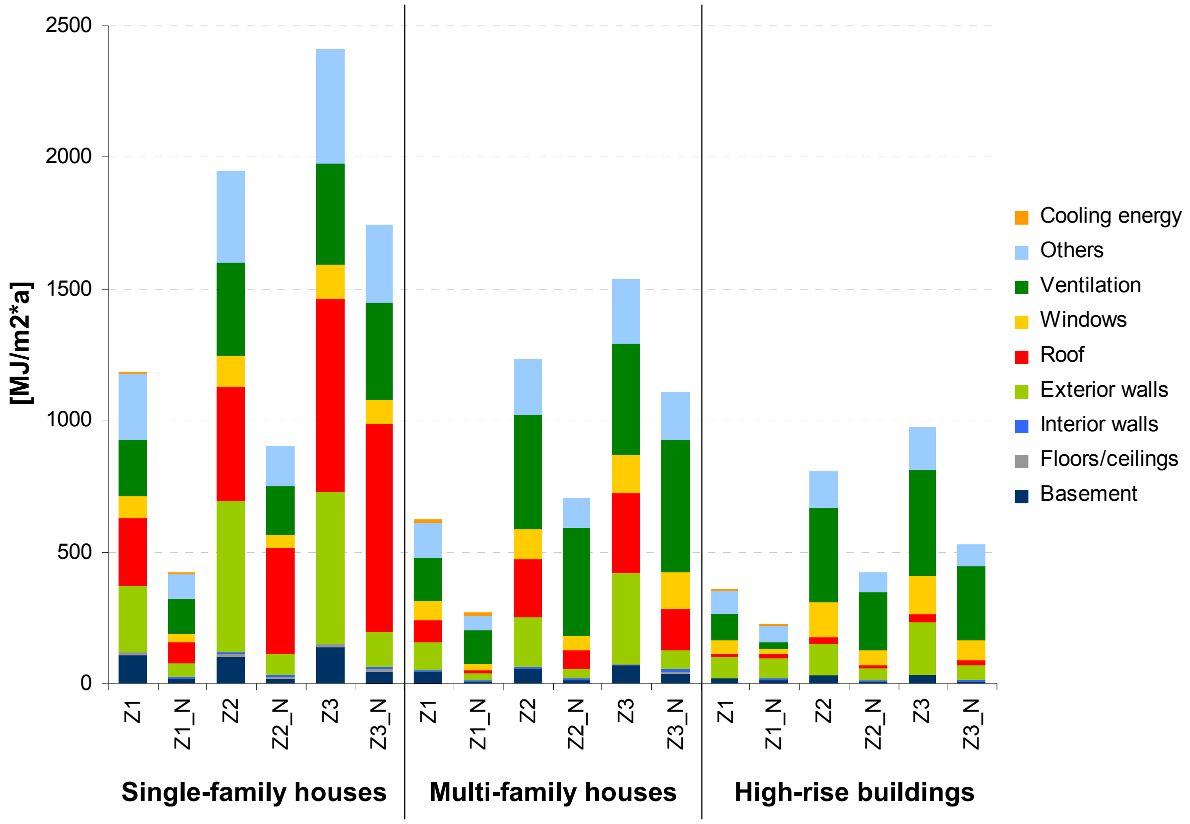


Figure 5.14 Contribution of the individual construction elements to the environmental impacts of the Use Phase (total Primary Energy) according to zone and building group (weighted average) _N denotes new buildings

Figure 5.14 first suggests a common pattern across the different zones and building types, namely the significant importance of heat losses, associated with building ventilation. Heat losses through roofs and external walls are also important for a majority of single-family and multi-family houses. In these cases, however, both the absolute and relative levels vary from one building type to another. The relative importance of heat losses from external walls in high-rise buildings is also significant, but, roofs are of low importance in the case of high-rise buildings. This results from both the lower share of roof surface to the total building envelope surface and from a higher insulation level.

For single-family and multi-family houses, the percentage heat losses through windows are smaller, because the corresponding surfaces involved are smaller, but also as a result of the underlying assumption that window retrofitting is, to some extent, part of an autonomous evolution in existing buildings and that it will take place during the life of the buildings. Their relative importance is, however, important for high-rise buildings.

The better energy performance of new buildings is also visible in this graph, reflecting the higher insulation standards these buildings fulfil.

Zone 1

For existing **single-family houses**, the roof and the exterior walls are the most important hotpots followed by ventilation. For new single-family houses, ventilation dominates the environmental burdens from the Use Phase, followed by the roof and the exterior walls.

Concerning **multi-family buildings**, ventilation and exterior walls are the most important elements for both existing buildings and for new buildings.

The hotspots for existing **high-rise buildings** are ventilation and exterior walls. For new HR buildings, the most dominant building elements from an environmental point of view are exterior walls and ventilation.

The heating losses through windows show some hotspots from an environmental point of view (existing multi-family houses and existing high-rise buildings). In existing single-family houses, the roof is of importance as well. The basement, floors/ceilings, interior walls and cooling energy only play a relatively minor role.

Zone 2

In general, existing **single-family houses** show that most of their environmental impacts relate to heating losses through the exterior walls followed by heating losses through the roof. For new single-family houses, the roof and ventilation show major impacts.

For existing and new **multi-family houses**, ventilation losses play a major role followed by the losses through the roof.

The environmental impacts of **high-rise buildings** during the Use Phase are dominated by ventilation losses of heating energy, windows, and exterior walls.

As in zone 1, the building elements basement, floors/ceilings, interior walls and cooling energy only play a minor role both for existing and new buildings.

Zone 3

Similar to the middle European countries, existing **single-family houses** in the northern part of Europe have most of their environmental impacts in heating losses through the roof and exterior walls. Ventilation losses occupy the third position. For new buildings, the roof is the most important building element, followed by ventilation.

Multi-family houses in this zone are quite similar to the middle European countries: Ventilation losses, heating losses through exterior walls and roof represent the hotspots of the Use Phase for this building group.

As for **high-rise buildings**, ventilation, exterior walls and windows dominate the use phase.

As for the other zones, the building elements basement, floors/ceilings, interior walls and cooling energy only play a minor role both for existing and new buildings.

5.4.3 Construction phase

The contributions of the single building elements to the environmental impacts of the Construction Phase are shown in Figure 5.15,. The impacts were aggregated for all new building types belonging to the respective building group (SI, MF, HR) and zone and then the averages were calculated. The total Primary Energy was used as an indicator for the environmental impacts, which is a good proxy for the environmental impacts (see Section 5.3.2).

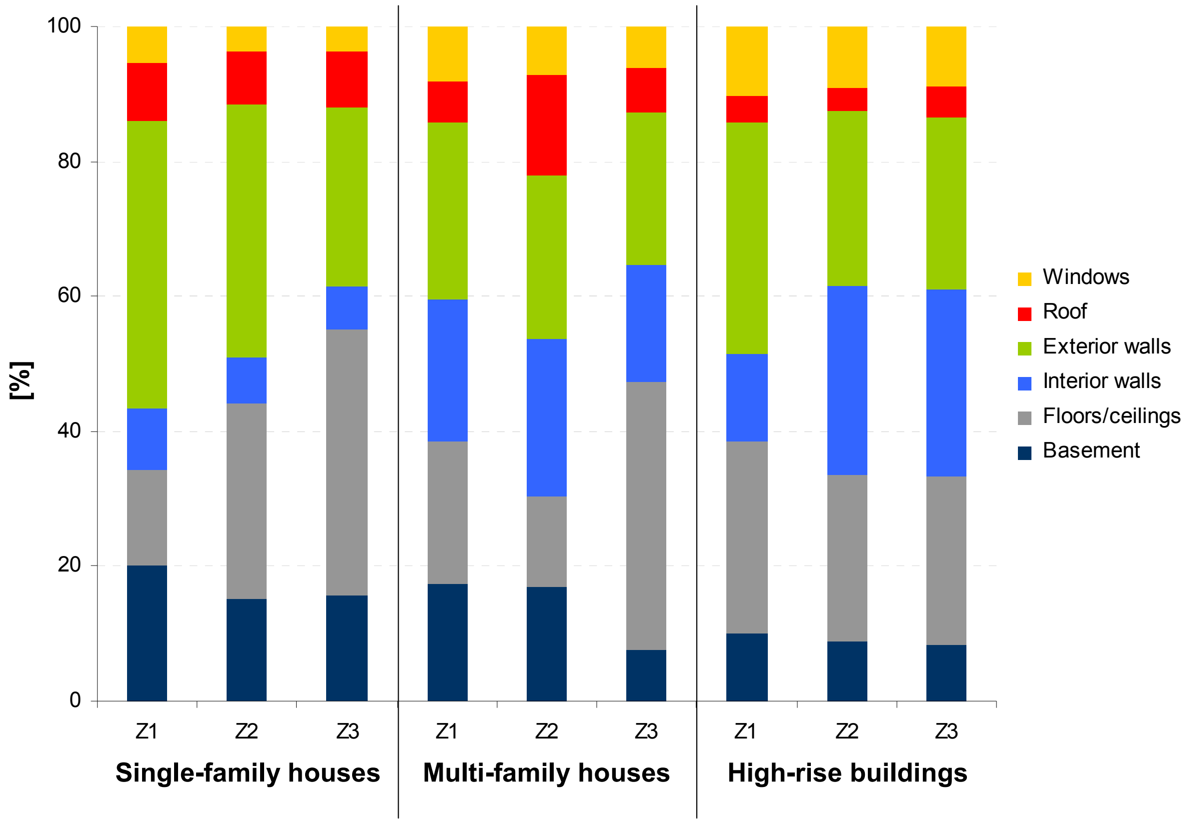


Figure 5.15 Contribution of the individual construction elements to the environmental impacts of the Construction Phase (total Primary Energy) for new buildings according to zone and building group

In all three zones, the exterior walls, the basement, and floors/ceilings are important. Interior walls, roof and windows play a minor role only.

The geometry and volume obviously influences the role of the different building elements. For instance, exterior walls tend to play a smaller relative role for high-rise buildings than for the others.

5.5 Robustness of results

For all building models, completeness checks were carried out for the overall mass of the construction materials, for the calculated energy in the use phase and for all end-of-life processes on a construction component level. All input data were internally reviewed to ensure the completeness of the life cycle models with regard to masses, areas and refurbishment cycles of the building elements.

Due to the fact that the life cycle models portray the input information, sensitivity analyses focused on the most relevant life cycle parameters were performed. The dominating environmental effects of the use phase show the relevance of good input data for heating and cooling energy demands. Similar results hold true for some aspects of the end-of-life phase, especially of existing buildings.

Before adapting the generic life cycle model to the specific building types, a consistency check was carried out. Consistent background processes were chosen, which ensured similar definitions for the system boundaries, cut-off criteria and other underlying modelling aspects. In the foreground system, the use of building elements, transport and energy requirements were defined consistently throughout all life cycle models. Hence, the inclusion and omission of life cycle aspects is similar in all LCAs.

6 Options for improving the environmental performance of residential buildings

The environmental hotspots derived in Section 5.4 are the basis for the definition of technical improvement options. The environmental life cycle impacts quantified in Chapter 5 and the derived environmental hotspots provide a sound basis for focusing the analysis of environmental improvements to the Use Phase and especially space heating and, in the case of new buildings, to the Construction Phase.

This chapter describes the improvement options considered for further analysis. The environmental improvement and costs of these measures are hereby quantified.

6.1 Improving the energy performance of existing buildings

In the case of existing buildings, energy efficiency can be improved by implementing higher thermal insulation levels on the envelope components (e.g. roof, external walls). In view of the environmental hotspots identified in 5.4.2.2, the most significant improvement options are:

- replacement of windows
- additional façade insulation
- additional roof insulation
- new sealings to reduce ventilation losses.

In the following information, the retrofit measures are described in terms of the general practices that reflect the best available techniques currently available in the EU-25. Measures which increase environmental performance may exist but they may also be technically less feasible or too expensive. The commonly used measures are listed in Table 6.1, with a short description regarding the techniques and materials involved (e.g. a thickness of the insulation board of 12 cm from ETICS - Exterior Thermal Insulation Composite System) and were derived from polls done during the European COST C16 action [BRAGANÇA 2007].

This project is not aimed at giving any detailed instructions on how to apply a measure. However, it has to be kept in mind that, in practice, the detailed carrying out of the measures has to suit the individual buildings.

Table 6.1 Improvement measures considered for existing buildings

Building element	Measure	Description
Exterior walls	Insulation plaster	Insulation plaster is sometimes used when either proper insulation with insulating boards is too costly or when the existing joints to, e.g. the roof, do not allow a thicker insulation
	External thermal insulation composite systems (ETICS)	The most commonly used system utilises polystyrene, mineral wool, recycled material or environmental friendly material as insulation material
	Core insulation: insulation between the wooden construction and parts of the wooden construction or insulation between masonry and curtain walling	This is the cheapest way of applying insulation to walls by just pumping insulation material into the core of the wall
	Interior insulation	If the building situation (e.g. the façade is regarded as national heritage) does not allow external insulation, this way of insulation is taken into account. The interior insulation can cause various problems with thermal bridges and stress of the load-bearing structure
Roof	Sloped roof: insulation over, between and under the spars; insulation of the roof floor	For sloped roofs, either the ceiling floor is insulated or the insulation is put under, between or over the spars, depending on whether the ceiling is inhabited and depending on the degradation state of the roof tiles
	Flat roof: insulation of the flat roof either by cold or warm roof	For flat roofs, in most cases, the retrofit measure of new insulation is applied when the flat roof is not waterproof any more and therefore the insulation would be affected by the replacement action, as well
	Wooden construction: wooden joists, roof battening	If a wooden construction is not load-bearing any more, due to humidity and fungal attack, the roof cladding is removed and a new roof framework is implemented
	Cladding: roof tile, bituminous layer, metal layer	The lower levels of the building have to be protected from rain and other environmental impacts
Basement	Insulation of the basement ceiling	Generally, in the basement/cellar, the temperature is lower than the necessary ambient temperature for living spaces. Therefore, the heat flux to these colder areas has to be reduced

6.1.1 Replacement of windows

The replacement of old, e.g. single glazed, windows by modern double glazed coated and gas filled glazing with corresponding optimised frames reduces ventilation and transmission losses tremendously while also improving the thermal comfort within the living spaces by reducing radiation losses and reducing the acoustic impact from outside. As improved glazing systems require larger frame structures and have a lower transmission coefficient (g-value), less radiation in the infra-red radiation but also in the visible spectrum is transmitted to the room. On the one hand, overheating, especially in summertime, accordingly reduces the cooling load which is a positive effect. On the other hand, less daylight within the room after the retrofit action occurs.

It should also be emphasised that in old buildings with high transmission losses through exterior walls mould and fungus growth is being recorded (especially on thermal bridges) through reduced ventilation losses caused by the new windows. Therefore, a replacement of the windows should be ideally coupled with an overall improvement of the thermal losses of the building envelope.

The replacement of windows is assumed to take place anyway in the base scenario after 10 years. The assumption of window replacements during the use phase comes from the outcome of the European research project INVESTIMMO, in which the life cycle and the degradation potential for windows were analysed. The most important factors that influence the degradation and, consequently, the replacement of windows were identified as follows:

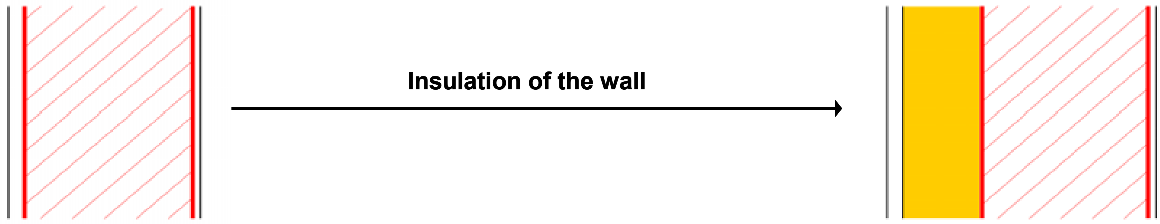
- frame type (wood, plastic, aluminium, wood and metal)
- frame paint (plastic, oil¸ weather resistant, anti-corrosion paint)
- quality of windows
- age
- building ownership status (public, private company owning more than four buildings, private company owning fewer than four buildings, one owner, many owners or finally craft guilds).

The measure ‘replacement of windows’ is nevertheless crucial as this measure might also lead to problems of reduced air change rate and corresponding air quality reduction, mould and fungus growth. For all measures but especially for window replacements and the reduction of ventilation losses, the advice of experts in building physics should be performed.

6.1.2 Additional façade insulation

Thermal insulation of the external walls reduces transmission losses and the corresponding radiation losses which increases the thermal comfort of the inhabitants. This can be done by putting layers of insulation material with low heat conductivity (around 0.040 W/mK) either on the internal wall, in the core (in case of cavity insulation), or as external insulation on the outer side of the wall (see Table 6.2). Problems with thermal bridges and thermal stress of the load-bearing structure are best avoided with external insulation.

Table 6.2 Improvement option: additional façade insulation

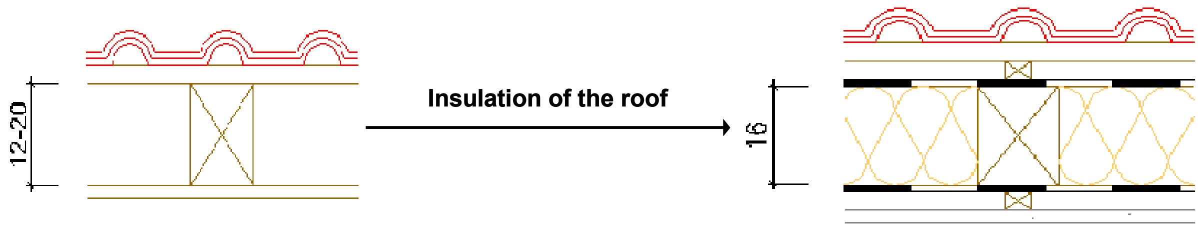


Detailed measure description	Specification
Cleaning and cladding repair of the existing wall; scaffolding. Insulation composite system applied to the wall with thermal insulation material (polystyrene and in some parts for fire protective reasons also mineral wool, e.g. in the windows embrasure), armour material, cladding and final coating. The insulation system is fixed to the wall with glue and dowels. In addition also the joints to the existing façade and building were taken into account for the cost analysis, these are: new larger window pane, expansion joints, footing in order to reduce thermal bridges the insulation is extended by 50 cm to the unheated footing in order to reduce thermal bridges.	External thermal insulation composite systems (ETICS) Alternatives include: • core insulation (if cavity wall) • insulation of the interior wall • insulation plaster

6.1.3 Additional roof insulation

The roof retrofitting with additional insulation will depend on the type of roof. In the case of sloped roofs, the insulating layer can be put under, between or over the spars. For flat roofs, insulation can be implemented as “cold roof” or “warm roof” (see Table 6.3). Also the insulation of the attic floor is common practice because of the low cost. As already described above, roof insulation also reduces transmission losses and the energy demand by simultaneously increasing the thermal comfort of the inhabitants of the highest floor in the building.

Table 6.3 Improvement option: additional roof insulation



Detailed measure description	Specification
Scaffolding with removal of existing roof covering (e.g. tiles, battening and vapour barrier), insulation (mineral wool) put between and over the rafters with subsequent covering measures of the roof by again putting the roof covering on the roof. The cheaper measure of putting an insulation between and under the rafters from below without removing the roof covering was not taken into account as this measure cannot be performed in inhabited attics where the rafters are usually covered by plasterboards.	Insulation of the pitch of the roof Insulation over the rafter Insulation between rafter Insulation of top ceiling

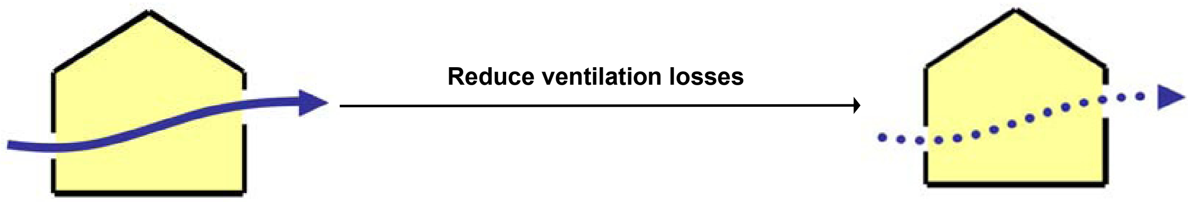
6.1.4 New sealings to reduce ventilation losses

For the sake of the well being and the comfort of the inhabitants, a minimum air change rate is essential for providing sufficient quantities of oxygen and for reducing the CO and CO_2 concentrations in the room. The minimum air change rate in national standards depends on the intended use of the room. For living spaces, in most cases, the minimum air change rate is intended to be as high as 0.3 to 0.5 /h. The air change rate also contributes to the reduction of the relative humidity in the room and thus the risk of mould and fungus formation. These aspects have to be taken into account when considering means to reduce ventilation losses and consequently to reduce energy losses.

The reduction of ventilation losses is a low-budget measure that can normally be performed simply by adding self-adhesive caulking strips of expanded plastic on the window frame and other parts of the house where high ventilation losses occur (see Table 6.4). Normally, a thermographic analysis of the building shows losses through, e.g. roller shutter boxes, sockets and, in the roof, through the gaps between the roof tiles.

The replacement of old windows also leads to a reduction of ventilation but this is only true for the first years after the installation of the new windows. Due to thermal and moisture stress, as well as through the usage of movable parts, the window frames do not close tightly a few years after their installation.

Table 6.4 Improvement option: new sealings to reduce ventilation



Detailed measure description	Specification
Because of thermal stress, window frames become leaky and therefore the gaps need to be covered by sealing material consisting of compounds or caulking strips.	Add self-adhesive caulking strip of expanded plastic Fitting of window gasket on the frame Mask of the reveal with window sheet

6.2 New buildings

6.2.1 Better energy efficiency

As shown in Section 5.4.2.2 and Section 5.2.1, new buildings have higher energy efficiency when compared to existing ones. This is the consequence of better construction practices which already implement higher insulation standards to the different building envelopes due to current policy regulation, including the Directive on the energy performance of buildings (EPBD) and its use in Member States.

This is the reason why such measures were not analysed within this project. It should be noted, however, that, in reality, the level of implementation and use in different Member States varies substantially, and that where delays are observed, lower insulation standards are applied.

It is also worth noting that, due to the long life of buildings, newly erected buildings today represent only a small share of the overall building stock in Europe. On the other hand, the decisions taken today for these new buildings will highly determine the pressure of the residential sector on energy resources and on climate change in the future years. The long term strategy of the EU to reduce greenhouse gas emissions will rely on drastic emission reductions in all the sectors, including the residential sector. In this respect, further innovative construction designs play an important role. This includes the new concepts of passive housing and the so-called “zero CO_2 emission building” for which space heating demand is in a range 10 to 20 kWh/m^2*a [SMEDS & WALL, 2007]. Such a low demand is only achievable with the combination of optimal building geometry (A:V ratio), high thermal insulation of the whole envelope, high air tightness and ventilation systems with a high energy performance, including heat exchangers, and proper building orientation and windows surfaces to optimise solar gains during heating periods and shading devices to avoid overheating during cooling periods.

High energy performance can also incorporate better heating and cooling systems such as heat pumps or solar panels which may also entail some changes in the buildings. These new building concepts thus require a much more integrated approach of the different buildings aspects, including better performing heating and cooling systems. It is also more difficult to quantify the additional costs of these new buildings in a generic way[5]. The assessment of such innovative systems is beyond the scope of this project.

6.2.2 Alternative construction materials

Regarding the Construction Phase of new buildings which also represents a significant proportion of the environmental impacts of the buildings, some options for changing the material composition are feasible. Some alternatives were considered with a view to illustrate the possible achievable improvement. The selection of considered alternatives was made keeping in mind some technical requirements, e.g. acoustic protection and fire protection.

The technical design of basements and foundations, and restrictions due to the load-bearing character of the basements do not generally allow variations in construction materials. The same holds true for floors and ceilings, where variations in materials for a specific building type is also strictly limited and therefore not evaluated here.

As a result, the alternatives were focused on exterior and interior walls and were compared to the respective base scenario. This included:

- breeze concrete
- sandlime
- wooden construction
- cored brick
- reinforced concrete.

[5] The cost could be as much as 40% of the normal price (see for instance http://news.bbc.co.uk/1/hi/business/6735715.stm).

7 Environmental benefits and cost efficiency

7.1 Existing buildings

The environmental potential and associated costs were analysed for the most representative buildings analysed in Chapter 5. In each case, the assessment was made in comparison to the relevant base case. The assessment was also made at the building stock level.

7.1.1 Considered building types

In order to keep the analysis feasible, while also focusing on the most important part of the building stock, the considered **existing** building types were selected to account for approximately 80% of the European residential building stock living area. This resulted in the list of building types given in Table 7.1.

Table 7.1 Existing building types analysed with regard to their environmental improvement potential. These building types account for 80% of the living area of all previously analysed building types

Building type	Total living area in million m² per building type	Share per building type in %	Accumulated share in %
Z2_SI_005	1 262	8.5	8.5
Z2_SI_001	981	6.6	15.0
Z1_MF_003	846	5.7	20.7
Z2_MF_003	814	5.5	26.1
Z2_SI_006_ex	776	5.2	31.3
Z1_SI_005_ex	697	4.7	36.0
Z2_MF_001	628	4.2	40.2
Z2_SI_002	549	3.7	43.9
Z1_HR_001_ex	515	3.4	47.3
Z1_HR_002	513	3.4	50.8
Z2_MF_005_ex	509	3.4	54.2
Z1_SI_001	458	3.1	57.2
Z1_SI_004	455	3.0	60.3
Z1_SI_006_ex	427	2.9	63.1
Z1_MF_001	360	2.4	65.6
Z1_SI_007_ex	335	2.2	67.8
Z2_MF_004	333	2.2	70.0
Z2_HR_001	318	2.1	72.2
Z1_MF_005	312	2.1	74.3
Z2_MF_007_ex	273	1.8	76.1
Z2_SI_007_ex	267	1.8	77.9
Z2_SI_003	239	1.6	79.5

For reference purposes, this list is compared with the list of building types which corresponds to 80% of the life cycle greenhouse gas emissions quantified for all the existing building types (see Table 7.2). With the exception of five building types, these two lists match.

Table 7.2 Existing building types analysed with regard to their environmental improvement potential. These building types account for 80% of the life cycle greenhouse gas emissions of all previously analysed building types

Building type	Total living area in million m² per building type	Share per building type in %	Accumulated share in %
Z2_SI_005	155	11.1%	11.1%
Z2_SI_001	133	9.5%	20.6%
Z2_SI_002	101	7.2%	27.8%
Z2_SI_006_ex	85	6.1%	33.8%
Z2_MF_003	71	5.1%	38.9%
Z1_SI_005_ex	63	4.5%	43.4%
Z2_MF_001	55	4.0%	47.4%
Z1_SI_004	48	3.4%	50.8%
Z1_MF_003	46	3.3%	54.1%
Z1_SI_006_ex	44	3.1%	57.2%
Z2_MF_005_ex	41	3.0%	60.1%
Z1_SI_001	41	2.9%	63.0%
Z2_SI_003	34	2.4%	65.5%
Z2_SI_007_ex	33	2.3%	67.8%
Z2_MF_004	30	2.1%	69.9%
Z2_SI_008_ex	27	1.9%	71.9%
Z1_SI_008	26	1.8%	73.7%
Z1_SI_007_ex	25	1.8%	75.5%
Z1_HR_002	22	1.6%	77.1%
Z1_MF_001	22	1.6%	78.7%
Z2_HR_001	20	1.4%	80.1%

It should be noted that, as a result of this selection criterion, buildings from zone 3 and possible improvements are not considered. This of course, does not mean that improvement is not feasible in the countries. It can be expected, that, in some countries (Baltic countries), further building insulation would result in substantial energy efficiency improvements. On the other hand, this zone represents a small share of the building stock in the EU-25. Therefore, the exclusion of zone 3 buildings in this assessment will not entail a significant underestimation of the overall improvement potential associated with existing building insulation.

All suggested retrofit measures for existing buildings are intended to reduce the heating energy consumption. The environmental hotspots and the resulting improvement options yielded three different retrofit measures:

- applying additional insulation material to the roof
- applying additional insulation material to the façade
- replacing joint sealings on doors and windows to reduce ventilation losses.

These retrofit measures are applied to the building types according to the matrix given in Table 7.3, which is the result of the procedure detailed in Section 5.4, in conjunction with the considered building types from Section 7.1.1.

Table 7.3 Mapping of identified environmental hotspots onto the considered existing building types for defining improvement options

Building type	Building stock in million m² per building type	Environmental hotspots in the Use Phase (heating & cooling)		
		Roof	Exterior walls	Ventilation
Z1_SI_001	457	X	X	X
Z1_SI_004	455	X	X	X
Z1_SI_005_ex	699	X	X	X
Z1_SI_006_ex	429	X	X	X
Z1_SI_007_ex	336	X	X	X
Z1_MF_001	359		X	X
Z1_MF_003	845		X	X
Z1_MF_005	311		X	X
Z1_HR_001_ex	514		X	X
Z1_HR_002	512		X	X
Z2_SI_001	939	X	X	
Z2_SI_002	523	X	X	
Z2_SI_003	231	X	X	
Z2_SI_005	1 205	X	X	
Z2_SI_006_ex	763	X	X	
Z2_SI_007_ex	268	X	X	
Z2_MF_001	939			X
Z2_MF_003	523			X
Z2_MF_004	231			X
Z2_MF_005_ex	1 205			X
Z2_MF_007_ex	763			X
Z2_HR_001	268			X

7.1.2 Improved building versus base case

Chapter 4 determined building types and related product systems representing base cases against which the improvement options ought to be assessed.

For each of the buildings listed in Table 7.3, and each considered retrofit measure, the generic model was adjusted with the corresponding parameter to calculate the new environmental profile of the building after retrofitting. These changed life cycle impacts were then compared to those estimated for the respective base case in order to quantify the environmental benefits of the measure. A similar approach was followed to quantify the additional costs entailed by the retrofitting measure (see Section 7.1.4). The comparison of the retrofitted building and the reference building has to be made cautiously, by taking into account all the changes that are likely to occur during the life of the building.

As already described in Section 4.5.3.3, some of the improvements are expected to be implemented any way to a certain fraction of the buildings. Certain parts have indeed to be replaced by parts of the buildings that are at least comparable in their functionality (refurbishment). In some cases, the buildings owners will consider that this is also the opportunity to improve the thermal insulation, especially when some policy incentives are already in place (e.g. subsidies, tax exemption). Therefore, to some extent, better thermal insulation of elements such as the roof or external walls will occur during the building life which was reflected in the base case.

Two types of further improvements can take place: on the one hand, these improvements could be applied more systematically when the building element is refurbished. On the other hand, the element retrofitting could be done earlier than what would occur autonomously.

Table 7.4 provides the description of the assumed changes for the reference building (refurbishment without any thermal insulation) and for the retrofitted building (refurbishment with thermal insulation) for respectively the three improvement measures analysed. This has to be taken into account when analysing the costs of the measures (see Section 7.1.4).

Table 7.4 Description of the improvement measures

Measure	Retrofitted building	Reference building
Additional façade insulation	ETICS (exterior thermal insulation composite system) – with insulation material 12 cm, fixed with dowels, armour, cladding and final paint. The ETICS is applied on existing cladding with corresponding preparation: cleaning and partial demolition of existing cladding. In addition, cost for scaffolding, royalty for planners, and accessory charges are included	Preparation (cleaning and partial demolition of existing cladding), new cladding and final paint In addition, cost for scaffolding, royalty for planners, and accessory charges are included
Additional roof insulation	Insulation of attic floor (uninhabited attic, sloped roof): Preparation of screed, levelling, insulation material 10 cm with connection cost (adaptation of attic entrance door, etc.) and final covering with walkable wooden floor Insulation over/between spars (sloped roof). Preparation including tile removal, insulation (16 cm) with vapour barrier, counter batten and tiles Insulation of flat roof. Preparation, removal of existing insulation and old bituminous layer, new insulation (16 cm), bituminous layer In addition, cost for scaffolding, royalty for planners, and accessory charges are included	Attic floor: Simple new levelling of attic floor with screed Sloped roof: Preparation including tile removal, new counter battens, vapour barrier and tiles Flat roof: New bituminous layer with removal of the existing one In addition, cost for scaffolding, royalty for planners, and accessory charges are included
New sealings to reduce ventilation losses	Self-adhesive caulking strip of expanded plastic put on all window frames in the building type	No alternative calculated

7.1.3 Fuel savings

The implementation of insulation material on the roof and/or on the external wall, or the reduction of ventilation losses made on the existing building today will obviously reduce its energy demand for space heating and will make it perform better than in its reference case.

However, the comparison with the reference case has to take into account the already assumed autonomous improvement in the base case. As detailed in Figure 7.1 to Figure 7.3, some buildings are assumed to have their roof insulated after a certain period of time so that their final energy demand will be reduced accordingly. Windows are also assumed to be retrofitted after 10 years as part of an autonomous improvement.

For each building, the evolution of the final energy demand during the building life of both buildings has to be compared. This is shown in Figure 7.1 and Figure 7.2 in the case of the building Z1_SI_001 and the "roof insulation" and "façade insulation" improved cases.

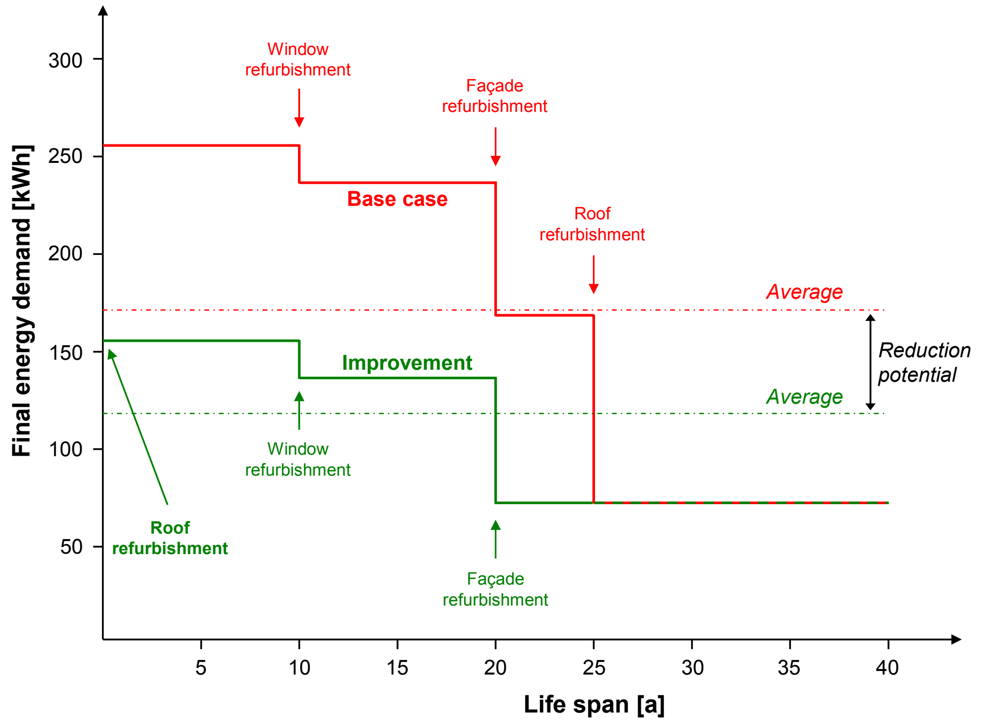


Figure 7.1 Annual final energy demand of the base case and improvement option "additional roof insulation"

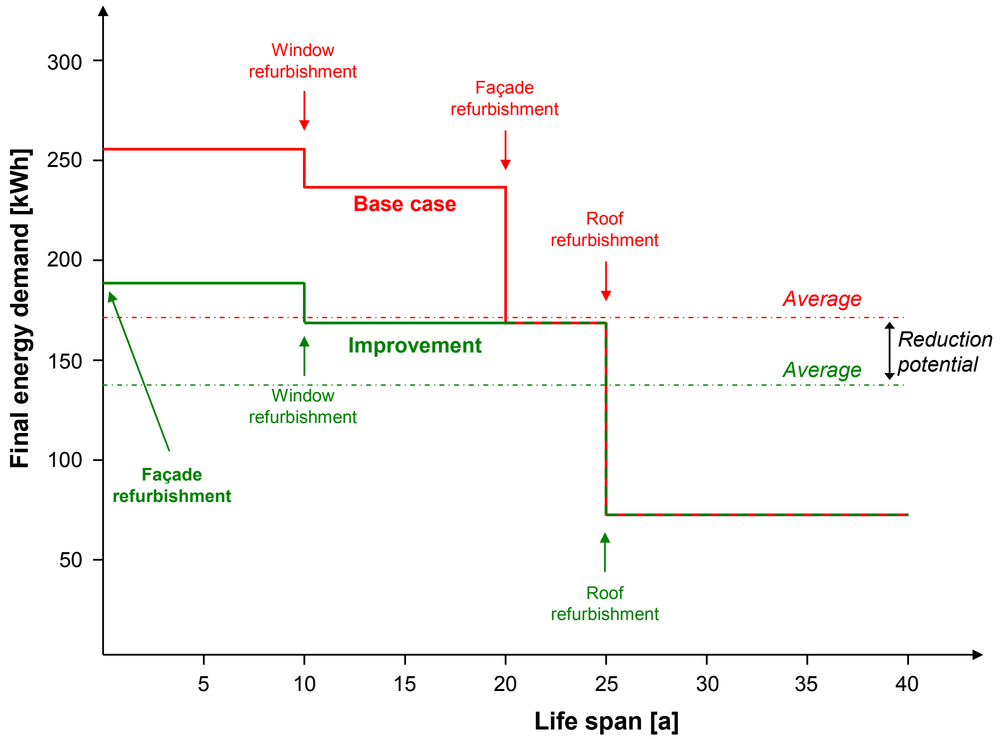


Figure 7.2 Annual final energy demand of the base case and improvement option "additional façade insulation"

In the improved case with reduced ventilation losses, the comparison of the improved building and the base case was limited to a 10 year time span (see Figure 7.3). This choice was guided by the fact that, one important share of the fuel savings assumed to be achieved with better sealings is relating to reduced gaps in windows. In the base case, it is assumed that windows are retrofitted after 10 years. Therefore, it should be expected that this retrofitting will also result in reduced ventilation losses. In addition, in the cases where roof retrofitting is also considered during the residual life of the base case building, some indirect effect on ventilation losses should also be expected. Considering a time horizon longer than 10 years would thus be misleading as it would result in distorted results.

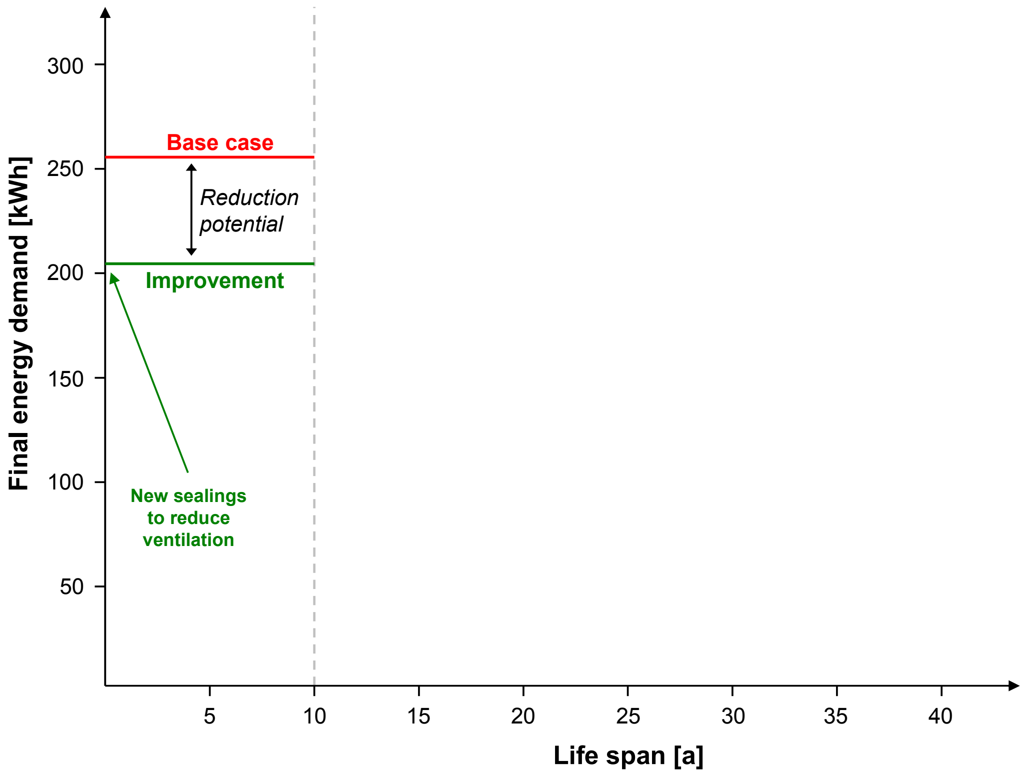


Figure 7.3 Annual final energy demand of the base case and improvement option "new sealings to reduce ventilation"

The overall description of the assumptions made per building is shown in Table 7.5 which gives the U-values per building element as assumed in the base case (initial value and, when relevant, the value after refurbishment) and in the improved case.

Table 7.5 U-values before and after retrofit measure in the EU-25 in W/m²K

Building type	Exterior wall		Roof		Window	
	Before	After	Before	After	Before	After
Z1_SI_001	1.10	0.12	3.20	0.16	3.50	1.60
Z1_SI_004	1.16	0.12	3.20	0.16	3.50	1.60
Z1_SI_005_ex	1.00	0.12	3.20	0.16	3.50	1.60
Z1_SI_006_ex	1.16	0.12	3.20	0.16	3.50	1.60
Z1_SI_007_ex	0.50	0.12	0.65	0.16	2.80	1.60
Z1_MF_001	1.10	0.12	3.20	0.16	3.50	1.60
Z1_MF_003	0.50	0.12	3.20	---	2.80	1.60
Z1_MF_005	1.70	0.12	0.80	---	5.80	1.60
Z1_HR_001_ex	0.50	0.12	0.80	---	2.80	1.60
Z1_HR_002	1.70	0.12	0.80	---	5.80	1.60
Z2_SI_001	1.10	0.12	3.20	0.16	3.50	1.60
Z2_SI_002	2.70	0.12	3.20	0.16	3.50	1.60
Z2_SI_003	1.50	0.12	3.20	0.16	3.50	1.60
Z2_SI_005	1.16	0.12	3.20	0.16	2.80	1.60
Z2_SI_006_ex	0.37	0.12	0.36	0.16	1.60	1.60
Z2_SI_007_ex	0.27	0.12	0.24	0.16	1.60	1.60
Z2_MF_001	1.10	---	3.20	---	3.50	1.60
Z2_MF_003	0.86	---	3.20	---	2.80	1.60
Z2_MF_004	1.00	---	3.20	---	2.80	1.60
Z2_MF_005_ex	0.37	---	0.37	---	2.80	1.60
Z2_MF_007_ex	1.00	---	3.20	---	1.60	1.60
Z2_HR_001	0.75	---	0.80	---	5.80	1.60

The energy savings were calculated with the European software program epiqr® for each building type and for each considered improvement. This is shown in Table 7.6.

Table 7.6 Final energy demand for the base case and the improvement options in kWh/m²a

Building type	Base case[a]	Additional roof insulation	Additional façade insulation	Additional roof & façade insulation	Base case[b]	New sealings to reduce ventilation
Z1_SI_001	169	107	135	75	253	202
Z1_SI_004	273	172	200	102	282	231
Z1_SI_005_ex	220	136	179	97	269	218
Z1_SI_006_ex	269	169	201	101	278	227
Z1_SI_007_ex	96	83	80	68	113	89
Z1_MF_001	119	---	99	---	150	100
Z1_MF_003	105	---	94	---	111	86
Z1_MF_005	146	---	95	---	167	117
Z1_HR_001_ex	42	---	36	---	53	31
Z1_HR_002	92	---	48	---	108	83
Z2_SI_001	351	237	289	177	---	---
Z2_SI_002	470	356	295	182	---	---
Z2_SI_003	381	267	292	179	---	---
Z2_SI_005	332	218	266	154	---	---
Z2_SI_006_ex	130	122	119	112	---	---
Z2_SI_007_ex	138	134	132	128	---	---
Z2_MF_001	227	---	---	---	315	223
Z2_MF_003	257	---	---	---	301	209
Z2_MF_004	263	---	---	---	310	218
Z2_MF_005_ex	156	---	---	---	181	92
Z2_MF_007_ex	201	---	---	---	205	114
Z2_HR_001	183	---	---	---	244	153

a) for additional roof insulation and façade insulation, the final energy demand for the base case and the improvement options was calculated as an average over the residual service life of the building type (20, 30 or 40 years);
b) for the new sealings, the final energy demand for the base case and the improvement options was calculated for the first 10 years only

7.1.4 Quantifying the costs

Each measure entails both additional investments and cost savings as a result of fuel cost savings in the forthcoming years. The procedure used to evaluate the net costs of each improvement potential is shown in Figure 7.4.

The software epiqr® was used to calculate the costs for the improvement measures based on national cost data. For example, for the additional façade insulation, e.g. the cost for cleaning the existing facade including partial demolition of the existing cladding, then the implementation of an exterior thermal insulation composite system (insulation fixed with dowels, armour, cladding, and paint) and finally the cost for scaffolding were calculated. For the calculation of the costs incurred in the base case, the simple refurbishment of the façade along with cleaning, partial demolition of loose cladding, new cladding and paint including scaffolding were calculated. In both cases, the royalty cost for external planners and accessory charges were included.

The additional costs incurred in the improved case have to take into account both types of changes incurred as a result of the improvement measures and as a result of the refurbishment action that take place anyway in both the base case and the improved case as shown in, e.g. Figure 7.1.

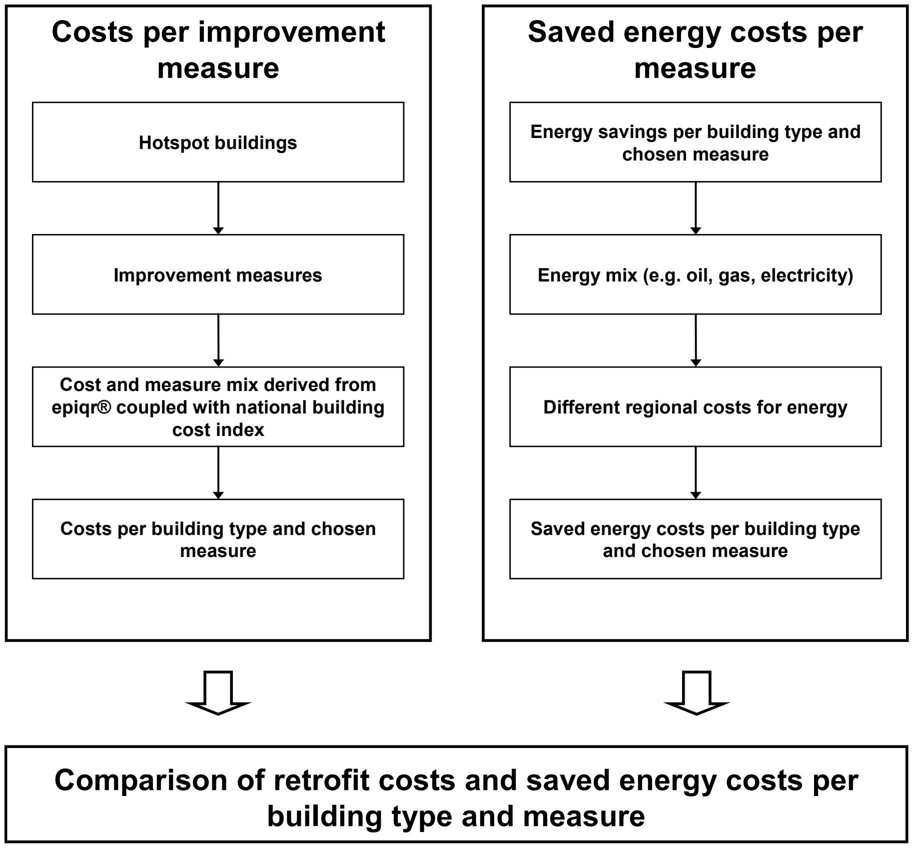


Figure 7.4 Procedure for the cost analysis

Each building type represents buildings in different European countries where construction and refurbishment costs vary as a result of different production costs (e.g. labour). Country-specific costs were derived by applying a building cost index. This country-specific building cost index is taken from [BKI 2007] where 1200 projects were analysed. The index is set to 1.0 for German buildings for the year 2007 (Figure 7.5). This means if, e.g. façade insulation costs on average 100 EUR in Germany (the price between the Polish border and Munich varies between 80 and 125 EUR) the same measure will cost on average 118 EUR in France as the French building cost index is 1.18 for 2007.

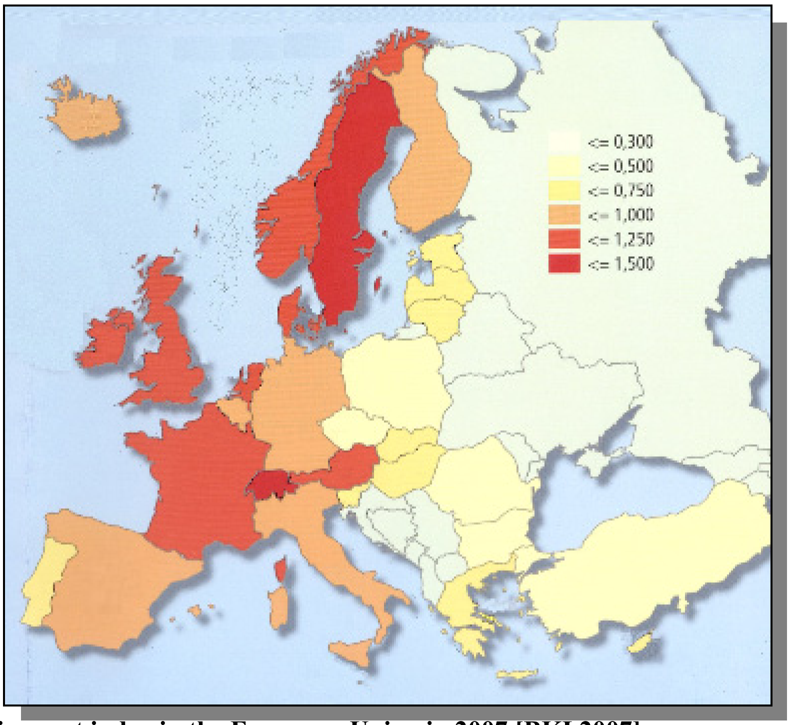


Figure 7.5 Building cost index in the European Union in 2007 [BKI 2007]

The costs per building type and country were then weighted according to their national representativeness to derive an average zone-specific price. The costs were also divided by the living area of the building type to calculate the prices per square metre (see Table 7.7).

Table 7.7 Example for the costs per m² for building types and measures in zone 1 (Euro)

Building type/measure	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
HR (high-rise buildings)							
Conventional façade refurbishment	84	54	50	40	64	35	43
Additional façade insulation	133	85	80	63	101	55	69
New sealings to reduce ventilation losses	8	5	5	4	6	3	4
MF (multi-family buildings)							
Conventional façade refurbishment	84	54	50	40	64	35	43
Additional façade insulation	133	85	80	63	101	55	69
New sealings to reduce ventilation losses	6	4	4	3	5	3	3
SI (single-, two-family and terrace houses)							
Conventional façade refurbishment	91	58	55	43	69	38	47
Additional facade insulation	145	93	87	68	110	60	75
New sealings to reduce ventilation losses	2	1	1	1	2	1	1
Conventional roof refurbishment	81	52	48	38	61	34	42
Additional roof insulation	107	69	64	51	82	45	55

The final energy demand estimates for the base case and improved cases (kWh/m^{2}a) were then multiplied by the energy cost per kWh to derive the fuel cost savings.

The average per kWh price was derived by taking into account the zone average energy mix and the national prices for each energy carrier. The price derived for zone 1 and zone 2 - zone 3 is not considered here - are respectively 0.054 €EUR/kWh and 0.051 EUR/kWh.

Two cost indicators were calculated (see Annex D for details): Net Present Value (NPV) and Internal Rate of Return (IRR). A discount rate of 4% and a yearly energy price increase of 2% was considered, which can be seen as a conservative approach.

7.1.5 Environmental improvement potential

This section presents the quantified environmental benefits of the improvement options for existing buildings. First, the environmental improvements are presented per building type and per m² living area and year. Then these potentials are rescaled at zone level.

As Chapter 6 showed that CO_2 emissions were a good proxy indicator for the majority of environmental impacts from existing buildings, the following results are limited to the greenhouse gas emissions. The results at building level per m² living area and year are given in Table 7.8 and Figure 7.6.

All retrofit measures can be seen to yield a significant net improvement compared to the base scenario, which varies depending on the building type and on the measure. For a majority of building types and retrofitting measures, the emissions are reduced by at least 20% when compared to the base case.

Table 7.8 Greenhouse gas emissions for the base case and the improvement options

Building type	Base case[a]	Additional roof insulation		Additional façade insulation		Additional roof & façade insulation		Base case[b]	New sealings to reduce ventilation	
	kg CO_2-eq./m^{2}a	kg CO_2-eq./m^{2}a	% reduction	kg CO_2-eq./m^{2}a	% reduction	kg CO_2-eq./m^{2}a	% reduction	kg CO_2-eq./m^{2}a	kg CO_2-eq./m^{2}a	% reduction
Z1_SI_001	45	28	37	36	20	20	56	67	54	20
Z1_SI_004	72	46	37	53	27	27	63	75	61	18
Z1_SI_005_ex	58	36	38	48	18	26	56	71	58	19
Z1_SI_006_ex	71	45	37	53	25	27	62	74	60	18
Z1_SI_007_ex	25	22	13	21	16	18	29	30	24	21
Z1_MF_001	32	---	---	26	17	---	---	40	27	33
Z1_MF_003	28	---	---	25	10	---	---	29	23	23
Z1_MF_005	39	---	---	25	35	---	---	44	31	30
Z1_HR_001_ex	11	---	---	9	16	---	---	14	8	42
Z1_HR_002	24	---	---	13	48	---	---	29	22	23
Z2_SI_001	87	59	32	72	18	44	50	---	---	---
Z2_SI_002	117	88	24	73	37	45	61	---	---	---
Z2_SI_003	95	66	30	72	23	44	53	---	---	---
Z2_SI_005	82	54	34	66	20	38	54	---	---	---
Z2_SI_006_ex	32	30	6	30	8	28	14	---	---	---
Z2_SI_007_ex	34	33	3	33	5	32	8	---	---	---
Z2_MF_001	56	---	---	---	---	---	---	78	55	29
Z2_MF_003	64	---	---	---	---	---	---	75	52	31
Z2_MF_004	65	---	---	---	---	---	---	77	54	30
Z2_MF_005_ex	39	---	---	---	---	---	---	45	23	49
Z2_MF_007_ex	50	---	---	---	---	---	---	51	28	44
Z2_HR_001	45	---	---	---	---	---	---	60	38	37

a) for additional roof insulation and façade insulation, the final energy demand for the base case and the improvement options was calculated as an average over the residual service life of the building type (20, 30 or 40 years);

b) for the new sealings, the final energy demand for the base case and the improvement options was calculated for the first 10 years only

It can also be seen that, within one zone and one building type (SI, MF and HR respectively) the higher the original impacts of the building, the greater the environmental improvement potential. This is the case for the poorly insulated buildings. This also explains the broad range of emission reductions, from almost 3% (additional roof insulation for Z2_SI_007_ex) to 49% (new sealings to reduce ventilation for Z2_MF_005_ex).

For single-family houses, roof insulation represents the biggest improvement potentials, followed by additional façade insulation and – for zone 1 – then reduced ventilation. Regarding roof insulation, the results suggest that the range of emission reductions when compared to the base case is higher in zone 1 (13 to 37%) than in zone 2 (3 to 34%).

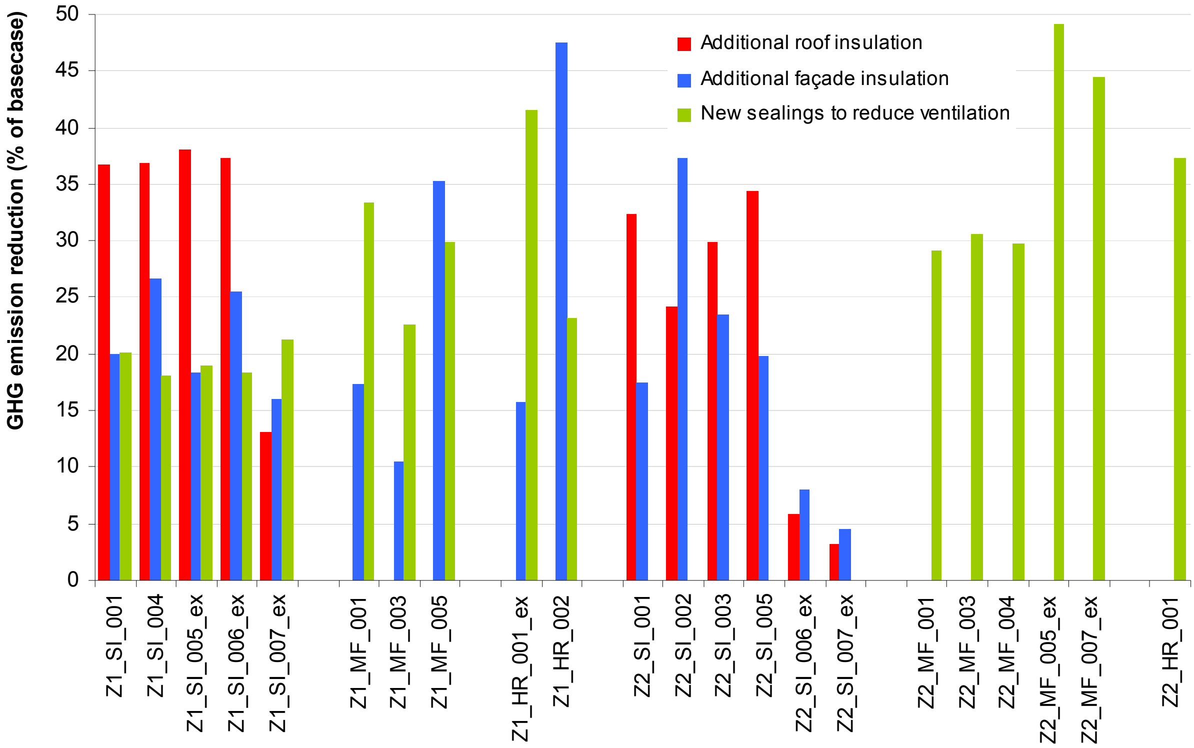


Figure 7.6 Relative environmental improvement potential for GHG emissions according to building type and measure

The environmental improvement potentials were rescaled to building stock level by multiplying the previous figures with the total living area of the respective building stock in the EU-25. This is shown in Table 7.9 and Figure 7.7. Figure 7.8 also presents the total environmental improvement potentials of the respective building type over the entire anticipated residual service life.

For some building types (especially those with significant environmental improvements and a significant share of the European building stock), the emissions reduction potential of the individual measures is very important (up to 34 Mt CO_2-eq./a).

For each measure, the highest improvement potentials from the European perspective are derived for Zone 2, even though roof and façade are assumed to be further insulated only for single family houses. This is partly due to the larger building stock in play and to the colder climate conditions.

These results also confirm that the improvement potentials are bigger for roof insulation than for façade insulation. The highest environmental improvement potential for additional façade insulation can be observed for single-family houses in zone 2. It is also worth noting that in some cases, external wall insulation represents the biggest potential: for building type Z2_SI_002, the emissions reduction potential is estimated to be 23 Mt CO_2-eq./a, which is higher than that achievable with roof insulation.

New sealings to reduce ventilation can also lead to significant GHG emissions reduction potentials, especially for multi-family houses in zone 2 (up to 27 Mt CO_2-eq./a for building type Z2_MF_005_ex).

Table 7.9 Greenhouse gas emission savings for the improvement options compared to the base case

Building type	**Additional roof insulation**[a]		**Additional façade insulation**		**Additional roof & façade insulation**		**New sealings to reduce ventilation**[b]	
	Mt CO_2-eq./a	% reduction	Mt CO_2-eq./a	% reduction	Mt CO_2-eq./a	% reduction	Mt CO_2-eq./a	% reduction
Z1_SI_001	7.5	37	4.1	20	11.4	56	6.2	20
Z1_SI_004	12.1	37	8.7	27	20.6	63	6.2	18
Z1_SI_005_ex	15.5	38	7.5	18	22.7	56	9.5	19
Z1_SI_006_ex	11.4	37	7.8	25	19.1	62	5.8	18
Z1_SI_007_ex	1.1	13	1.4	16	2.5	29	2.1	21
Total SI	*47.7*	*36*	*29.5*	*22*	*76.3*	*57*	*29.7*	*19*
Z1_MF_001			2.0	17			4.8	33
Z1_MF_003			2.5	10			5.6	23
Z1_MF_005			4.2	35			4.1	30
Total MF			*8.7*	*19*			*14.5*	*27*
Z1_HR_001_ex			0.9	16			3.0	42
Z1_HR_002			5.9	48			3.4	23
Total HR			*6.8*	*37*			*6.4*	*29*
Total zone 1			**44.9**	**23**			**50.6**	**22**
Z2_SI_001	26.4	32	14.3	18	40.6	50		
Z2_SI_002	14.8	24	22.8	37	37.4	61		
Z2_SI_003	6.5	30	5.1	23	11.6	53		
Z2_SI_005	34.0	34	19.6	20	53.3	54		
Z2_SI_006_ex	1.4	6	2.0	8	3.4	14		
Z2_SI_007_ex	0.3	3	0.4	5	0.7	8		
Total SI	*83.5*	*28*	*64.2*	*22*	*147.0*	*49*		
Z2_MF_001							21.4	29
Z2_MF_003							11.9	31
Z2_MF_004							5.3	30
Z2_MF_005_ex							26.6	49
Z2_MF_007_ex							17.2	44
Total MF							*82.4*	*37*
Z2_HR_001							6.1	37
Total HR							*6.1*	*37*
Total zone 2							**88.4**	**37**

a) for additional roof insulation and façade insulation, the final energy demand for the base case and the improvement options was calculated as an average over the residual service life of the building type (20, 30 or 40 years);
b) for the new sealings, the final energy demand for the base case and the improvement options was calculated for the first 10 years only

The improvement potentials were only calculated according to the mapping of the identified environmental hotspots and the considered existing building types (see Table 7.3). Thus, blank cells do not mean that there is no reduction potential. These improvement options/building type combinations were just not assessed because the building element was not detected to be an environmental hotspot for the respective building type (e.g. roof for multi-family houses and high-rise buildings in zone 1) in the hotspot analysis (see Section 5.4).

From these results, it can be concluded that the major improvement potentials lie with single-, two-family and terrace houses, followed by multi-family houses. Considering high-rise buildings, despite important percentage reduction potentials, the smaller emissions reductions are expected in absolute terms due to the lower relevance of these building types in terms of the share of building stock.

When summed over all building types considered and respective measures, the total emissions reductions reach about 360 Mt CO_2-eq./a.

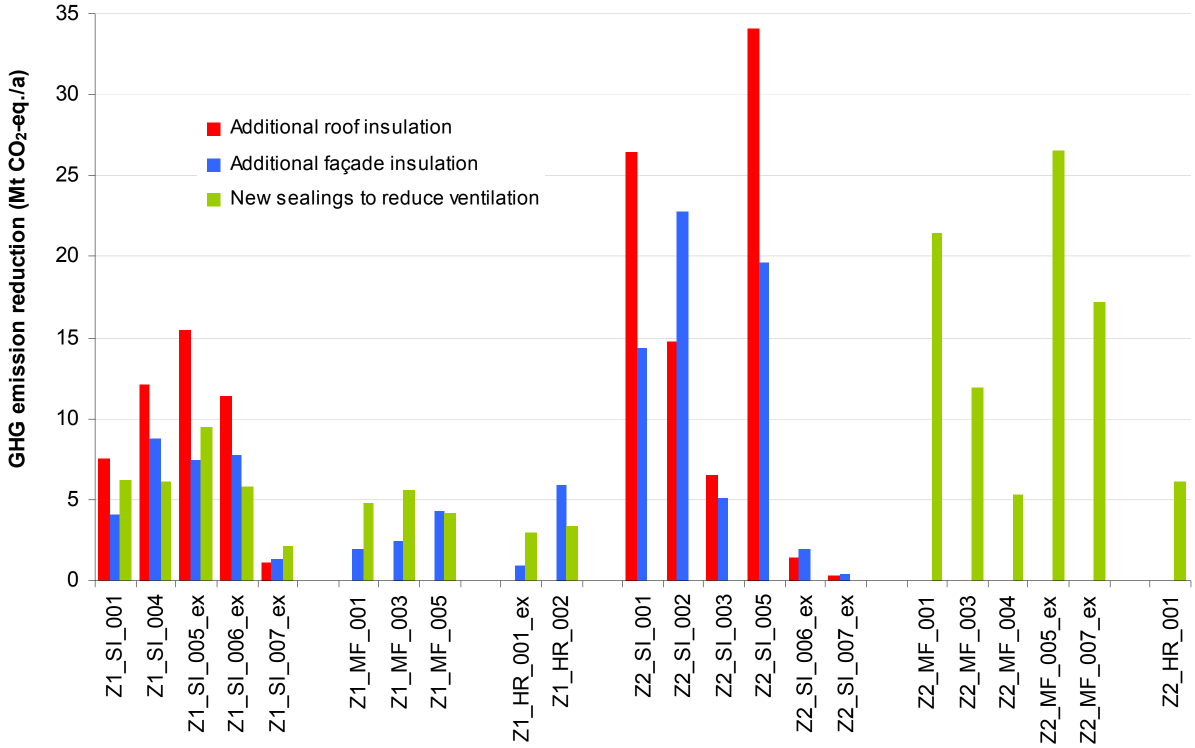


Figure 7.7 Total environmental improvement potential for GHG emissions according to building type and measure in the EU-25 per year

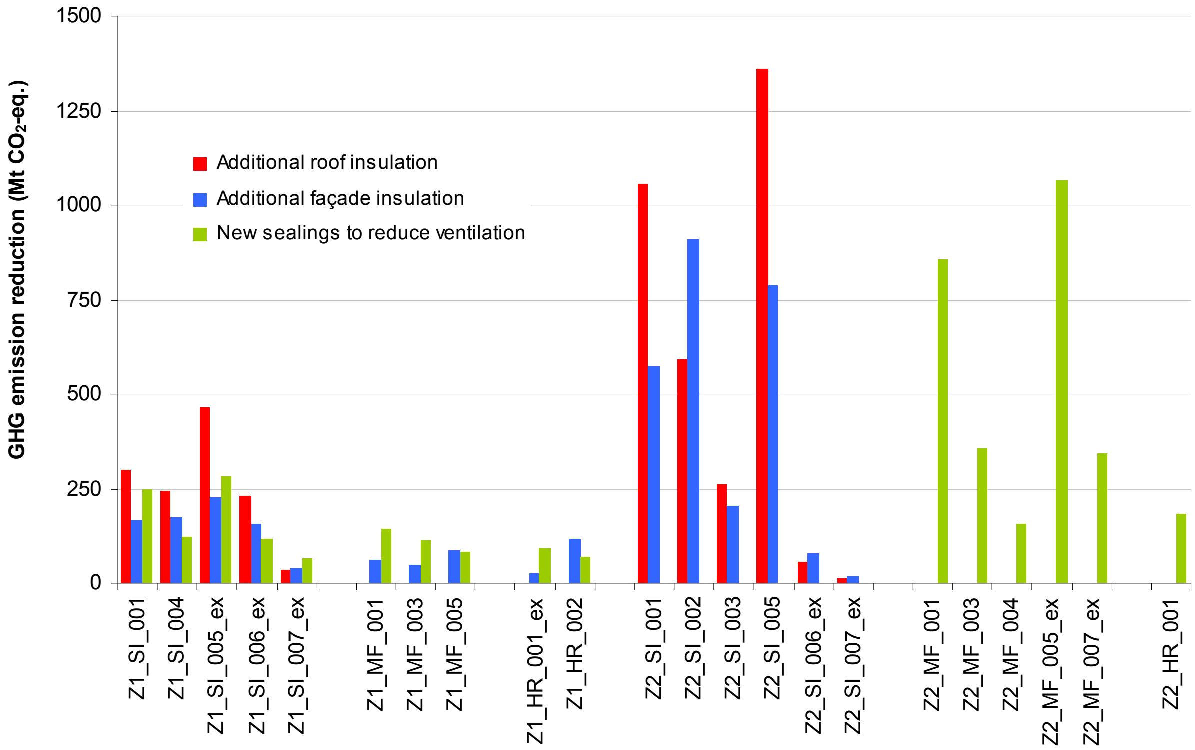


Figure 7.8 Total environmental improvement potential for GHG emissions according to building type and measure in the EU-25 over the total residual service life of the building type

7.1.6 Cost efficiency of the improvement options

Table 7.10 gives an overview of the cost assessment of the selected improvement action based on the internal rate of return – assuming a 2% annual increase of energy prices (see Annex D 2).

For **additional roof insulation**, only three building types show a negative internal rate of return, all other building types show high internal rates of return and therefore are preferable from an economic point of view.

Regarding **additional façade insulation,** 16 building types were identified for the measure to improve the external wall. Five building types show a negative internal rate of return. For the remaining nine building types, the internal rate of return is between 1.8% and 14.6%.

For **reduced ventilation losses**, as a result of the low investment costs when compared to the fuel cost savings, the internal rate of return is very high. It should be noted, however, that such a measure has to be implemented properly to avoid severe problems such as reduced indoor quality and moisture problems resulting from reduced air quality.

Overall, in a majority of cases (building types and improvement options), the measures analysed are cost efficient.

However, this general conclusion only holds true if the energy savings are granted to the investor. If the building is rented, the cost can hardly be transferred completely to the tenant. On the other hand, the tenant only benefits from the energy savings. Therefore the conclusion stated above only holds true if the investor also benefits from the energy cost reduction.

Table 7.10 Internal rate of return for the retrofit measures in %

Building type	Additional roof insulation	Additional façade insulation	Additional roof & façade insulation	New sealings to reduce ventilation
Z1_SI_001	10.59	1.77	5.23	93.83
Z1_SI_004	15.31	2.29	7.21	94.25
Z1_SI_005_ex	15.41	1.83	7.19	105.26
Z1_SI_006_ex	18.52	3.50	9.22	113.28
Z1_SI_007_ex	X	X	X	46.20
Z1_MF_001	---	4.02	---	83.69
Z1_MF_003	---	X	---	50.50
Z1_MF_005	---	14.57	---	81.44
Z1_HR_001_ex	---	X	---	39.19
Z1_HR_002	---	14.45	---	47.20
Z2_SI_001	16.38	4.33	8.84	---
Z2_SI_002	16.32	12.88	13.99	---
Z2_SI_003	16.68	6.90	10.36	---
Z2_SI_005	16.52	4.76	9.10	---
Z2_SI_006_ex	X	X	X	---
Z2_SI_007_ex	X	X	X	---
Z2_MF_001	---	---	---	141.77
Z2_MF_003	---	---	---	146.19
Z2_MF_004	---	---	---	165.24
Z2_MF_005_ex	---	---	---	139.96
Z2_MF_007_ex	---	---	---	172.81
Z2_HR_001	---	---	---	182.50

a) X stands for negative internal rate of return

> 5%
> 10%
< 0%

7.1.7 CO_2 abatement costs

Using the NPV of the improvement measures when compared to the base case (see Annex D), which, by definition, accounts for all the incurred life cycle costs (investment and fuel costs savings), the costs per unit of abated life cycle CO_2 emissions were calculated (abatement cost).

In Figure 7.9, the individual measures as applied to the considered building types were ranked according to the increasing abatement costs (shown by the vertical axis). The horizontal axis shows the cumulated emissions reduction potential at EU-25 level.

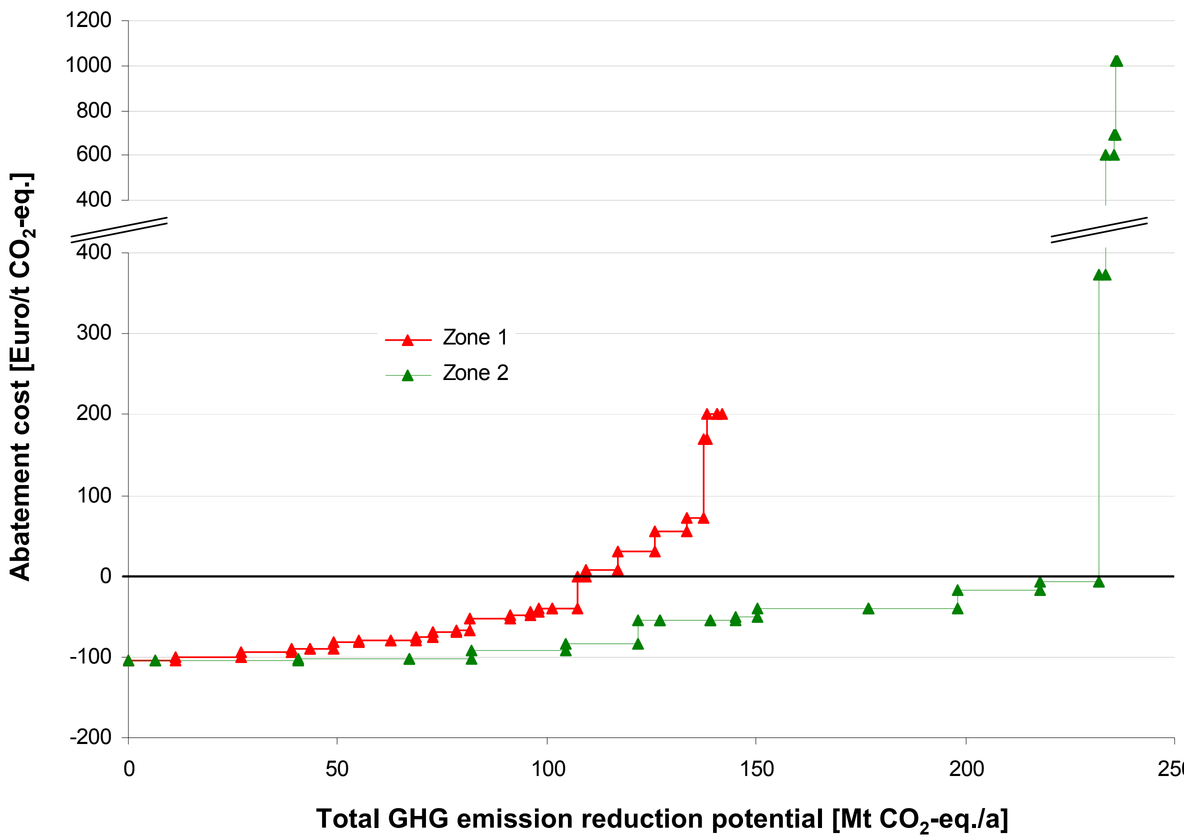


Figure 7.9 Abatement cost of the improvement measures related to the total GHG emission reduction potential for the EU-25

Figure 7.9 shows that most of the improvement options are feasible with a negative abatement cost, which means that the energy savings resulting from the measure outweigh the initial investment cost: 80% of the total GHG reduction potential in zone 1 and 95% of the potential in zone 2 can be realised in this way. Only a few improvement measures show positive abatement costs. For the measure "new sealings to reduce ventilation", the abatement costs turn out to be positive for one building only which, in addition, represents a low improvement potential (see Table 7.11). Regarding "additional roof insulation", most of the measures are cost efficient (see Table 7.10). They also come with a high total reduction potential for the EU-25.

The additional façade insulation shows comparably high CO_2 abatement costs with a medium reduction potential. Still, for most building types, the internal rate of return is positive (see Table 7.10).

In conclusion, the measures "additional roof insulation" and "new sealings to reduce ventilation losses" may be favourable both from the total environmental improvement potentials and from the efficiency in terms of costs of CO_2 abatement.

Table 7.11 CO_2 abatement costs and reduction potentials for the retrofit measures

Building type	Additional roof insulation		Additional façade insulation		New sealings to reduce ventilation	
	Abatement costs €/t CO2-eq.	Emission reductions Mt CO_2-eq.	Abatement costs €/t CO2-eq.	Emission reductions Mt CO_2-eq.	Abatement costs €/t CO2-eq.	Emission reductions Mt CO_2-eq.
Z1_SI_001	-80.6	7.5	71.7	4.1	-39.4	6.2
Z1_SI_004	-94.0	12.1	30.0	8.7	-78.9	6.2
Z1_SI_005_ex	-100.5	15.5	55.1	7.5	-52.7	9.5
Z1_SI_006_ex	-105.3	11.4	8.0	7.8	-81.5	5.8
Z1_SI_007_ex	201.3	1.1	422.7	1.4	-44.1	2.1
Z1_MF_001	---	---	-0.4	2.0	-49.4	4.8
Z1_MF_003	---	---	200.3	2.5	-69.3	5.6
Z1_MF_005	---	---	-90.8	4.2	-76.3	4.1
Z1_HR_001_ex	---	---	169.4	0.9	-39.6	3.0
Z1_HR_002	---	---	-90.3	5.9	-66.6	3.4
Z2_SI_001	-103.3	26.4	-7.5	14.3	---	---
Z2_SI_002	-103.2	14.8	-92.4	22.8	---	---
Z2_SI_003	-104.0	6.5	-50.0	5.1	---	---
Z2_SI_005	-103.7	34.0	-16.7	19.6	---	---
Z2_SI_006_ex	372.9	1.4	598.1	2.0	---	---
Z2_SI_007_ex	689.6	0.3	1020.9	0.4	---	---
Z2_MF_001	---	---	---	---	-40.3	21.4
Z2_MF_003	---	---	---	---	-55.1	11.9
Z2_MF_004	---	---	---	---	-55.6	5.3
Z2_MF_005_ex	---	---	---	---	-40.6	26.6
Z2_MF_007_ex	---	---	---	---	-84.8	17.2
Z2_HR_001	---	---	---	---	-54.9	6.1

Negative abatement cost
Positive abatement cost with negative IRR
Positive abatement cost with positive IRR

7.1.8 Socio-cultural impacts

Besides costs, the project has not quantified the socio-economic impacts of the improvement measures at EU level. Some indirect impacts of these measures can be identified as listed below:

- most of all the **thermal comfort** of the inhabitants is improved by insulation measures. As the human body senses temperature by around two thirds through radiation exchange between the surrounding radiating surfaces, warmer surfaces (in winter time) caused by insulation of the wall and the roof cause greater thermal comfort
- the reduction of the ventilation losses and new windows can increase **insulation against noise**
- the **health** of the inhabitants can be also be increased by higher surface temperatures of the inside of external wall as the mould and fungus growth is reduced. This may not be true for reduced moisture transport through reduced ventilation
- other functional or social aspects such as breaking down barriers for disabled or elderly persons, security, improved neighbourhood situation, etc. can't be attributed to the measures.

7.1.9 Conclusions

The three measures, roof insulation, façade insulation and reduced ventilation yield a significant environmental improvement potential, which, for a majority of buildings represents at least a 20% improvement when compared to the base case.

Additional roof insulation and new sealings to reduce ventilation represent the biggest potentials (about 130 Mt CO_2-eq./a and 140 Mt CO_2-eq./a respectively for the building types considered). The potential for roof insulation is particularly high for single-family houses. Both measures were shown to be applicable with economic profitability in most cases. The additional insulation of external walls also represents an important potential (about 110 Mt CO_2-eq./a). In this case, however, the economic profitability is less systematic as, in some cases, the fuel costs savings do not compensate the higher initial investments.

For each measure, the highest improvement potentials from the European perspective are derived for zone 2. This is partly due to the larger building stock in play and to the colder climate conditions.

When summed over all building types considered and all respective measures, the total emissions reductions reach 360 Mt CO_2-eq./a. The results have also shown that most of the improvement options are feasible with negative abatement costs.

The decision on which measure to take for an individual building can, to some extent, be guided from these results but the results also show the need to take account of the individual building situation before deciding on the priority measure.

7.2 New buildings

Regarding improvement options for new buildings, as explained in Section 6.2, the quantification of environmental benefits has been limited to the options that primarily reduce the impacts from the construction phase by changing the material composition of buildings.

The analysis was made by using the generic building model initially developed and used in Section 4.5. The alternatives were modelled in order to calculate the new resulting life cycle impact assessments (LCIA) and to be able to compare them with the base case ones. This was applied to four building types selected from the initial list of new buildings, and one example of each group of building types was selected (see Table 7.12).

Table 7.12 New buildings selected for analysis with the construction elements considered for material substitution

Building Types	Building stock in Mio. m²	Environmental hotspots in the Construction Phase			
		Exterior walls	Interior walls	Floors/ceiling	Basement
Z1_HR_001	271	**X**		**X**	
Z1_MF_004	215	**X**	**X**		
Z1_SI_007	283	**X**			**X**
Z2_SI_008	366	**X**		**X**	

For each of the four building types, alternative material compositions were selected:

- breeze concrete
- sandlime

- wooden construction
- cored brick
- reinforced concrete.

The alternative construction materials were assessed for exterior and interior walls, but not for floors/ceilings or basements. These alternatives have different environmental impacts and not all alternatives necessarily have a lower impact than the base scenario. This is illustrated in Figure 7.10 which compares four alternatives for exterior walls with the base scenario corresponding to the building type Z1_MF_004. This graph shows that three of the proposed alternatives have a reduced environmental profile when compared to the base scenario and that the alternative proposing reinforced concrete has an increased environmental profile. In addition, the only alternative which results in a significant improvement is the wood construction as, in this case, the life cycle greenhouse gas emissions are reduced by 12%.

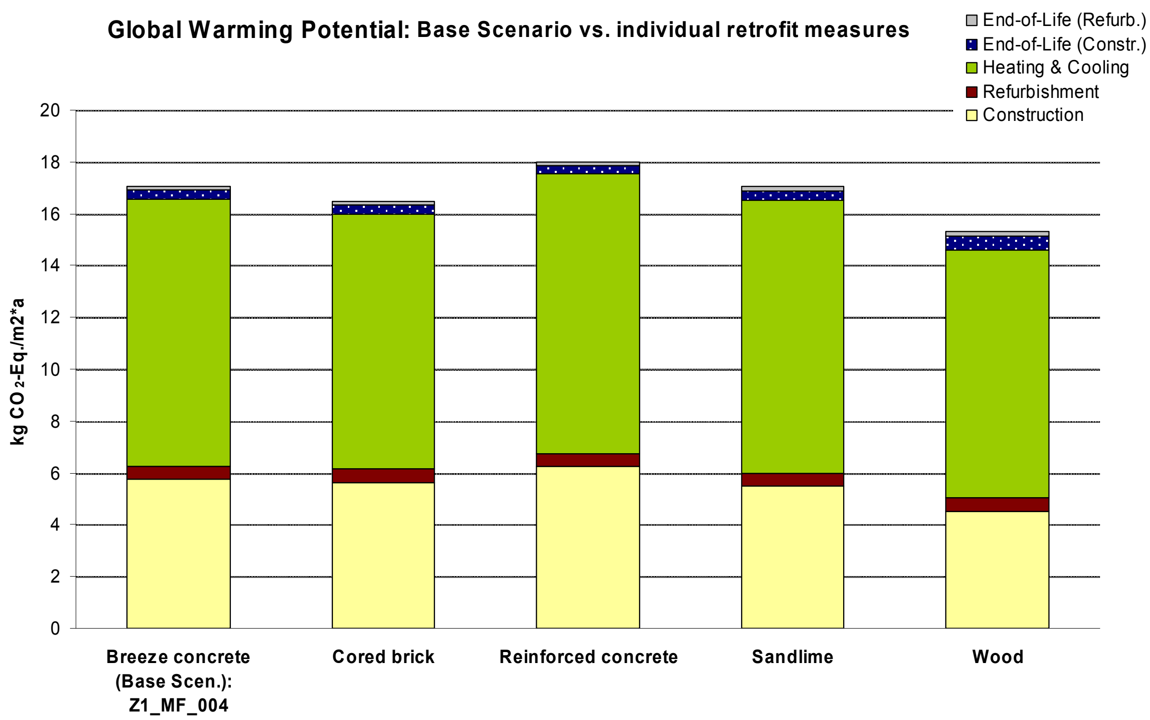


Figure 7.10 Example of results (greenhouse gas emissions) for new buildings (here: Z1_MF_004): comparison of base case (breeze concrete) to four alternative construction materials for exterior walls

All the results for the buildings considered and alternative construction materials in Table 7.13, show the total life cycle impacts relative to the corresponding baseline values. This table confirms the conclusions derived from the previous example.

It can generally be stated that the wooden construction alternative has the lowest environmental impacts. The other construction options may differ from each other but any systematic benefit that would result is not as obvious.

Table 7.13 Total life cycle impacts of the constructional alternatives compared to the base case

	Z1_HR_001 External wall Base case: wooden frame			**Z1_MF_004** External wall Base case: breeze concrete				**Z1_MF_004** Internal wall Base case: breeze concrete			**Z1_SI_007** External wall Base case: reinforced concrete			**S2_SI_008** External wall Base case: wooden frame			
Impact category	Sandlime	Breeze concrete	Reinforced concrete	Cored brick	Reinforced concrete	Sandlime	Wood	Cored brick	Sandlime	Reinforced concrete	Breeze concrete	Sandlime	Wood	Breeze concrete	Alternative brick	Reinforced concrete	Sandlime
PE	95	93	99	101	100	101	96	104	102	105	104	101	101	109	106	110	102
GWP	100	100	107	94	100	100	88	100	106	112	106	104	94	113	106	113	104
AP	95	98	102	97	102	100	91	100	98	105	108	101	96	112	105	110	101
EP	100	100	125	100	100	100	100	100	100	120	108	100	92	110	105	110	100
POCP	100	100	107	100	107	100	93	100	100	107	106	104	98	111	104	110	101
ODP	97	97	105	98	106	100	95	103	101	108	105	102	99	108	103	108	99

Environmental impacts smaller than 98% compared to base case
Environmental impacts greater than 102% compared to base case

Although, wood appears to represent a better performing material from an environmental standpoint, it is, however, not as easy to derive an improvement potential at EU level. Extrapolating such results at EU level would indeed require further investigation of the construction options which better suit with the local and weather conditions – considering, amongst other things, thermal mass requirements. For this reason, the figures presented were not rescaled at EU level.

Another aspect which would need to be further investigated is the consideration of the upstream processes involved which includes the conditions for forest management. If the wood is taken from a forest under sustainable management, it can be assumed that the carbon balance is neutral for the atmosphere. If, on the other hand, the harvested wood is not compensated by continuous forest growth, it should be borne in mind that carbon is likely to be emitted to the atmospheres from, e.g. the soils. In such cases, the carbon balance would not be neutral and net emissions to the atmosphere have to be accounted for. The effects on biodiversity would also need to be further assessed.

8 Conclusions

This project analysed the life cycle impacts of residential buildings in Europe, identified the main sources of environmental impacts and assessed the environmental improvement potential.

A buildings typology was first defined, leading to a selection of 72 building types, amongst which there were 19 new building types. These were assessed to be representative for about 80% of the residential building stock in the EU-25. These buildings were described in terms of their building stock representativity, geographical distribution, size, age, design, material composition, residual lifespan, and thermal insulation.

8.1 Life cycle impacts

The derived buildings models were subjected to a life cycle assessment. In particular, the final energy demand for heating was calculated by using the standard calculation method, taking into account all determinant parameters (e.g. climate, indoor setting temperature, building geometry).

This first analysis emphasised the important role of energy use in most of the environmental impacts quantified, first as a result of fuel combustion for space heating, and, second, as a result of the industrial processes involved in the manufacturing of building products. Consequently, both primary energy use and GHG emissions are good proxy indicators to assess the environmental performance of the buildings.

New buildings, as currently erected, generally show better environmental performance than existing ones. This is due to the better energy performances achieved as long as the best available practices are applied, especially in terms of building insulation.

Weather conditions obviously entail higher space heating demands, which results in higher energy demand for buildings in northern European regions. However, when normalised to similar weather conditions (based on heating degree days), buildings in these zones tended to have the best energy performances. The effect of the buildings geometry was also reflected in the general trend of higher energy demand in single-family houses when compared to the others. Cooling demand was estimated to be currently negligible in the total building energy demand. The effect of the increase in cooling systems sales on the future cooling demand in buildings was, however, not analysed.

The use phase of buildings, as dominated by energy demand for heating is by far the highest for all buildings. For new buildings, the construction phase is also significant and its relative importance varies from one impact category to the other. The end-of-life phase is of much lower importance. The environmental impacts from the use phase were broken down into the different building elements based on the respective heat losses. This showed that heat losses resulting from ventilation and infiltration are of significant importance for all buildings. This also holds true for external walls, particularly for high-rise buildings. Heat losses through roofs are important for a majority of single-family and multi-family houses. Windows were suggested to be of lower importance. This is partly because the retrofitting of windows was assumed to be part of autonomous improvement, which may, to some extent, provide a too optimistic picture. In general, the variations observed from one building type to the other are explained by the geometry and current insulation level of the building.

The use phase was also shown to be the most important one for new buildings with, however, a lower relative importance as a result of the better energy performance of these buildings. Besides this, the construction phase is of second importance, especially related to the exterior walls, the basement, and floors/ceilings. Interior walls, roofs and windows only play a minor role.

8.2 Improvement options

Improvement options for relevant building types were identified, focusing on the environmental hotspots (use phase and construction phase). They were analysed against the base cases that were initially defined.

For the reasons given in Section 6.2.1 regarding **new building types**, the quantification of environmental benefits has been limited to the options that primarily reduce the impacts from the construction phase by changing the material composition of the buildings.

The results showed that, amongst the alternatives considered, significant environmental improvements can be expected only when the substitution leads to the use of wood products instead of more “conventional” products (concrete, reinforced concrete, bricks).

For **existing buildings** the measures are consistent with the dominant role of the use phase, addressing this life cycle part, and particularly space heating, whenever the corresponding building element was shown to be an environmental hotspot. The three measures, “additional roof insulation”, “additional façade insulation”, and “new sealings to reduce ventilation” yield a significant environmental improvement potential, which, for a majority of the buildings types analysed represent at least a 20% improvement compared to the base case.

When rescaled at the EU-25 level, the resulting improvement potentials as measured in terms of CO_2 emission reductions is high. For each measure, the highest improvement potentials from the European perspective are derived for Zone 2. This is partly due to the larger building stock in play and to the colder climate conditions.

The major improvement potentials are found with single-, two-family and terrace houses, followed by multi-family buildings. Despite important percentage reductions potentials for high-rise buildings, smaller emissions reductions are expected in absolute terms due to the smaller share of these buildings in the overall building stock.

When combining and totalling the building types and relevant retrofit measures, the derived total life cycle CO_2 emissions reductions potential reaches 360 Mt CO_2-eq/a which corresponds to about 7% of the total direct greenhouse gas emissions in the EU-25 in 2005 (without land use, land use change and forestry) [EEA 2007]. This high emissions reductions potential estimation can be achieved provided that all barriers (e.g. social, economic) are overcome. The initial investment costs may represent one of these barriers. These life cycle costs of the retrofit measures were analysed through the calculated internal return rates and the net present values associated with these retrofit measures.

For both roof insulation and reduced ventilation, the measures were shown to be economically profitable (positive internal return rate) for a majority of buildings (see Table 8.1). For external wall insulation, the economic profitability is less systematic as, in some cases, the subsequent fuel costs savings do not compensate the higher initial investments. When compared to the two other measures, the application of new sealings in order to reduce ventilation bears smaller improvement potentials but has a higher economic profitability as a result of very low initial investments.

It was also shown that most of the improvement options are feasible with a negative CO_2 abatement cost: 80% of the total GHG reductions potential in zone 1 and 95% of the potential in zone 2.

Table 8.1 Summary of environmental improvement potential and abatement costs

Improvement measure	Building group	Zone	Abatement cost Euro/t CO_2-eq.	Total improvement potential Mt CO_2-eq./a
Additional roof insulation	Single-family houses	Zone 1	-90	48.67
		Zone 2	-93	83.50
Additional façade insulation	Single-family houses	Zone 1	55	29.46
		Zone 2	-19	64.21
	Multi-family houses	Zone 1	12	8.67
		Zone 2	Na	na
	High-rise buildings	Zone 1	-56	6.81
		Zone 2	Na	na
New sealings to reduce ventilation	Single-family houses	Zone 1	-60	29.71
		Zone 2	Na	na
	Multi-family houses	Zone 1	-65	14.48
		Zone 2	-53	82.39
	High-rise buildings	Zone 1	-54	6.39
		Zone 2	-55	6.06

These general conclusions provide elements to guide policy making aimed to support the implementation of these measures with instruments such as subsidies, and consumer awareness. However, the decision on which measure to apply for an individual building should be based on a prior assessment which should take into account the individual situation of the building.

8.3 Key message

Summarising, it can be stated that the current situation of the European residential building stock in terms of environmental performance is far from the currently discussed low-energy standards and there is a tremendous potential for improvements. If the measures examined are carried out on the buildings considered, the emissions of greenhouse gasses from these buildings may be cut by around 30 to 50% over the next 40 years. Therefore, active promotion and strong actions from all stakeholders have to be undertaken in order to seize this environmental opportunity. The information in this study provides the basis for discussions on measures and steps that can be taken in that direction.

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Annex

Annex A Country specific tables with building groups

This annex gives an overview on the number of dwellings in each of the EU-25 member-countries and their clustering into the groups of building types, used in this study.

	Single-family houses			Multi-family houses			High-rise buildings		
	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)
Austria						**Number of dwellings in entire housing stock: 3 297 000**			
Total	1 584 000	48	100	1 713 000	52	100	na		
Until 1945	437 184	13	28	456 456	14	27			
1945 to 1990	906 048	27	57	921 492	28	54			
Since 1990	240 768	7	15	334 620	10	20			
Belgium						**Number of dwellings in entire housing stock: 4 800 000**			
Total	3 600 000	75	100	1 008 000	21	100	192 000	4	100
Until 1945	1 170 000	24	33	327 600	7	33	62 400	1	33
1945 to 1990	1 630 800	34	45	456 624	10	45	86 976	2	45
Since 1990	799 200	17	22	223 776	5	22	42 624	1	22
Cyprus						**Number of dwellings in entire housing stock: 300 000**			
Total	201 000	67	100	99 000	33	100	na		
Until 1945									
1945 to 1990									
Since 1990									
Czech Republic						**Number of dwellings in entire housing stock: 4 400 000**			
Total	1 848 000	42	100	1 584 000	36	100	968 000	22	100
Until 1945	473 088	11	26	272 448	6	17	112 288	3	12
1945 to 1990	1 223 376	28	66	1 213 344	28	77	792 792	18	82
Since 1990	151 356	3	8	98 208	2	6	62 920	1	7
Denmark						**Number of dwellings in entire housing stock: 2 610 000**			
Total	1 326 000	51	100	1 024 000	39	100	260 000	10	100
Until 1945	490 620	19	37	471 510	18	46	173 420	7	67
1945 to 1990	737 256	28	56	487 734	19	48	78 260	3	30
Since 1990	98 124	4	7	64 896	2	6	8 320	0	3
Estonia						**Number of dwellings in entire housing stock: 602 000**			
Total	174 000	29	100	228 000	38	100	200 000	33	100
Until 1945	16 356	3	9	14 820	2	7			
1945 to 1990	129 456	22	74	173 052	29	76			
Since 1990	28 188	5	16	40 128	7	18			

	Single-family houses			Multi-family houses			High-rise buildings		
	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)
Finland						**Number of dwellings in entire housing stock: 2 600 000**			
Total	1 092 000	42	100	1 508 000	58	100	na		
Until 1945	102 648	4	9	98 020	4	7			
1945 to 1990	812 448	31	74	1 144 572	44	76			
Since 1990	176 904	7	16	265 408	10	18			
France						**Number of dwellings in entire housing stock: 29 500 000**			
Total	17 405 000	59	100	8 850 000	30	100	3 245 000	11	100
Until 1945	5 395 550	18	31	3 451 500	12	39			
1945 to 1990	9 746 800	33	56	4 690 500	16	53			
Since 1990	2 262 650	8	13	708 000	2	8			
Germany						**Number of dwellings in entire housing stock: 38 900 000**			
Total	17 894 000	46	100	19 061 000	49	100	1 945 000	5	100
Until 1945	4 992 426	13	28	4 841 494	12	25	97 250	0	5
1945 to 1990	10 915 340	28	61	12 313 406	32	65	1 711 600	4	88
Since 1990	1 986 234	5	11	1 906 100	5	10	136 150	0	7
Greece						**Number of dwellings in entire housing stock: 5 500 000**			
Total	3 245 000	59	100	2 255 000	41	100	na		
Until 1945	454 300	8	14	225 500	4	10			
1945 to 1990	2 271 500	41	70	1 713 800	31	76			
Since 1990	519 200	9	16	315 700	6	14			
Hungary						**Number of dwellings in entire housing stock: 4 141 000**			
Total	2 542 000	61	100	943 000	23	100	656 000	16	100
Until 1945	681 256	16	27	192 372	5	20	86 592	2	13
1945 to 1990	1 682 804	41	66	714 794	17	76	560 880	14	86
Since 1990	177 940	4	7	35 834	1	4	8 528	0	1
Ireland						**Number of dwellings in entire housing stock: 1 600 000**			
Total	1 504 000	94	100	96 000	6	100	na		
Until 1945	70 688	4	5	4 512	0	5			
1945 to 1990	1 090 400	68	73	69 600	4	73			
Since 1990	342 912	21	23	21 888	1	23			
Italy						**Number of dwellings in entire housing stock: 26 500 000**			
Total	10 600 000	40	100	12 190 000	46	100	3 710 000	14	100
Until 1945	2 544 000	10	24	2 559 900	10	21	445 200	2	12
1945 to 1990	7 208 000	27	68	8 654 900	33	71	3 042 200	11	82
Since 1990	848 000	3	8	975 200	4	8	222 600	1	6

	Single-family houses			Multi-family houses			High-rise buildings		
	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)
Latvia					**Number of dwellings in entire housing stock: 1 000 000**				
Total	260 000	26	100	740 000	74	100	na		
Until 1945	65 780	7	25	187 220	19	25			
1945 to 1990	185 120	19	71	526 880	53	71			
Since 1990	9 100	1	4	25 900	3	4			
Lithuania					**Number of dwellings in entire housing stock: 1 300 000**				
Total	494 000	38	100	806 000	62	100	na		
Until 1945	133 380	10	27	217 620	17	27			
1945 to 1990	326 040	25	66	531 960	41	66			
Since 1990	34 580	3	7	56 420	4	7			
Luxembourg					**Number of dwellings in entire housing stock: 195 000**				
Total	132 000	68	100	42 000	22	100	21 000	11	100
Until 1945	36 312	19	28	8 442	4	20	352	0	2
1945 to 1990	72 760	37	55	20 622	11	49	13 684	7	65
Since 1990	23 256	12	18	12 810	7	31	7 216	4	34
Malta					**Number of dwellings in entire housing stock: 1300 000**				
Total	130 000	100	100	na			na		
Until 1945	33 800	26	26						
1945 to 1990	84 500	65	65						
Since 1990	11 700	9	9						
Poland					**Number of dwellings in entire housing stock: 11 749 000**				
Total	5 023 000	43	100	4 130 000	35	100	2 596 000	22	100
Until 1945	1 167 020	10	23	991 200	8	24	129 800	1	5
1945 to 1990	3 247 360	28	65	2 684 500	23	65	2 102 760	18	81
Since 1990	608 880	5	12	454 300	4	11	363 440	3	14
Portugal					**Number of dwellings in entire housing stock: 5 300 000**				
Total	3 233 000	61	100	1 060 000	20	100	1 007 000	19	100
Until 1945	452 620	9	14	127 200	2	12	30 210	1	3
1945 to 1990	2 036 790	38	63	773 800	15	73	654 550	12	65
Since 1990	743 590	14	23	159 000	3	15	322 240	6	32
Slovakia					**Number of dwellings in entire housing stock: 1 900 000**				
Total	1 007 000	53	100	513 000	27	100	380 000	20	100
Until 1945	115 805	6	12	18 981	1	4	9 880	1	3
1945 to 1990	823 726	43	82	470 421	25	92	353 780	19	93
Since 1990	67 469	4	7	23 598	1	5	16 720	1	4

	Single-family houses			Multi-family houses			High-rise buildings		
	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)	Dwellings	Proportion (%)	Scaled proportion (%)
Slovenia	**Number of dwellings in entire housing stock: 800 000**								
Total	520 000	65	100	192 000	24	100	88 000	11	100
Until 1945	122 200	15	24	20 928	3	11	3 423	0	4
1945 to 1990	357 240	45	69	162 240	20	85	81 664	10	93
Since 1990	40 560	5	8	8 832	1	5	2 904	0	3
Spain	**Number of dwellings in entire housing stock: 20 900 000**								
Total	7 733 000	37	100	7 942 000	38	100	5 225 000	25	100
Until 1945	1 082 620	5	14	794 200	4	10	418 000	2	8
1945 to 1990	5 413 100	26	70	6 035 920	29	76	4 232 250	20	81
Since 1990	1 237 280	6	16	1 111 880	5	14	574 750	3	11
Sweden	**Number of dwellings in entire housing stock: 4 400 000**								
Total	2 112 000	48	100	2 288 000	52	100	na		
Until 1945	612 480	14	29	823 680	19	36			
1945 to 1990	1 330 560	30	63	1 281 280	29	56			
Since 1990	168 960	4	8	183 040	4	8			
The Netherlands	**Number of dwellings in entire housing stock: 6 800 000**								
Total	4 216 000	62	100	2 108 000	31	100	476 000	7	100
Until 1945	459 544	7	11	377 332	6	18	11 900	0	3
1945 to 1990	3 048 168	45	72	1 372 308	20	65	370 804	5	78
Since 1990	708 288	10	17	358 360	5	17	93 296	1	20
United Kingdom	**Number of dwellings in entire housing stock: 25 575 000**								
Total	20 204 000	79	100	4 859 000	19	100	512 000	2	100
Until 1945	7 786 240	30	39	1 288 960	5	27	89 088	0	17
1945 to 1990	11 102 976	43	55	3 254 016	13	67	413 184	2	81
Since 1990	1 314 560	5	7	316 160	1	7	9 728	0	2

Annex B Detailed technical description of all building types

The tables in this annex describe all identified building types on a technical level, providing all relevant background information used to conduct the construction materials-based parts of the Life Cycle Assessment. For this purpose, all building types are divided into the same construction elements. Whenever refurbishment takes place, this fact is highlighted in yellow.

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_001**	**Brick masonry with wooden flooring and pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1 300.0	0.0	220.0	4.4		5 720.0	5.7
			brick	80	0.0	1 800.0	0.5	220.0	110.0		198 000.0	198.0
			interior plaster (lime-gypsum)	30	0.3	1 000.0	0.0	220.0	4.4		4 400.0	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	60.0	1.2		1 200.0	1.2
			brick	80	0.0	1 800.0	0.3	60.0	18.0		32 400.0	32.4
			interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	60.0	1.2		1 200.0	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	100.0	2.0		2 000.0	2.0
			wooden construction	20	1.0	500.0	0.1	10.0	0.8		400.0	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1 000.0	0.0	100.0	2.0		2 000.0	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500.0	0.2	21.9	3.5		1 750.0	1.8
			roof battening (timber spruce 12%)	25	0.6	500.0	0.0	12.5	0.5		250.0	0.3
			roof tile	25	0.6	2 000.0	0.0	120.0	2.4		4 800.0	4.8
			REFURBISHMENT: insulation	40	0.6	80.0	0.1	100.0	12.0			0.0
		Floor	floor timber spruce	20	1.0	500.0	0.0	90.0	2.7	2.0	2 700.0	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	20	1.0	500.0	0.2	15.6	2.5	2.0	2 500.0	2.5
			wooden boarding	20	1.0	690.0	0.0	90.0	1.8	2.0	2 484.0	2.5
			interior plaster (lime-gypsum)	20	1.0	1 000.0	0.0	90.0	1.8	2.0	3 600.0	3.6
		Basement wall	brick	80	0.0	1 800.0	0.8	80.0	64.0		115 200.0	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1 800.0	0.1	120.0	8.4		15 120.0	15.1
			wooden construction	20	1.0	500.0	0.1	31.3	2.5		1 250.0	1.3
			filling sand and grit	30	0.3	2 000.0	0.1	90.0	7.2		14 400.0	14.4
			wooden boarding	20	1.0	690.0	0.0	90.0	1.8		1 242.0	1.2
		Basement ground Floor	brick	80	0.0	1 800.0	0.1	90.0	9.0		16 200.0	16.2
		Foundation	brick	80	0.0	1 800.0	0.5	25.0	12.5		22 500.0	22.5
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22.0	**451 316.0**	**451.3**
			REFURBISHMENT: window	25						26.4		
Z1	**SI_002**	**Limestone/fieldstone masonry with wooden flooring and pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			limestone/fieldstone	80	0.0	2000	0.5	220	110		220000	220.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
			limestone/fieldstone	80	0.0	2000	0.3	60	18		36000	36.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.6	80	0.12	100	12		960	1.0
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	20	1.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	20	1.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	limestone/fieldstone	80	0.0	2000	0.8	80	64		128000	128.0
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	20	1.0	500	0.08	31.25	2.5		1250	1.3
			filling sand and grit	30	0.3	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	1.0	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	compact loam	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	limestone/fieldstone	80	0.0	2000	0.5	25	12.5		25000	25.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22		**493.2**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_003**	**Limestone/fieldstone masonry, wooden flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	200	4		5200	5.2
40			limestone/fieldstone	80	0.0	2000	0.5	200	100		200000	200.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	200	4		4000	4.0
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
			limestone/fieldstone	80	0.0	2000	0.3	60	18		36000	36.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum)	20	1.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5		1250	1.3
			battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			exterior plaster (lime-cement)	20	1.0	1300	0.02	200	4		5200	5.2
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	120	2.4		2400	2.4
			REFURBISHMENT: insulation	40	1.0	80	0.12	100	12		960	1.0
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	1	1350	1.4
			wooden joist (timber spruce 12%), distance 0,6mx0,1	20	1.0	500	0.16	16	2.5	1	1250	1.3
			wooden boarding	20	1.0	690	0.02	90	1.8	1	1242	1.2
			interior plaster (lime-gypsum)	20	1.0	1000	0.02	90	1.8	1	1800	1.8
		Basement wall									0	
		Basement ceiling									0	
		Basement ground Floor	compact loam	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	limestone/fieldstone	80	0.0	2000	0.5	25	12.5		25000	25.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					20		**308.9**
			REFURBISHMENT: window	25						24		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_004**	**Brick masonry, hollow brick flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	220	4.4		5720	5.7
20			cored brick	80	0.0	1200	0.3	220	66		79200	79.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.0	500	0.04	13	0.5		250	0.3
			roof tile	25	0.0	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.0	80	0.16	100	16		1280	1.3
		Floor	cement floor, screed topping	30	0.0	2400	0.04	90	3.6	2	17280	17.3
			reinforced concrete filling	40	0.0	2400	0.04	90	3.6	2	17280	17.3
			ceramic block	20	0.0	800	0.16	90	14.4	2	23040	23.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	200	0.03	90	2.25		450	0.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.4					22		**304.4**
			REFURBISHMENT: window	25						8.8		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m^3)	Thickness (m)	Area (m^2)	Volume (m^3)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_005_ex**	**Brick masonry, reinforced concrete flooring, pitched roof 20°**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	220	4.4		5720	5.7
30			cored brick	80	0.0	1200	0.3	220	66		79200	79.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.5	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.2	500	0.04	13	0.5		250	0.3
			roof tile	25	0.2	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.2	80	0.16	100	16		1280	1.3
		Floor	anhydrite screed	30	0.0	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.0	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.8					22		**329.4**
			REFURBISHMENT: window	25						17.6		
Z1	**SI_005**	**Brick masonry, reinforced concrete flooring, pitched roof 20°**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			**insulation**			80	**0.1**	**220**	**22**		1760	1.8
			brick	80	0.0	1200	0.3	220	66		79200	79.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			insulation			80	**0.1**	**100**	**10**		800	0.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	**plastic frame 1mx1,5m (with double-glazing)**	25	0.6					22		**330.8**
			REFURBISHMENT: window							13.2		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_006_ex**	**Brick masonry, reinforced concrete flooring, flat roof**										
Building's service life: 20		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	200	4		5200	5.2
			cored brick	80	0.0	1200	0.3	200	60		72000	72.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	200	4		4000	4.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
		Roof	gravel	80	0.0	2000	0.05	90	4.5		9000	9.0
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8		1800	1.8
			REFURBISHMENT: insulation	40	0.0	80	0.16	100	16		1280	1.3
		Floor	anhydrite screed	30	0.0	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.0	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.4					22		**359.8**
			REFURBISHMENT: window	25						8.8		
Z1	**SI_006**	**Brick masonry, reinforced concrete flooring, flat roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	200	4		5200	5.2
			insulation			80	**0.1**	**220**	**22**		1760	1.8
			brick	80	0.0	1200	0.3	200	60		72000	72.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	200	4		4000	4.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	gravel	80	0.0	2000	0.05	90	4.5		9000	9.0
			insulation			80	**0.1**	**90**	**9**		720	0.7
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8		1800	1.8
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	**plastic frame 1mx1,5m (with double-glazing)**	25	0.6					22		**361.2**
			REFURBISHMENT: window							**13.2**		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_007_ex**	**Brick masonry insulated, reinforced concrete flooring, pitched roof 20°**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	220	4.4		5720	5.7
30			cored brick	80	0.0	1200	0.3	220	66		79200	79.2
			core insulation	30	0.0	80	0.05	220	11		880	0.9
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.5	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			insulation	25	0.2	80	0.05	120	6.0		480	0.5
			roof battening (timber spruce 12%)	25	0.2	500	0.04	13	0.5		250	0.3
			roof tile	25	0.2	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.2	80	0.16	100	16		1280	1.3
		Floor	anhydrite screed	30	0.0	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.0	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					22	330748	**330.7**
			REFURBISHMENT: window	25						17.6		
Z1	**SI_007**	**Brick masonry insulated, reinforced concrete flooring, pitched roof 20°**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			brick	80	0.0	1200	0.3	220	66		79200	79.2
			core insulation	30	0.3	80	**0.1**	220	22		1760	1.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			brick	80	0.0	1200	0.2	60	12		14400	14.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			insulation	25	0.6	80	0.05	120	6.0		480	0.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	25	0.6					22		**330.5**
			REFURBISHMENT: window							13.2		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**SI_008**	**Wooden frame with stone filler, wooden flooring, pitched roof**										
Building's service life: 20		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	220	4.4		5720	5.7
			brick filling	30	0.0	1200	0.16	180	28.8		34560	34.6
			wooden construction	30	0.0	500	0.16	40	6.4		3200	3.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	0.0	1000	0.02	60	1.2		1200	1.2
			brick filling	30	0.0	1200	0.16	60	9.6		11520	11.5
			wooden construction	30	0.0	500	0.16	20	3.2		1600	1.6
			interior plaster (lime-gypsum) with straw	20	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	0.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	0.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	0.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.0	500	0.04	13	0.5		250	0.3
			roof tile	25	0.0	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.0	80	0.16	100	16		1280	1.3
		Floor	floor timber spruce	20	0.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	25	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	0.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	20	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	solid brick	80	0.0	1800	0.8	80	64		115200	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	30	0.0	500	0.08	31	2.5		1250	1.3
			filling sand and grit	30	0.0	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	0.0	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	brick	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	brick	80	0.0	1800	0.5	25	12.5		22500	22.5
		Window	wooden frame 1mx1,5m (with single-glazing)	10	0.4					22		**273.1**
			REFURBISHMENT: window	25						8.8		
Z1	**MF_001**	**Brick masonry with wooden flooring and pitched roof**										
Building's service life: 30		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	860	17.2		22360	22.4
			brick	80	0.0	1800	0.5	860	430		774000	774.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	0.5	1000	0.02	1100	22		22000	22.0
			brick	80	0.0	1800	0.3	1100	330		594000	594.0
			interior plaster (lime-gypsum) with straw	20	0.5	1000	0.02	1100	22		22000	22.0
		Interior wall	interior plaster (lime-gypsum) with straw	20	0.5	1000	0.02	1400	28		28000	28.0
			wooden construction	20	0.5	500	0.08	140	11.2		5600	5.6
			interior plaster (lime-gypsum) with straw	20	0.5	1000	0.02	1400	28		28000	28.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.2	500	0.04	62.5	2.5		1250	1.3
			roof tile	25	0.2	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	440	70.4		5632	5.6
		Floor	floor timber spruce	20	0.5	500	0.03	380	11.4	4	22800	22.8
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	4	22000	22.0
			wooden boarding	20	0.5	690	0.02	380	7.6	4	20976	21.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	brick	80	0.0	1800	0.8	540	432		777600	777.6
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	600	42		75600	75.6
			wooden construction	30	0.0	500	0.08	62.5	5		2500	2.5
			filling sand and grit	30	0.0	2000	0.08	380	30.4		60800	60.8
			wooden boarding	20	0.5	690	0.02	380	7.6		5244	5.2
		Basement ground Floor	brick	80	0.0	1800	0.1	380	38		68400	68.4
		Foundation	brick	80	0.0	1800	0.5	90	45		81000	81.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	0.8					170		**2714.4**
			REFURBISHMENT: window	25						136		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**MF_002**	**Limestone/fieldstone masonry with wooden flooring and pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
			limestone/fieldstone	80	0.0	2000	0.5	860	430		860000	860.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
			limestone/fieldstone	80	0.0	2000	0.3	1100	330		660000	660.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.6	80	0.16	440	70.4		5632	5.6
		Floor	floor timber spruce	20	1.0	500	0.03	380	11.4	4	22800	22.8
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	4	22000	22.0
			wooden boarding	20	1.0	690	0.02	380	7.6	4	20976	21.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	limestone/fieldstone	80	0.0	2000	0.8	540	432		864000	864.0
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	600	42		75600	75.6
			wooden construction	30	0.3	500	0.08	63	5		2500	2.5
			filling sand and grit	30	0.3	2000	0.08	380	30.4		60800	60.8
			wooden boarding	20	1.0	690	0.02	380	7.6		5244	5.2
		Basement ground Floor	compact loam	80	0.0	1800	0.1	380	38		68400	68.4
		Foundation	limestone/fieldstone	80	0.0	2000	0.5	90	45		90000	90.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					170		**2961.8**
			REFURBISHMENT: window	25						204		
Z1	**MF_003**	**Brick masonry, reinforced concrete flooring, pitched roof**										
Building's service life: 20		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	860	17.2		22360	22.4
			cored brick	80	0.0	1200	0.35	860	301		361200	361.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			cored brick	80	0.0	1200	0.3	1100	330		396000	396.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	interior plaster (lime-gypsum)	20	0.0	1000	0.02	1400	28		28000	28.0
			wooden construction	20	0.0	500	0.08	140	11.2		5600	5.6
			interior plaster (lime-gypsum)	20	0.0	1000	0.02	1400	28		28000	28.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.0	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.0	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	440	70.4		5632	5.6
		Floor	cement floor, screed topping	30	0.0	2400	0.04	380	15.2	4	145920	145.9
			reinforced concrete filling	30	0.0	2400	0.04	380	15.2	4	145920	145.9
			ceramic block	20	0.0	800	0.16	380	60.8	4	194560	194.6
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	0.4					170		**2077.3**
			REFURBISHMENT: window	25						68		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**MF_004_ex**	**Breeze concrete, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	860	17.2		22360	22.4
20			breeze concrete	40	0.0	600	0.3	860	258		154800	154.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			breeze concrete	40	0.0	600	0.2	1100	220		132000	132.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.0	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.0	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	440	70.4		5632	5.6
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.4					170		**1601.4**
			REFURBISHMENT: window	25						68		
Z1	**MF_004**	**Breeze concrete, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			**insulation**			80	**0.05**	**860**	**43**		3440	3.4
			breeze concrete	40	0.0	600	0.3	860	258		154800	154.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			breeze concrete	40	0.0	600	0.2	1100	220		132000	132.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.3	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	**plastic frame 1mx1,5m (with double-glazing)**	25	0.6					170		**1599.8**
			REFURBISHMENT: window							102		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**MF_005**	**Concrete wall insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	concrete	20	0.0	2400	0.2	800	160		384000	384.0
20			core insulation	20	0.0	80	0.05	800	40		3200	3.2
		Interior load-bearing wall	concrete	40	0.0	2400	0.2	1100	220		528000	528.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
		Roof	bitumen	20	0.0	1200	0	380	0.76		912	0.9
			insulation	20	0.0	80	0.05	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6		7600	7.6
			REFURBISHMENT: insulation	40	0.0	80	0.16	380	60.8		4864	4.9
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.4					170		**2272.6**
			REFURBISHMENT: window	25						68		
Z1	**MF_006_ex**	**Brick masonry, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	800	16		20800	20.8
20			cored brick	80	0.0	1200	0.35	800	280		336000	336.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	800	16		16000	16.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			cored brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
		Roof	bitumen	20	0.0	1200	0	380	0.76		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6		7600	7.6
			REFURBISHMENT: insulation	40	0.0	80	0.16	380	60.8		4864	4.9
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	4	76000	76.0
			insulation	30	0.0	80	0.03	380	11.4	4	3648	3.6
			reinforced concrete	40	0.0	2400	0.16	380	60.8	4	583680	583.7
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.4					170		**2210.7**
			REFURBISHMENT: window	25						68		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**MF_006**	**Brick masonry, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	800	16		20800	20.8
40			**insulation**			80	**0.05**	**860**	**43**		3440	3.4
			brick	80	0.0	1200	0.35	800	280		336000	336.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	800	16		16000	16.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	bitumen	20	1.0	1200	0	380	0.76		912	0.9
			insulation			80	**0.1**	**380**	**38**		3040	3.0
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6		7600	7.6
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	4	76000	76.0
			insulation	30	0.3	80	0.03	380	11.4	4	3648	3.6
			reinforced concrete	40	0.0	2400	0.16	380	60.8	4	583680	583.7
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	25	0.6					170		**2212.9**
			REFURBISHMENT: window							102		
Z1	**MF_007**	**Concrete wall, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	concrete	20	0.0	2400	0.3	1450	435		1044000	1044.0
20		Interior load-bearing wall	concrete	40	0.0	2400	0.2	1930	386		926400	926.4
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	2180	26.16		36624	36.6
			wooden construction	20	0.0	500	0.08	218	17.44		8720	8.7
			plaster board (gypsum)	20	0.0	1400	0.01	2180	26.16		36624	36.6
		Roof	bitumen	20	0.0	1200	0	380	0.76		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6		7600	7.6
			REFURBISHMENT: insulation	40	0.0	80	0.16	380	60.8		4864	4.9
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	6	114000	114.0
			insulation	30	0.0	80	0.03	380	11.4	6	5472	5.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8	6	875520	875.5
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	6	45600	45.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	90	72		172800	172.8
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.4					270		**3941.3**
			REFURBISHMENT: window	25						108		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**MF_008_ex**	**Brick cavity masonry with core insulated, reinforced concrete flooring, flat roof**										
Building's service life: 30		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	1450	29		37700	37.7
			cored brick	80	0.0	1200	0.2	1450	290		348000	348.0
			core insulation	20	0.5	80	0.05	1450	72.5		5800	5.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1450	29		29000	29.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1930	38.6		38600	38.6
			concrete	40	0.0	2400	0.2	1930	386		926400	926.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1930	38.6		38600	38.6
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2180	26.16		36624	36.6
			wooden construction	20	0.5	500	0.08	218	17.44		8720	8.7
			plaster board (gypsum)	20	0.5	1400	0.01	2180	26.16		36624	36.6
		Roof	bitumen	20	0.5	1200	0	380	0.76		912	0.9
			insulation	20	0.5	80	0.05	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6		7600	7.6
			REFURBISHMENT: insulation	40	0.0	80	0.16	380	60.8		4864	4.9
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	6	114000	114.0
			insulation	30	0.0	80	0.03	380	11.4	6	5472	5.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8	6	875520	875.5
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	6	45600	45.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	90	72		172800	172.8
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					270		**3396.5**
			REFURBISHMENT: window	25						216		
Z1	**MF_008**	**Brick cavity masonry with core insulated, reinforced concrete flooring, flat roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	1450	29		37700	37.7
			brick	80	0.0	1200	0.2	1450	290		348000	348.0
			core insulation	20	1.0	80	**0.1**	1450	145		11600	11.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1450	29		29000	29.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1930	38.6		38600	38.6
			concrete	40	0.0	2400	0.2	1930	386		926400	926.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1930	38.6		38600	38.6
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	2180	26.16		36624	36.6
			wooden construction	20	1.0	500	0.08	218	17.44		8720	8.7
			plaster board (gypsum)	20	1.0	1400	0.01	2180	26.16		36624	36.6
		Roof	bitumen	20	1.0	1200	0	380	0.76		912	0.9
			insulation	20	1.0	80	**0.1**	380	38		3040	3.0
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6		7600	7.6
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	6	114000	114.0
			insulation	30	0.3	80	0.03	380	11.4	6	5472	5.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8	6	875520	875.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	6	45600	45.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	90	72		172800	172.8
		Window	plastic frame 1mx1,5m (with double-glazing)	25	0.6					270		**3399.6**
			REFURBISHMENT: window							162		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**HR_001_ex**	**Brick masory, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	cored brick	30	0.0	1200	0.35	2000	700		840000	840.0
30			interior plaster (lime-gypsum)	30	0.0	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
			concrete	40	0.0	2400	0.2	1800	360		864000	864.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
			wooden construction	20	0.5	500	0.08	270	21.6		10800	10.8
			plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	0.5	1200	0	450	0.9		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9		9000	9.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	450	72		5760	5.8
		Floor	anhydrite screed	30	0.0	2000	0.03	450	11.25	9	202500	202.5
			insulation	30	0.0	80	0.03	450	13.5	9	9720	9.7
			reinforced concrete	40	0.0	2400	0.16	450	72	9	1555200	1555.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9	9	81000	81.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					470		**4701.2**
			REFURBISHMENT: window	25						376		
Z1	**HR_001**	**Brick masory, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	**interior plaster (lime-gypsum)**			1000	**0.02**	**2000**	**40**		40000	40.0
40			**insulation**			80	**0.1**	**380**	**38**		3040	3.0
			brick	30	0.3	1200	0.35	2000	700		840000	840.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1800	36		36000	36.0
			concrete	40	0.0	2400	0.2	1800	360		864000	864.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	2700	32.4		45360	45.4
			wooden construction	20	1.0	500	0.08	270	21.6		10800	10.8
			plaster board (gypsum)	20	1.0	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	1.0	1200	0	450	0.9		1080	1.1
			insulation			80	**0.1**	**450**	**45**		3600	3.6
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	450	9		9000	9.0
		Floor	anhydrite screed	30	0.3	2000	0.03	450	11.25	9	202500	202.5
			insulation	30	0.3	80	0.03	450	13.5	9	9720	9.7
			reinforced concrete	40	0.0	2400	0.16	450	72	9	1555200	1555.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	450	9	9	81000	81.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with double-glazing)	25	0.6					470		**4742.7**
			REFURBISHMENT: window							282		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z1	**HR_002**	**Concrete wall, reinforced concrete flooring, flat roof**										
Building's service life: 20		Exterior wall	reinforced concrete	20	0.0	2400	0.3	2000	600		1440000	1440.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
			reinforced concrete	40	0.0	2400	0.2	1800	360		864000	864.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	2700	32.4		45360	45.4
			reinforced concrete	40	0.0	2400	0.08	2700	216		518400	518.4
			plaster board (gypsum)	20	0.0	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	0.0	1200	0	450	0.9		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9		9000	9.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	450	72		5760	5.8
		Floor	anhydrite screed	30	0.0	2000	0.03	450	11.25	6	135000	135.0
			insulation	30	0.0	80	0.03	450	13.5	6	6480	6.5
			reinforced concrete	40	0.0	2400	0.16	450	72	6	1036800	1036.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9	6	54000	54.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	600	120		288000	288.0
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	450	11.25		22500	22.5
			insulation	30	0.0	80	0.03	450	13.5		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
		Basement ground Floor	concrete	40	0.0	2400	0.1	450	45		108000	108.0
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with single-glazing)	10	0.4					270		**5268.8**
			REFURBISHMENT: window	25						108		
Z2	**SI_001**	**Brick masonry with wooden flooring and pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			solid brick	80	0.0	1800	0.5	220	110		198000	198.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
			solid brick	80	0.0	1800	0.3	60	18		32400	32.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.6	80	0.16	105.6	16.9		1351.68	1.4
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	solid brick	80	0.0	1800	0.8	80	64		115200	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	30	0.3	500	0.08	31	2.5		1250	1.3
			filling sand and grit	30	0.3	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	1.0	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	brick	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	brick	80	0.0	1800	0.5	25	12.5		22500	22.5
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22		**452.7**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_002**	**Rubble stone masonry with wooden flooring and pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			rubble stone masonry	80	0.0	1600	0.5	220	110		176000	176.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
			rubble stone masonry	80	0.0	1600	0.3	60	18		28800	28.8
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.6	80	0.16	105.6	16.9		1351.68	1.4
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	rubble stone masonry	80	0.0	1600	0.8	80	64		102400	102.4
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	30	0.3	500	0.08	31	2.5		1250	1.3
			filling sand and grit	30	0.3	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	1.0	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	compact loam	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	rubble stone masonry	80	0.0	1600	0.5	25	12.5		20000	20.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22		**411.8**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_003**	**Wooden frame with stone filler, wooden flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			brick filling	30	0.3	1200	0.16	180	28.8		34560	34.6
			wooden construction	20	1.0	500	0.16	40	6.4		3200	3.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
			brick filling	30	0.3	1200	0.16	60	9.6		11520	11.5
			wooden construction	20	1.0	500	0.16	20	3.2		1600	1.6
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	12.5	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.6	80	0.16	105.6	16.9		1351.68	1.4
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	solid brick	80	0.0	1800	0.8	80	64		115200	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	30	0.3	500	0.08	31	2.5		1250	1.3
			filling sand and grit	30	0.3	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	1.0	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	brick	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	brick	80	0.0	1800	0.5	25	12.5		22500	22.5
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22		**273.1**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_004**	**Brick masonry, hollow brick Flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	220	4.4		5720	5.7
30			cored brick	80	0.0	1200	0.3	220	66		79200	79.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.3	60	18		21600	21.6
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	0.5	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.2	500	0.04	13	0.5		250	0.3
			roof tile	25	0.2	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.2	80	0.16	105.6	16.9		1351.68	1.4
		Floor	cement floor, screed topping	30	0.0	2400	0.04	90	3.6	2	17280	17.3
			reinforced concrete filling	40	0.0	2400	0.04	90	3.6	2	17280	17.3
			ceramic block	20	0.5	800	0.16	90	14.4	2	23040	23.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	wooden frame 1mx1,5m (with double-glazing)	10	0.8					22		**316.3**
			REFURBISHMENT: window	25						17.6		
Z2	**SI_005**	**Brick wall, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			cored brick	80	0.0	1200	0.35	220	77		92400	92.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.3	60	18		21600	21.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.6	80	0.16	105.6	16.9		1351.68	1.4
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					22		**349.9**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_006_ex**	**Brick masory insulated, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			insulation	30	0.3	80	0.1	220	22		1760	1.8
			cored brick	80	0.0	1200	0.35	220	77		92400	92.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			cored brick	80	0.0	1200	0.3	60	18		21600	21.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			NO additional insulation								0	
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					22		**351.8**
			REFURBISHMENT: window	25						26.4		
Z2	**SI_006**	**Brick masory insulated, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			**insulation**	30	0.3	80	**0.15**	220	33		2640	2.6
			brick	80	0.0	1200	0.35	220	77		92400	92.4
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			brick	80	0.0	1200	0.3	60	18		21600	21.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					22		**352.8**
			REFURBISHMENT: window							13.2		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_007_ex**	**Sandlime masory insulated, reinforced concrete flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			insulation	30	0.3	80	0.1	220	22		1760	1.8
			sandlime	80	0.0	1800	0.2	220	44		79200	79.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			sandlime	80	0.0	1800	0.2	60	12		21600	21.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			NO additional insulation								0	
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					22		**338.6**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_007**	**Sandlime masory insulated, reinforced concrete flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			insulation	30	0.3	80	**0.15**	220	33		2640	2.6
			sandlime	80	0.0	1800	0.2	220	44		79200	79.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			sandlime	80	0.0	1800	0.2	60	12		21600	21.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					22		**339.6**
			REFURBISHMENT: window							13.2		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**SI_008_ex**	**Wooden frame insulated, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	220	4.4		5720	5.7
30			mineral insulation	30	0.0	80	0.16	180	28.8		2304	2.3
			wooden construction	20	0.5	500	0.16	40	6.4		3200	3.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	plaster board (gypsum)	20	0.5	1400	0.01	60	0.72		1008	1.0
			wooden construction	20	0.5	500	0.16	20	3.2		1600	1.6
			plaster board (gypsum)	20	0.5	1400	0.01	60	0.72		1008	1.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.5	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.0	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.2	500	0.04	13	0.5		250	0.3
			roof tile	25	0.2	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.2	80	0.16	105.6	16.9		1351.68	1.4
		Floor	floor timber spruce	20	0.5	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	0.5	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	0.8					22		**173.2**
			REFURBISHMENT: window	25						17.6		
Z2	**SI_008**	**Wooden frame insulated, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			**insulation**			80	**0.05**	220	11		880	0.9
			mineral insulation	30	0.3	80	**0.16**	180	28.8		2304	2.3
			wooden construction	20	1.0	500	0.16	40	6.4		3200	3.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	plaster board (gypsum)	20	1.0	1400	0.01	60	0.72		1008	1.0
			wooden construction	20	1.0	500	0.16	20	3.2		1600	1.6
			plaster board (gypsum)	20	1.0	1400	0.01	60	0.72		1008	1.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	**wooden frame 1mx1,5m (with thermo single-glazing)**	25	0.6					22		**172.9**
			REFURBISHMENT: window							13.2		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**MF_001**	**Brick masonry with wooden flooring**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			brick	80	0.0	1800	0.5	860	430		774000	774.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
			brick	80	0.0	1800	0.3	1100	330		594000	594.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
			brick	80	0.0	1800	0.1	1400	140		252000	252.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	62.5	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.6	80	0.16	440	70.4		5632	5.6
		Floor	floor timber spruce	20	1.0	500	0.03	380	11.4	4	22800	22.8
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	4	22000	22.0
			wooden boarding	20	1.0	690	0.02	380	7.6	4	20976	21.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	solid brick	80	0.0	1800	0.8	540	432		777600	777.6
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	600	42		75600	75.6
			wooden construction	30	0.3	500	0.08	63	5		2500	2.5
			filling sand and grit	30	0.3	2000	0.08	380	30.4		60800	60.8
			wooden boarding	20	1.0	690	0.02	380	7.6		5244	5.2
		Basement ground Floor	brick	80	0.0	1800	0.1	380	38		68400	68.4
		Foundation	brick	80	0.0	1800	0.5	90	45		81000	81.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					170		**2960.8**
			REFURBISHMENT: window	25						204		
Z2	**MF_002**	**Rubble stone masonry with wooden flooring**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			rubble stone	80	0.0	1600	0.5	860	430		688000	688.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
			rubble stone	80	0.0	1600	0.3	1100	330		528000	528.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.6	80	0.16	440	70.4		5632	5.6
		Floor	floor timber spruce	20	1.0	500	0.03	380	11.4	4	22800	22.8
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	4	22000	22.0
			wooden boarding	20	1.0	690	0.02	380	7.6	4	20976	21.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	limestone/fieldstone	80	0.0	2000	0.8	540	432		864000	864.0
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	600	42		75600	75.6
			wooden construction	30	0.3	500	0.08	62.5	5		2500	2.5
			filling sand and grit	30	0.3	2000	0.08	380	30.4		60800	60.8
			wooden boarding	20	1.0	690	0.02	380	7.6		5244	5.2
		Basement ground Floor	compact loam	80	0.0	1800	0.1	380	38		68400	68.4
		Foundation	rubble stone	80	0.0	1600	0.5	90	45		72000	72.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					170		**2639.8**
			REFURBISHMENT: window	25						204		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m^3)	Thickness (m)	Area (m^2)	Volume (m^3)	Piece	Mass (kg, St)	Mass (t)
Z2	**MF_003**	**Brick masonry, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	860	17.2		22360	22.4
30			cored brick	80	0.0	1200	0.35	860	301		361200	361.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			cored brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.5	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.2	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.2	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.2	80	0.16	440	70.4		5632	5.6
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	wooden frame 1mx1,5m (with double-glazing)	10	0.8					170		**1939.8**
			REFURBISHMENT: window	25						136		
Z2	**MF_004**	**Breeze concrete, reinforced concrete flooring, pitched roof**										
building's service life		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	800	16		20800	20.8
30			breeze concrete	40	0.0	600	0.3	800	240		144000	144.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	800	16		16000	16.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.5	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	87.5	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.2	500	0.04	62.5	2.5		1250	1.3
			roof tile	25	0.2	2000	0.02	380	7.6		15200	15.2
			REFURBISHMENT: insulation	40	0.2	80	0.16	334.4	53.5		4280.32	4.3
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					170		**1977.7**
			REFURBISHMENT: window	25						136		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**MF_005_ex**	**Brick masonry insulated, reinforced concrete flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
			cored brick	80	0.0	1200	0.35	860	301		361200	361.2
			insulation	30	0.3	80	0.08	860	68.8		5504	5.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			cored brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	25	0.6	80	0.1	500	50		4000	4.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	62.5	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			NO additional insulation								0	
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.3	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					170		**1943.7**
			REFURBISHMENT: window	25						204		
Z2	**MF_005**	**Brick masonry insulated, reinforced concrete flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
			brick	80	0.0	1200	0.35	860	301		361200	361.2
			insulation	30	0.3	80	**0.15**	860	129		10320	10.3
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	25	0.6	80	**0.15**	500	75		6000	6.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.3	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					170		**1951.1**
			REFURBISHMENT: window							102		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**MF_006_ex**	**Bandlime masonry insulated, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			insulation	30	0.3	80	0.1	860	86		6880	6.9
			sandlime	80	0.0	1800	0.2	860	172		309600	309.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			sandlime	80	0.0	1800	0.2	1100	220		396000	396.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			mineral insulation	30	0.3	80	0.16	500	80		6400	6.4
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			NO additional insulation								0	
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	2	38000	38.0
			insulation	30	0.3	80	0.03	380	11.4	2	1824	1.8
			reinforced concrete	40	0.0	2400	0.16	380	60.8	2	291840	291.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	2	15200	15.2
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					170		**1854.4**
			REFURBISHMENT: window	25						204		
Z2	**MF_006**	**Bandlime masonry insulated, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			**insulation**	30	0.3	80	**0.15**	860	129		10320	10.3
			sandlime	80	0.0	1800	0.2	860	172		309600	309.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			sandlime	80	0.0	1800	0.2	1100	220		396000	396.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			mineral insulation	30	0.3	80	0.16	500	80		6400	6.4
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	2	38000	38.0
			insulation	30	0.3	80	0.03	380	11.4	2	1824	1.8
			reinforced concrete	40	0.0	2400	0.16	380	60.8	2	291840	291.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	2	15200	15.2
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					170		**1858.5**
			REFURBISHMENT: window							102		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**MF_007_ex**	**Concrete wall, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	800	16		20800	20.8
20			reinforced concrete	40	0.0	2400	0.2	800	160		384000	384.0
			core insulation	30	0.0	80	0.05	800	40		3200	3.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	800	16		16000	16.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
			reinforced concrete	40	0.0	2400	0.06	1400	84		201600	201.6
			plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
		Roof	prefabricated concrete joist	30	0.0	2400	0.14	100	14		33600	33.6
			wooden boarding	20	0.0	690	0.02	380	7.6		5244	5.244
			concrete tile	20	0.0	2000	0.02	380	7.6		15200	15.2
			REFURBISHMENT: insulation	40	0.0	80	0.16	334.4	53.5		4280.32	4.3
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.4					170		**2447.5**
			REFURBISHMENT: window	25						68		
Z2	**MF_007**	**Concrete wall, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	800	16		20800	20.8
40			reinforced concrete	40	0.0	2400	0.2	800	160		384000	384.0
			core insulation	30	0.3	80	**0.12**	800	96		7680	7.7
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	800	16		16000	16.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			reinforced concrete	40	0.0	2400	0.06	1400	84		201600	201.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	prefabricated concrete joist	30	0.3	2400	0.14	100	14		33600	33.6
			insulation			80	**0.14**	**380**	**53.2**		4256	4.3
			wooden boarding	20	1.0	690	0.02	380	7.6		5244	5.2
			concrete tile	20	1.0	2000	0.02	380	7.6		15200	15.2
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.3	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					170		**2452.6**
			REFURBISHMENT: window							102		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**MF_008**	**Concrete wall insulated, reinforced concrete flooring, flat roof**										
Building's service life: 30		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	1450	29		37700	37.7
			reinforced concrete	40	0.0	2400	0.2	1450	290		696000	696.0
			core insulation	30	0.0	80	0.05	1450	72.5		5800	5.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1450	29		29000	29.0
			REFURBISHMENT: insulation	40	0.0	80	0.15	1450	217.5		17400	17.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1930	38.6		38600	38.6
			reinforced concrete	40	0.0	2400	0.2	1930	386		926400	926.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1930	38.6		38600	38.6
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2180	26.16		36624	36.6
			reinforced concrete	40	0.0	2400	0.06	2180	130.8		313920	313.9
			plaster board (gypsum)	20	0.5	1400	0.01	2180	26.16		36624	36.6
		Roof	bitumen	20	0.5	1200	0	380	0.76		912	0.9
			insulation	20	0.5	80	0.1	380	38		3040	3.0
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6		7600	7.6
			REFURBISHMENT: insulation	40	0.0	80	0.16	380	60.8		4864	4.9
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	6	114000	114.0
			insulation	30	0.0	80	0.03	380	11.4	6	5472	5.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8	6	875520	875.5
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	6	45600	45.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	90	72		172800	172.8
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					270		**4068.6**
			REFURBISHMENT: window	25						216		
Z2	**HR_001**	**Concrete wall insulated, reinforced concrete flooring, flat roof**										
Building's service life: 30		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	2000	40		52000	52.0
			reinforced concrete	40	0.0	2400	0.25	2000	500		1200000	1200.0
			core insulation	30	0.0	80	0.05	2000	100		8000	8.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	2000	40		40000	40.0
			REFURBISHMENT: insulation	40	0.0	80	0.15	2000	300		24000	24.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
			reinforced concrete	40	0.0	2400	0.2	1800	360		864000	864.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
			reinforced concrete	40	0.0	2400	0.06	2700	162		388800	388.8
			plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	0.5	1200	0	450	0.9		1080	1.1
			insulation	30	0.0	80	0.1	450	45		3600	3.6
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9		9000	9.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	450	72		5760	5.8
		Floor	anhydrite screed	30	0.0	2000	0.03	450	11.25	6	135000	135.0
			insulation	30	0.0	80	0.03	450	13.5	6	6480	6.5
			reinforced concrete	40	0.0	2400	0.16	450	72	6	1036800	1036.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9	6	54000	54.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	600	120		288000	288.0
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	450	11.25		22500	22.5
			insulation	30	0.0	80	0.03	450	13.5		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
		Basement ground Floor	concrete	40	0.0	2400	0.1	450	45		108000	108.0
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					270		**4986.8**
			REFURBISHMENT: window	25						216		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z2	**HR_002_ex**	**Brick masonry insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	2000	40		52000	52.0
30			cored brick	80	0.0	1200	0.3	2000	600		720000	720.0
			core insulation	30	0.0	80	0.05	2000	100		8000	8.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	2000	40		40000	40.0
			REFURBISHMENT: insulation	40	0.0	80	0.15	2000	300		24000	24.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
			cored brick	80	0.0	1200	0.3	1800	540		648000	648.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
			wooden construction	20	0.5	500	0.08	270	21.6		10800	10.8
			plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	0.5	1200	0	450	0.9		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9		9000	9.0
			REFURBISHMENT: insulation	40	0.0	80	0.16	450	72		5760	5.8
		Floor	anhydrite screed	30	0.0	2000	0.03	450	11.25	9	202500	202.5
			insulation	30	0.0	80	0.03	450	13.5	9	9720	9.7
			reinforced concrete	40	0.0	2400	0.16	450	72	9	1555200	1555.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9	9	81000	81.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					470		**4449.2**
			REFURBISHMENT: window	25						376		
Z2	**HR_002**	**Brick masonry insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	2000	40		52000	52.0
40			brick	80	0.0	1200	0.3	2000	600		720000	720.0
			core insulation	30	0.3	80	**0.12**	2000	240		19200	19.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1800	36		36000	36.0
			brick	80	0.0	1200	0.3	1800	540		648000	648.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	2700	32.4		45360	45.4
			wooden construction	20	1.0	500	0.08	270	21.6		10800	10.8
			plaster board (gypsum)	20	1.0	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	1.0	1200	0	450	0.9		1080	1.1
			insulation			80	**0.15**	**450**	**67.5**		5400	5.4
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	450	9		9000	9.0
		Floor	anhydrite screed	30	0.3	2000	0.03	450	11.25	9	202500	202.5
			insulation	30	0.3	80	0.03	450	13.5	9	9720	9.7
			reinforced concrete	40	0.0	2400	0.16	450	72	9	1555200	1555.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	450	9	9	81000	81.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					470		**4436.7**
			REFURBISHMENT: window							282		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**SI_001**	**Brick masonry, wooden flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			brick	80	0.0	1800	0.5	220	110		198000	198.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
			brick	80	0.0	1800	0.3	60	18		32400	32.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.6	80	0.2	105.6	21.12		1689.6	1.7
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	brick	80	0.0	1800	0.8	80	64		115200	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	30	0.3	500	0.08	31	2.5		1250	1.3
			filling sand and grit	30	0.3	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	1.0	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	brick	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	brick	80	0.0	1800	0.5	25	12.5		22500	22.5
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22		**453.0**
			REFURBISHMENT: window	25						26.4		
Z3	**SI_002**	**Brick masonry, reinforced concrete flooring, pitched roof**										
Building's service life: 30		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	220	4.4		5720	5.7
			brick	80	0.0	1200	0.4	220	88		105600	105.6
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			reinforced concrete	40	0.0	2400	0.2	60	12		28800	28.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.5	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.5	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.2	500	0.04	13	0.5		250	0.3
			roof tile	25	0.2	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.2	80	0.2	105.6	21.12		1689.6	1.7
		Floor	anhydrite screed	30	0.0	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.0	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					22		**370.6**
			REFURBISHMENT: window	25						17.6		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**SI_003**	**Wooden wall, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	wooden wall	20	0.5	500	0.16	220	35.2		17600	17.6
30		Interior load-bearing wall	wooden wall	20	0.5	500	0.16	60	9.6		4800	4.8
		Interior wall	interior plaster (lime-gypsum) with straw	20	0.5	1000	0.02	100	2		2000	2.0
			wooden construction	20	0.5	500	0.08	10	0.8		400	0.4
			interior plaster (lime-gypsum) with straw	20	0.5	1000	0.02	100	2		2000	2.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			roof battening (timber spruce 12%)	25	0.2	500	0.04	13	0.5		250	0.3
			roof tile	25	0.2	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.2	80	0.2	105.6	21.12		1689.6	1.7
		Floor	floor timber spruce	20	0.5	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	0.5	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	solid brick	80	0.0	1800	0.8	80	64		115200	115.2
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	120	8.4		15120	15.1
			wooden construction	30	0.0	500	0.08	31	2.5		1250	1.3
			filling sand and grit	30	0.0	2000	0.08	90	7.2		14400	14.4
			wooden boarding	20	0.5	690	0.02	90	1.8		1242	1.2
		Basement ground Floor	brick	80	0.0	1800	0.1	90	9		16200	16.2
		Foundation	brick	80	0.0	1800	0.5	25	12.5		22500	22.5
		Window	wooden frame 1mx1,5m (with double-glazing)	10	0.8					22		**232.5**
			REFURBISHMENT: window	25						17.6		
Z3	**SI_004**	**Wooden wall insulated and brick facade, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	220	4.4		5720	5.7
20			cored brick	80	0.0	1200	0.1	220	22		26400	26.4
			wooden construction	20	0.0	500	0.16	50	8		4000	4.0
			insulation	20	0.0	80	0.1	220	22		1760	1.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			reinforced concrete	40	0.0	2400	0.2	60	12		28800	28.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			insulation	30	0.0	80	0.1	120	12		960	1.0
			roof battening (timber spruce 12%)	25	0.0	500	0.04	13	0.5		250	0.3
			roof tile	25	0.0	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.0	80	0.2	105.6	21.12		1689.6	1.7
		Floor	anhydrite screed	30	0.0	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.0	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.4					22		**298.1**
			REFURBISHMENT: window	25						8.8		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**SI_005**	**Breeze concrete wall, brezze concrete block flooring, pitched roof**										
Building's service life: 20		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	220	4.4		5720	5.7
			brezze concrete	40	0.0	600	0.3	220	66		39600	39.6
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
			brezze concrete	40	0.0	600	0.3	60	18		10800	10.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	0.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	0.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			insulation	30	0.0	80	0.1	120	12		960	1.0
			roof battening (timber spruce 12%)	25	0.0	500	0.04	13	0.5		250	0.3
			roof tile	25	0.0	2000	0.02	120	2.4		4800	4.8
			REFURBISHMENT: insulation	40	0.0	80	0.2	105.6	21.12		1689.6	1.7
		Floor	cement floor, screed topping	30	0.0	2400	0.04	90	3.6	2	17280	17.3
			reinforced concrete filling	30	0.0	2400	0.02	90	1.8	2	8640	8.6
			brezze concrete block	40	0.0	600	0.16	90	14.4	2	17280	17.3
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.0	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.4					22		**252.2**
			REFURBISHMENT: window	25						8.8		
Z3	**SI_006_ex**	**Brick masonry, reinforced concrete flooring, pitched roof**										
Building's service life: 40		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
			insulation	30	0.3	80	0.12	220	26.4		2112	2.1
			cored brick	80	0.0	1200	0.25	220	55		66000	66.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			reinforced concrete	40	0.0	2400	0.2	60	12		28800	28.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			NO additional insulation								0	
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with triple-glazing)	20	0.8					22		**333.0**
			REFURBISHMENT: window	25						17.6		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**SI_006**	**Brick masonry, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			**insulation**	30	0.3	80	**0.15**	220	33		2640	2.6
			brick	80	0.0	1200	0.25	220	55		66000	66.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
			reinforced concrete	40	0.0	2400	0.2	60	12		28800	28.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	60	1.2		1200	1.2
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	anhydrite screed	30	0.3	2000	0.03	90	2.25	2	9000	9.0
			insulation	30	0.3	80	0.03	90	2.7	2	432	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4	2	69120	69.1
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	plastic frame 1mx1,5m (with triple-glazing)	25	0.6					22		**333.6**
			REFURBISHMENT: window							13.2		
Z3	**SI_007_ex**	**Wooden frame wall insulated, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			mineral insulation	30	0.3	80	0.16	180	28.8		2304	2.3
			wooden construction	30	0.3	500	0.16	40	6.4		3200	3.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	plaster board (gypsum)	20	1.0	1400	0.01	60	0.72		1008	1.0
			wooden construction	20	1.0	500	0.16	20	3.2		1600	1.6
			plaster board (gypsum)	20	1.0	1400	0.01	60	0.72		1008	1.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
			NO additional insulation								0	
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	0.03	90	2.7		216	0.2
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	wooden frame 1mx1,5m (with single-glazing)	10	1.2					22		**171.9**
			REFURBISHMENT: window	25						26.4		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**SI_007**	**Wooden frame wall insulated, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	220	4.4		5720	5.7
40			**insulation**			80	**0.05**	**220**	**11**		880	0.9
			mineral insulation	30	0.3	80	0.16	180	28.8		2304	2.3
			wooden construction	30	0.3	500	0.16	40	6.4		3200	3.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	220	4.4		4400	4.4
		Interior load-bearing wall	plaster board (gypsum)	20	1.0	1400	0.01	60	0.72		1008	1.0
			wooden construction	20	1.0	500	0.16	20	3.2		1600	1.6
			plaster board (gypsum)	20	1.0	1400	0.01	60	0.72		1008	1.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
			wooden construction	20	1.0	500	0.08	10	0.8		400	0.4
			plaster board (gypsum)	20	1.0	1400	0.01	100	1.2		1680	1.7
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	22	3.5		1750	1.8
			mineral insulation	30	0.3	80	0.16	120	19.2		1536	1.5
			roof battening (timber spruce 12%)	25	0.6	500	0.04	13	0.5		250	0.3
			roof tile	25	0.6	2000	0.02	120	2.4		4800	4.8
		Floor	floor timber spruce	20	1.0	500	0.03	90	2.7	2	2700	2.7
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	16	2.5	2	2500	2.5
			wooden boarding	20	1.0	690	0.02	90	1.8	2	2484	2.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	90	1.8	2	3600	3.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	80	16		38400	38.4
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	90	2.25		4500	4.5
			insulation	30	0.3	80	**0.05**	90	4.5		360	0.4
			reinforced concrete	40	0.0	2400	0.16	90	14.4		34560	34.6
		Basement ground Floor	concrete	40	0.0	2400	0.1	90	9		21600	21.6
		Foundation	concrete	40	0.0	2400	0.5	25	12.5		30000	30.0
		Window	**wooden frame 1mx1,5m (with thermo double-glazing)**	25	0.6					22		**172.9**
			REFURBISHMENT: window							13.2		
Z3	**MF_001**	**Brick masonry with wooden flooring and pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			brick	80	0.0	1800	0.5	860	430		774000	774.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
			brick	80	0.0	1800	0.3	1100	330		594000	594.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1100	22		22000	22.0
		Interior wall	interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
			brick	80	0.0	1800	0.1	1400	140		252000	252.0
			interior plaster (lime-gypsum) with straw	20	1.0	1000	0.02	1400	28		28000	28.0
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.6	80	0.2	440	88		7040	7.0
		Floor	floor timber spruce	20	1.0	500	0.03	380	11.4	4	22800	22.8
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	4	22000	22.0
			wooden boarding	20	1.0	690	0.02	380	7.6	4	20976	21.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	4	30400	30.4
		Basement wall	brick	80	0.0	1800	0.8	540	432		777600	777.6
		Basement ceiling	vaulted brick ceilling	40	0.0	1800	0.07	600	42		75600	75.6
			wooden construction	30	0.3	500	0.08	63	5		2500	2.5
			filling sand and grit	30	0.3	2000	0.08	380	30.4		60800	60.8
			wooden boarding	20	1.0	690	0.02	380	7.6		5244	5.2
		Basement ground Floor	brick	80	0.0	1800	0.1	380	38		68400	68.4
		Foundation	brick	80	0.0	1800	0.5	90	45		81000	81.0
		Window	wooden frame 1mx1,5m (with double-glazing)	10	1.2					170		**2962.2**
			REFURBISHMENT: window	25						204		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**MF_002**	**Breeze concrete wall, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.0	1300	0.02	860	17.2		22360	22.4
20			breeze concrete	40	0.0	600	0.3	860	258		154800	154.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	87.5	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.0	500	0.04	62.5	2.5		1250	1.3
			roof tile	25	0.0	2000	0.02	380	7.6		15200	15.2
			REFURBISHMENT: insulation	40	0.0	20	0.2	334.4	66.88		1337.6	1.3
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.4					170		**1988.3**
			REFURBISHMENT: window	25						68		
Z3	**MF_003**	**Wooden wall insulated brick facade, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	cored brick	30	0.0	1200	0.1	860	86		103200	103.2
30			wooden construction	30	0.0	500	0.16	200	32		16000	16.0
			insulation	30	0.0	80	0.1	860	86		6880	6.9
			plaster board (gypsum)	20	0.5	1400	0.02	860	17.2		24080	24.1
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.5	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	30	0.0	80	0.1	500	50		4000	4.0
			roof battening (timber spruce 12%)	25	0.2	500	0.04	62.5	2.5		1250	1.3
			roof tile	25	0.2	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.2	80	0.2	440	88		7040	7.0
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall									0	
		Basement ceiling									0	
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					170		**1533.6**
			REFURBISHMENT: window	25						136		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**MF_004**	**Brick masonry, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	860	17.2		22360	22.4
30			cored brick	80	0.0	1200	0.4	860	344		412800	412.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	0.5	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	0.5	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			roof battening (timber spruce 12%)	25	0.2	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.2	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.2	80	0.2	440	88		7040	7.0
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					170		**2256.8**
			REFURBISHMENT: window	25						136		
Z3	**MF_005**	**Breeze and reinforced concrete wall, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	reinforced concrete	40	0.0	2400	0.15	800	120		288000	288.0
20			breeze concrete	40	0.0	600	0.15	800	120		72000	72.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	800	16		16000	16.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
			reinforced concrete	40	0.0	2400	0.2	1100	220		528000	528.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
			reinforced concrete	40	0.0	2400	0.06	1100	66		158400	158.4
			plaster board (gypsum)	20	0.0	1400	0.01	1400	16.8		23520	23.5
		Roof	prefabricated concrete joist	40	0.0	2400	0.14	100	14		33600	33.6
			wooden boarding	20	0.0	690	0.02	380	7.6		5244	5.244
			roof tile	25	0.0	2000	0.02	380	7.6		15200	15.2
			REFURBISHMENT: insulation	40	0.0	80	0.2	334.4	66.88		5350.4	5.4
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.0	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.4					170		**2357.4**
			REFURBISHMENT: window	25						68		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**MF_006_ex**	**Wooden wall insulated, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	wooden facade	20	1.0	500	0.02	860	17.2		8600	8.6
40			wooden construction	20	1.0	500	0.16	200	32		16000	16.0
			insulation	30	0.3	80	0.16	860	137.6		11008	11.0
			plaster board (gypsum)	20	1.0	1400	0.02	860	17.2		24080	24.1
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			wooden construction	30	0.3	500	0.16	220	35.2		17600	17.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	30	0.3	80	0.1	500	50		4000	4.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.6	80	0.2	440	88		7040	7.0
		Floor	floor timber spruce	20	1.0	500	0.03	380	11.4	2	11400	11.4
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	2	11000	11.0
			wooden boarding	20	1.0	690	0.02	380	7.6	2	10488	10.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	2	15200	15.2
		Basement wall										
		Basement ceiling										
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					170		**460.5**
			REFURBISHMENT: window	25						204		
Z3	**MF_006**	**Wooden wall insulated, wooden flooring, pitched roof**										
Building's service life:		Exterior wall	wooden facade	20	1.0	500	0.02	860	17.2		8600	8.6
40			**insulation**			80	**0.05**	**90**	**4.5**		360	0.4
			wooden construction	20	1.0	500	0.16	200	32		16000	16.0
			insulation	30	0.3	80	0.16	860	137.6		11008	11.0
			plaster board (gypsum)	20	1.0	1400	0.02	860	17.2		24080	24.1
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			wooden construction	30	0.3	500	0.16	220	35.2		17600	17.6
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	30	0.3	80	**0.16**	440	70.4		5632	5.6
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
		Floor	floor timber spruce	20	1.0	500	0.03	380	11.4	2	11400	11.4
			wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	69	11	2	11000	11.0
			wooden boarding	20	1.0	690	0.02	380	7.6	2	10488	10.5
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	2	15200	15.2
		Basement wall										
		Basement ceiling										
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
			insulation			80	**0.1**	**500**	**50**		4000	4.0
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	25	0.6					170		**459.5**
			REFURBISHMENT: window							102		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**MF_007_ex**	**Brick masonry insulated, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			cored brick	80	0.0	1200	0.25	860	215		258000	258.0
			insulation	30	0.3	80	0.12	860	103.2		8256	8.3
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			cored brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	30	0.3	80	0.1	500	50		4000	4.0
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
			REFURBISHMENT: insulation	40	0.6	80	0.2	440	88		7040	7.0
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.3	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	plastic frame 1mx1,5m (with double-glazing)	10	1.2					170		**1850.3**
			REFURBISHMENT: window	25						204		
Z3	**MF_007**	**Brick masonry insulated, reinforced concrete flooring, pitched roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	860	17.2		22360	22.4
40			brick	80	0.0	1200	0.25	860	215		258000	258.0
			insulation	**30**	0.3	80	**0.15**	860	129		10320	10.3
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	860	17.2		17200	17.2
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
			brick	80	0.0	1200	0.2	1100	220		264000	264.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1100	22		22000	22.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
			wooden construction	20	1.0	500	0.08	140	11.2		5600	5.6
			plaster board (gypsum)	20	1.0	1400	0.01	1400	16.8		23520	23.5
		Roof	wooden joist (timber spruce 12%), distance 0,6mx0,1	40	0.0	500	0.16	88	14.0		7000	7.0
			insulation	**40**	0.0	80	**0.16**	440	70.4		5632	5.6
			roof battening (timber spruce 12%)	25	0.6	500	0.04	63	2.5		1250	1.3
			roof tile	25	0.6	2000	0.02	500	10		20000	20.0
		Floor	anhydrite screed	30	0.3	2000	0.03	380	9.5	3	57000	57.0
			insulation	30	0.3	80	0.03	380	11.4	3	2736	2.7
			reinforced concrete	40	0.0	2400	0.16	380	60.8	3	437760	437.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	380	7.6	3	22800	22.8
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	**30**	0.3	80	**0.05**	380	19		1520	1.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.5	90	45		108000	108.0
		Window	**plastic frame 1mx1,5m (with thermo double-glazing)**	**25**	0.6					170		**1847.5**
			REFURBISHMENT: window							102		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**MF_008**	**Concrete wall insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	1450	29		37700	37.7
30			reinforced concrete	40	0.0	2400	0.2	1450	290		696000	696.0
			core insulation	30	0.0	80	0.05	1450			0	
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1450	29		29000	29.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1930	38.6		38600	38.6
			reinforced concrete	40	0.0	2400	0.2	1930	386		926400	926.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1930	38.6		38600	38.6
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2180	26.16		36624	36.6
			reinforced concrete	40	0.0	2400	0.06	2180	130.8		313920	313.9
			plaster board (gypsum)	20	0.5	1400	0.01	2180	26.16		36624	36.6
		Roof	bitumen	20	0.5	1200	0	380	0.76		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
			insulation	40	0.0	80	0.08	380	30.4		2432	2.4
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6		7600	7.6
			REFURBISHMENT: insulation	40	0.0	80	0.2	380	76		6080	6.1
		Floor	anhydrite screed	30	0.0	2000	0.03	380	9.5	6	114000	114.0
			insulation	30	0.0	80	0.03	380	11.4	6	5472	5.5
			reinforced concrete	40	0.0	2400	0.16	380	60.8	6	875520	875.5
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	380	7.6	6	45600	45.6
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	90	72		172800	172.8
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					270		**4046.0**
			REFURBISHMENT: window	25						216		
Z3	**HR_001**	**Concrete wall insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	2000	40		52000	52.0
30			reinforced concrete	40	0.0	2400	0.25	2000	500		1200000	1200.0
			core insulation	30	0.0	80	0.1	2000	200		16000	16.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
			reinforced concrete	40	0.0	2400	0.2	1800	360		864000	864.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
			reinforced concrete	40	0.0	2400	0.06	2700	162		388800	388.8
			plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	0.5	1200	0	450	0.9		1080	1.1
			insulation	30	0.0	80	0.1	450	45		3600	3.6
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9		9000	9.0
			REFURBISHMENT: insulation	40	0.0	80	0.2	450	90		7200	7.2
		Floor	anhydrite screed	30	0.0	2000	0.03	450	11.25	6	135000	135.0
			insulation	30	0.0	80	0.03	450	13.5	6	6480	6.5
			reinforced concrete	40	0.0	2400	0.16	450	72	6	1036800	1036.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9	6	54000	54.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	600	120		288000	288.0
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	450	11.25		22500	22.5
			insulation	30	0.0	80	0.03	450	13.5		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
		Basement ground Floor	concrete	40	0.0	2400	0.1	450	45		108000	108.0
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					270		**4972.3**
			REFURBISHMENT: window	25						216		

Zone	Type and number	Construction/ description	Material	Residual Service Life	Refurbishment Factor	Density (kg/m³)	Thickness (m)	Area (m²)	Volume (m³)	Piece	Mass (kg, St)	Mass (t)
Z3	**HR_002_ex**	**Brick cavity wall insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	0.5	1300	0.02	2000	40		52000	52.0
30			cored brick	80	0.0	1200	0.3	2000	600		720000	720.0
			core insulation	30	0.0	80	0.1	2000	200		16000	16.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
			cored brick	80	0.0	1200	0.3	1800	540		648000	648.0
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
			wooden construction	20	0.5	500	0.08	270	21.6		10800	10.8
			plaster board (gypsum)	20	0.5	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	0.5	1200	0	450	0.9		1080	1.1
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9		9000	9.0
			REFURBISHMENT: insulation	40	0.0	80	0.2	450	90		7200	7.2
		Floor	anhydrite screed	30	0.0	2000	0.03	450	11.25	9	202500	202.5
			insulation	30	0.0	80	0.03	450	13.5	9	9720	9.7
			reinforced concrete	40	0.0	2400	0.16	450	72	9	1555200	1555.2
			interior plaster (lime-gypsum)	30	0.0	1000	0.02	450	9	9	81000	81.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.0	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.0	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with double-glazing)	10	0.8					470		**4434.7**
			REFURBISHMENT: window	25						376		
Z3	**HR_002**	**Brick cavity wall insulated, reinforced concrete flooring, flat roof**										
Building's service life:		Exterior wall	exterior plaster (lime-cement)	20	1.0	1300	0.02	2000	40		52000	52.0
40			brick	80	0.0	1200	0.3	2000	600		720000	720.0
			core insulation	30	0.3	80	**0.12**	2000	240		19200	19.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	2000	40		40000	40.0
		Interior load-bearing wall	interior plaster (lime-gypsum)	30	0.3	1000	0.02	1800	36		36000	36.0
			brick	80	0.0	1200	0.3	1800	540		648000	648.0
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	1800	36		36000	36.0
		Interior wall	plaster board (gypsum)	20	1.0	1400	0.01	2700	32.4		45360	45.4
			wooden construction	20	1.0	500	0.08	270	21.6		10800	10.8
			plaster board (gypsum)	20	1.0	1400	0.01	2700	32.4		45360	45.4
		Roof	bitumen	20	1.0	1200	0	450	0.9		1080	1.1
			core insulation			80	**0.1**	**450**	**45**		3600	3.6
			reinforced concrete	40	0.0	2400	0.16	450	72		172800	172.8
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	450	9		9000	9.0
		Floor	anhydrite screed	30	0.3	2000	0.03	450	11.25	9	202500	202.5
			insulation	30	0.3	80	**0.05**	450	22.5	9	16200	16.2
			reinforced concrete	40	0.0	2400	0.16	450	72	9	1555200	1555.2
			interior plaster (lime-gypsum)	30	0.3	1000	0.02	450	9	9	81000	81.0
		Basement wall	reinforced concrete	40	0.0	2400	0.2	540	108		259200	259.2
		Basement ceiling	anhydrite screed	30	0.3	2000	0.03	380	9.5		19000	19.0
			insulation	30	0.3	80	0.03	380	11.4		912	0.9
			reinforced concrete	40	0.0	2400	0.16	380	60.8		145920	145.9
		Basement ground Floor	concrete	40	0.0	2400	0.1	380	38		91200	91.2
		Foundation	concrete	40	0.0	2400	0.8	120	96		230400	230.4
		Window	plastic frame 1mx1,5m (with thermo double-glazing)	25	0.6					470		**4440.7**
			REFURBISHMENT: window							282		

Annex C Life Cycle Impact Assessment results for all building types

This annex delivers all necessary information to characterize the building types on a building level (not on a materials-level) and the results of the Life Cycle Assessments for each building type.

For each building type, two pages are provided. Page one displays the information to characterize the building type. Page two presents a table providing the data to identify the contributions of life cycle phases, construction elements and building aspects to the total impacts of the building type as well as a graph displaying the contribution of the construction elements and building aspects for Primary Energy use (total) per m^2 and year.

Annex C 1 Building type Z1_SI_001

Single-family house
Brick masonry, wooden flooring, pitched roof

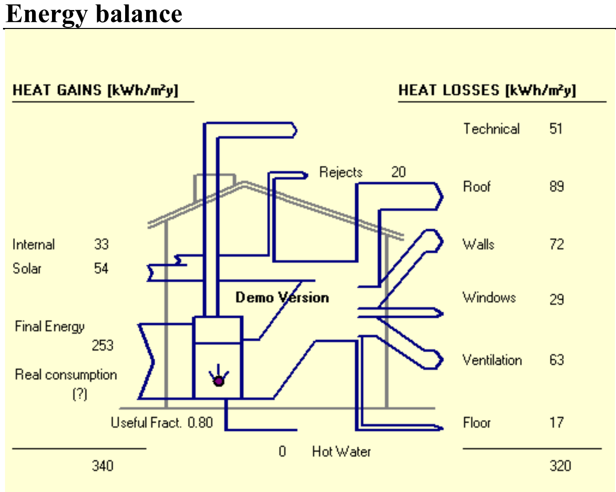
Statistics Proportion of Z1_SI_001 in the EU-25: 2.5%

	France	**Italy**	**Greece**	**Portugal**	**Spain**	**Malta**	**Cyprus**
Number of dwellings [1 000]	2950.0	1325.0	275.0	106.0	418.0	6.5	15.0
Number of buildings [1 000]	1966.7	883.3	183.3	70.7	278.7	4.3	10.0
Stock in Mio. m^2	264	120	23	9	38	1	3
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	3.6	3.9	4.2	4.4	4.4	5.0	5.0

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	001
Year of construction	Until 1900
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Solid brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Solid brick
Window	Wooden frame and single-glazing

Energy balance

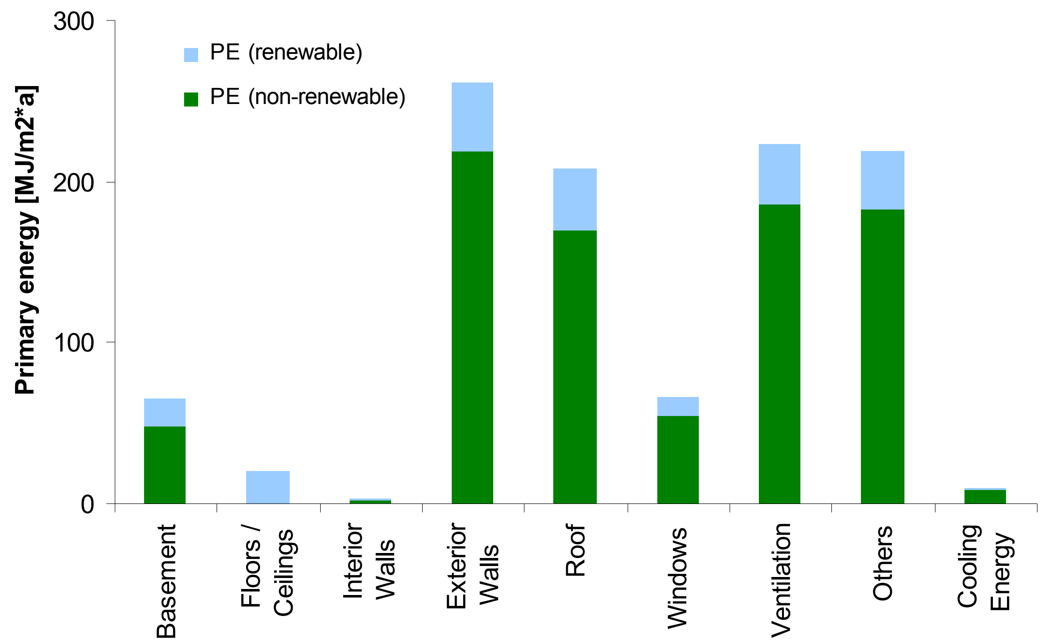


Z1_SI_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 104**	**68.5**	**-19.5**	**49.0**	**1.9E-01**	**1.2E-02**	**6.3E-02**	**3.8E-06**
Refurbishment	72	3.2	-3.3	-0.1	1.2E-02	1.0E-03	1.9E-03	2.2E-07
Heating & cooling	1 032	65.3	-16.2	49.1	1.8E-01	1.1E-02	6.1E-02	3.6E-06
End-of-Life	**-43**	**4.6**	**0.0**	**4.6**	**-4.2E-04**	**2.4E-04**	**-2.1E-05**	**-1.3E-07**
Construction	-18	2.5	0.0	2.5	1.4E-03	3.0E-04	1.4E-04	-6.0E-08
Refurbishment	-25	2.0	0.0	2.0	-1.9E-03	-5.8E-05	-1.6E-04	-6.9E-08
Total*	**1 104**	**68.5**	**-19.5**	**49.0**	**1.9E-01**	**1.2E-02**	**6.3E-02**	**3.8E-06**
Heating & Cooling								
Basement	5.8%	5.8%	5.9%	5.8%	5.8%	5.8%	5.9%	5.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	24.8%	24.8%	24.9%	24.5%	24.6%	24.7%	24.9%	24.2%
Roof	19.9%	19.9%	20.1%	19.7%	19.8%	19.9%	20.0%	19.5%
Windows	5.9%	5.9%	5.9%	5.8%	5.8%	5.8%	5.9%	5.7%
Ventilation	21.7%	21.7%	21.8%	21.4%	21.5%	21.6%	21.7%	21.2%
Others	21.3%	21.3%	21.4%	21.1%	21.1%	21.2%	21.4%	20.8%
Cooling Energy	0.9%	0.7%	0.1%	0.8%	1.5%	0.9%	0.3%	2.9%

* Total = Use Phase

Z1_SI_001



Annex C 2 Building type Z1_SI_002

Single-family house
Limestone/fieldstone masonry, wooden flooring, pitched roof

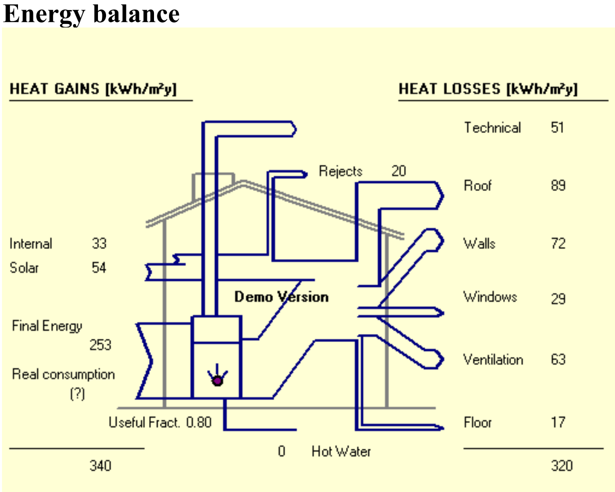
Statistics Proportion of Z1_SI_002 in the EU-25: 1.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	885.0	530.0	165.0	106.0	418.0	32.5	75.0
Number of buildings [1 000]	590.0	353.3	110.0	70.7	278.7	21.7	50.0
Stock in Mio. m^2	79	48	14	9	38	3	14
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	3.6	3.9	4.2	4.4	4.4	5.0	5.0

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	002
Year of construction	Until 1900
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Limestone/fieldstone 50 cm
Interior load-bearing wall	Limestone/fieldstone 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Limestone/fieldstone 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Fieldstone
Window	Wooden frame and single-glazing

Energy balance



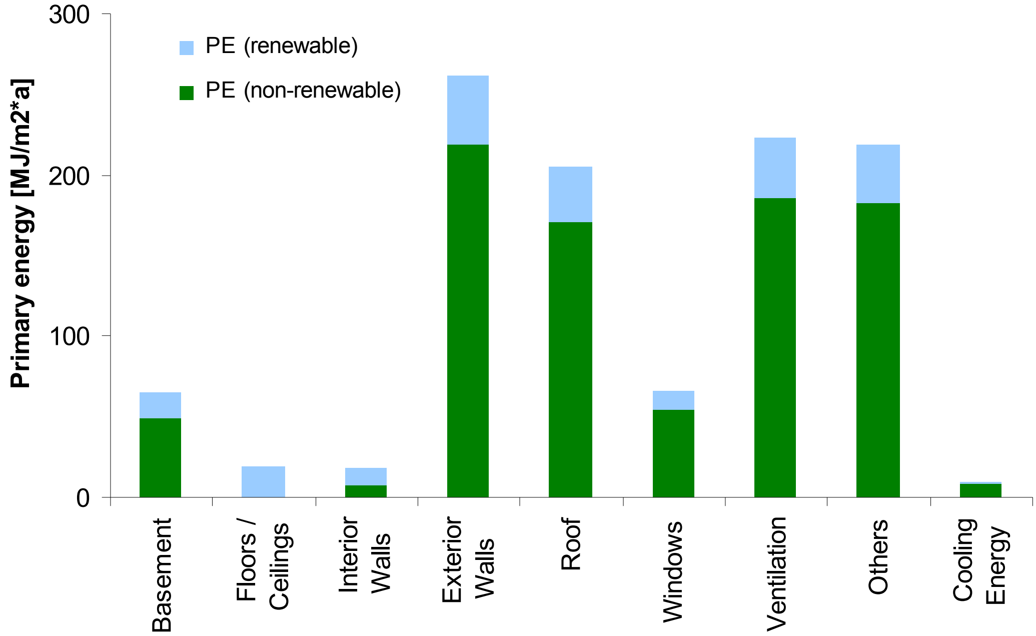
Z1_SI_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 111**	**68.7**	**-19.9**	**48.8**	**1.9E-01**	**1.2E-02**	**6.3E-02**	**3.9E-06**
Refurbishment	79	3.4	-3.7	-0.3	1.2E-02	1.1E-03	1.9E-03	2.4E-07
Heating & cooling	1 032	65.3	-16.2	49.1	1.8E-01	1.1E-02	6.1E-02	3.6E-06
End-of-Life	**-38**	**4.3**	**0.0**	**4.3**	**1.3E-04**	**2.8E-04**	**2.8E-05**	**-1.2E-07**
Construction	-17	2.5	0.0	2.5	1.7E-03	3.3E-04	1.7E-04	-5.6E-08
Refurbishment	-21	1.8	0.0	1.8	-1.6E-03	-4.8E-05	-1.4E-04	-6.0E-08
Total*	**1 111**	**68.7**	**-19.9**	**48.8**	**1.9E-01**	**1.2E-02**	**6.3E-02**	**3.9E-06**

Heating & Cooling								
Basement	5.9%	5.8%	5.9%	5.8%	5.8%	5.8%	5.9%	5.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	24.8%	24.8%	24.9%	24.5%	24.6%	24.7%	24.9%	24.2%
Roof	19.9%	19.9%	20.0%	19.7%	19.8%	19.9%	20.0%	19.5%
Windows	5.9%	5.9%	5.9%	5.8%	5.8%	5.8%	5.9%	5.7%
Ventilation	21.7%	21.7%	21.8%	21.4%	21.5%	21.6%	21.8%	21.2%
Others	21.3%	21.3%	21.4%	21.0%	21.1%	21.2%	21.4%	20.8%
Cooling Energy	0.9%	0.7%	0.1%	0.8%	1.5%	0.9%	0.3%	2.9%

* Total = Use Phase

Z1_SI_002



Annex C 3 Building type Z1_SI_003

Single-family house
Limestone/fieldstone masonry, wooden flooring, flat roof

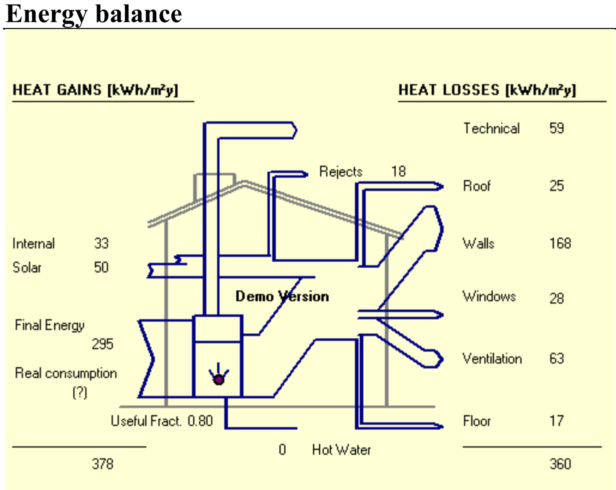

Statistics — Proportion of Z1_SI_003 in the EU-25: 0.4%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]			165.0	106.0	418.0	26.0	60.0
Number of buildings [1 000]			110.0	70.7	278.7	17.3	40.0
Stock in Mio. m^2			14	9	38	3	11
Density in m^2/occupant			29.5	28.6	31.0	34.0	59.0
Occupants per building			4.2	4.4	4.4	5.0	5.0

Description of the building type — **EXISTING**

Zone	1
Building type	Single-family house
Number	003
Year of construction	Until 1900
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Plaster (lime-cement)
Exterior wall	Limestone/fieldstone 50 cm
Interior load-bearing wall	Limestone/fieldstone 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	
Basement ceiling	
Foundation	Fieldstone
Window	Wooden frame and single-glazing

Energy balance

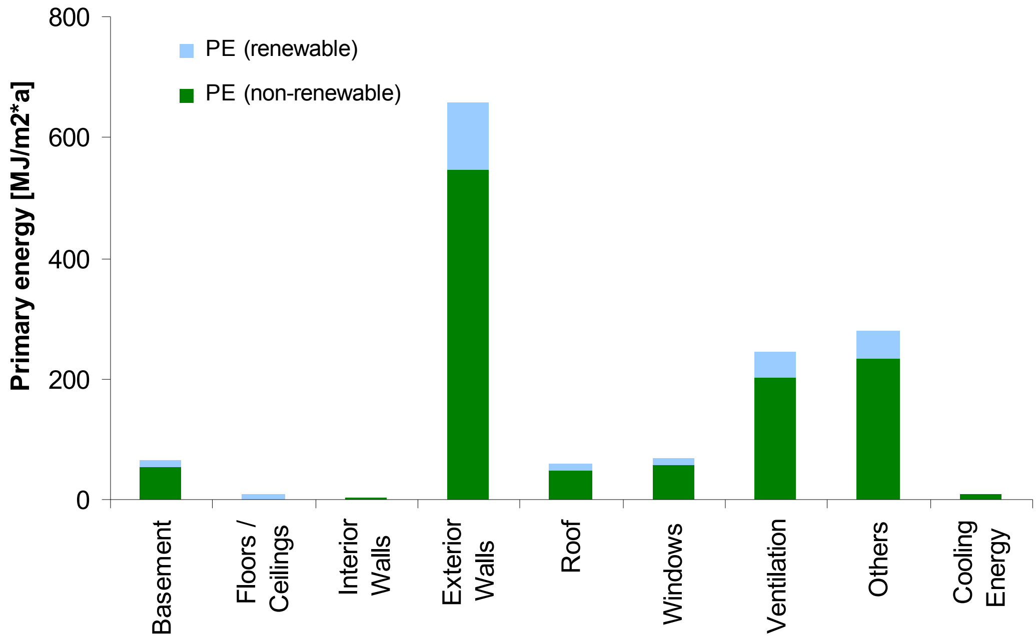


Z1_SI_003

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 405**	**88.5**	**-22.8**	**65.7**	**2.5E-01**	**1.6E-02**	**8.3E-02**	**4.9E-06**
Refurbishment	33	1.7	-1.2	0.5	6.4E-03	5.7E-04	1.1E-03	1.0E-07
Heating & cooling	1 372	86.8	-21.6	65.2	2.4E-01	1.5E-02	8.2E-02	4.8E-06
End-of-Life	**-15**	**2.0**	**0.0**	**2.0**	**8.6E-04**	**2.1E-04**	**9.1E-05**	**-4.8E-08**
Construction	-6	1.2	0.0	1.2	1.4E-03	2.1E-04	1.3E-04	-2.4E-08
Refurbishment	-9	0.8	0.0	0.8	-5.0E-04	-2.3E-06	-3.9E-05	-2.5E-08
Total*	**1 405**	**88.5**	**-22.8**	**65.7**	**2.5E-01**	**1.6E-02**	**8.3E-02**	**4.9E-06**
Heating & Cooling								
Basement	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	47.4%	47.5%	47.7%	47.4%	47.2%	47.4%	47.7%	46.7%
Roof	4.2%	4.2%	4.3%	4.2%	4.2%	4.2%	4.3%	4.2%
Windows	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.6%
Ventilation	17.8%	17.8%	17.9%	17.8%	17.7%	17.8%	17.9%	17.5%
Others	20.4%	20.4%	20.5%	20.4%	20.3%	20.4%	20.5%	20.1%
Cooling Energy	0.7%	0.5%	0.0%	0.7%	1.1%	0.7%	0.2%	2.2%

* Total = Use Phase

Z1_SI_003



Annex C 4 Building type Z1_SI_004

Single-family house
Brick masonry, hollow
brick flooring, pitched roof

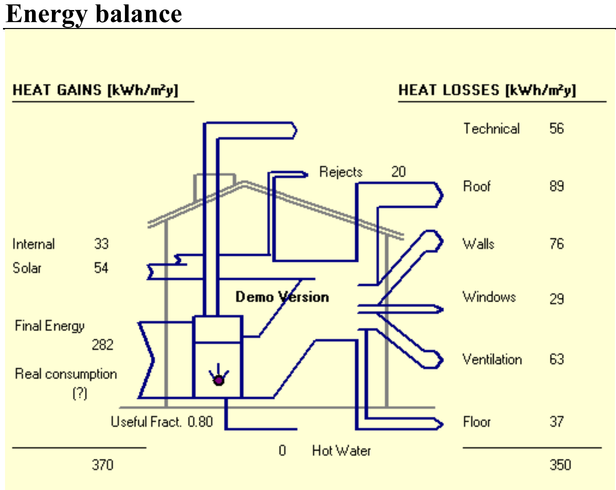
Statistics Proportion of Z1_SI_004 in the EU-25: 2.5%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	2950.0	2120.0					
Number of buildings [1 000]	1966.7	1413.3					
Stock in Mio. m^2	264	191					
Density in m^2/occupant	37.3	34.7					
Occupants per building	3.6	3.9					

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	004
Year of construction	1945-1990
Residual service life	20 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick masonry 30 cm
Interior load-bearing wall	Brick masonry 30 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Hollow brick flooring
Basement wall	Reinforced concrete
Basement ceiling	Concrete
Foundation	Concrete
Window	Plastic frame and single-glazing

Energy balance

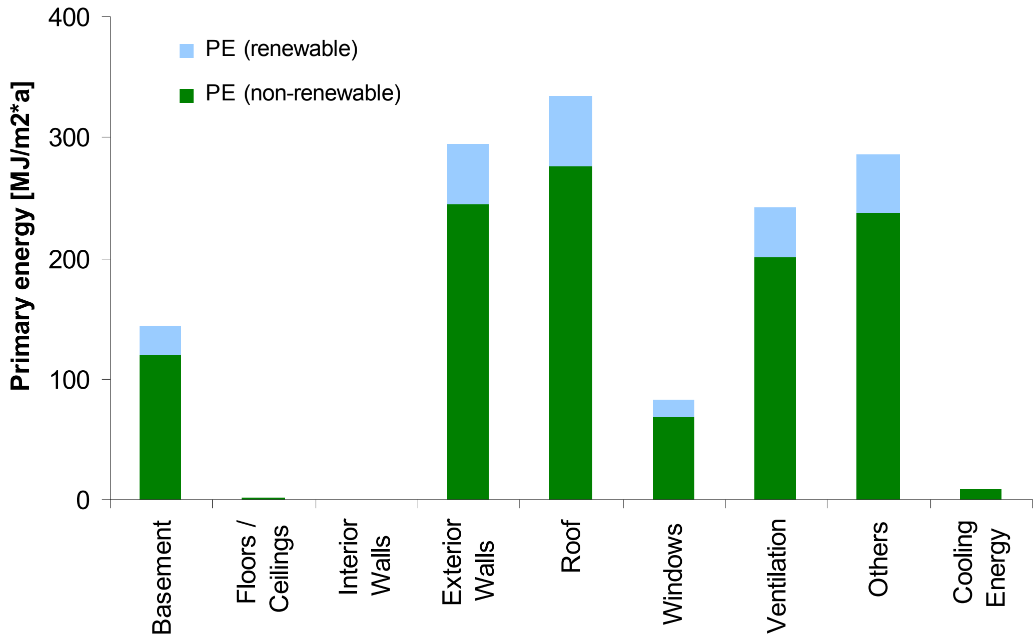


Z1_SI_004

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 401**	**88.6**	**-22.1**	**66.5**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.9E-06**
Refurbishment	5	0.3	-0.1	0.2	1.4E-03	1.3E-04	2.2E-04	2.0E-08
Heating & cooling	1 396	88.3	-22.0	66.4	2.4E-01	1.5E-02	8.3E-02	4.9E-06
End-of-Life	**-6**	**1.4**	**0.0**	**1.4**	**2.4E-03**	**3.2E-04**	**2.0E-04**	**-1.6E-08**
Construction	-5	1.4	0.0	1.4	2.4E-03	3.1E-04	2.0E-04	-1.5E-08
Refurbishment	0	0.0	0.0	0.0	-3.5E-05	3.3E-06	-2.8E-06	-1.4E-09
Total*	**1 401**	**88.6**	**-22.1**	**66.5**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.9E-06**
Heating & Cooling								
Basement	10.2%	10.2%	10.3%	10.2%	10.1%	10.2%	10.2%	10.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	20.9%	21.0%	21.1%	20.9%	20.8%	20.9%	21.0%	20.6%
Roof	24.5%	24.6%	24.7%	24.5%	24.4%	24.5%	24.6%	24.2%
Windows	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.8%	5.7%
Ventilation	17.4%	17.4%	17.5%	17.4%	17.3%	17.3%	17.4%	17.1%
Others	20.6%	20.6%	20.7%	20.6%	20.5%	20.5%	20.6%	20.2%
Cooling Energy	0.7%	0.5%	0.0%	0.7%	1.1%	0.7%	0.2%	2.1%

* Total = Use Phase

Z1_SI_004



Annex C 5 Building type Z1_SI_005_ex

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof

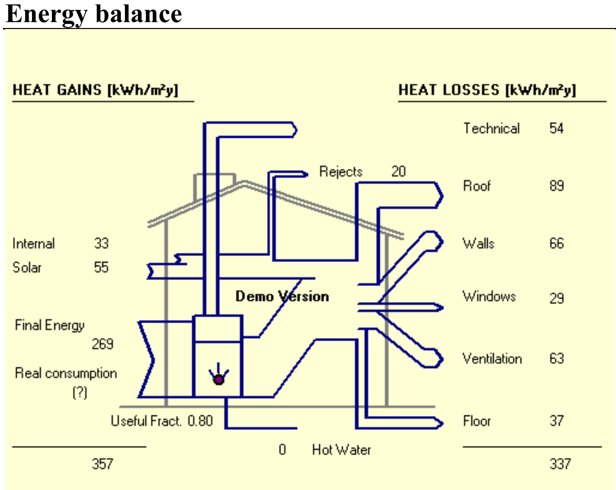
Statistics Proportion of Z1_SI_005_ex in the EU-25: 3.9%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	2065.0	1855.0	825.0	1060.0	2090.0		
Number of buildings [1 000]	1376.7	1236.7	550.0	706.7	1393.3		
Stock in Mio. m^2	185	168	68	88	188		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31		
Occupants per building	3.6	3.9	4.2	4.4	4.4		

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	005_ex
Year of construction	Since 1965
Residual service life	30 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick masonry 30 cm
Interior load-bearing wall	Brick masonry 30 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete 20 cm
Foundation	Reinforced concrete 20 cm
Window	Plastic frame and single-glazing

Energy balance

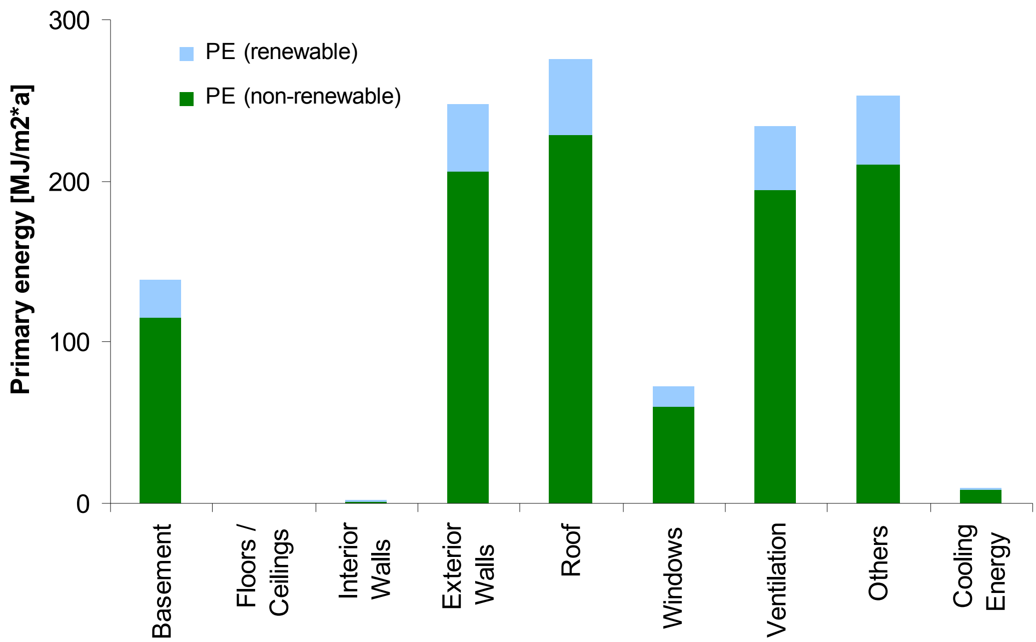


Z1_SI_005_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 238**	**78.4**	**-19.6**	**58.8**	**2.2E-01**	**1.4E-02**	**7.3E-02**	**4.3E-06**
Refurbishment	13	0.9	-0.3	0.5	3.3E-03	3.3E-04	4.2E-04	4.8E-08
Heating & cooling	1 224	77.5	-19.3	58.2	2.1E-01	1.3E-02	7.3E-02	4.3E-06
End-of-Life	**-5**	**1.0**	**0.0**	**1.0**	**1.3E-03**	**1.8E-04**	**1.0E-04**	**-1.4E-08**
Construction	-4	0.8	0.0	0.8	1.3E-03	1.7E-04	1.0E-04	-1.0E-08
Refurbishment	-1	0.1	0.0	0.1	-4.4E-05	8.6E-06	-3.1E-06	-3.6E-09
Total*	**1 238**	**78.4**	**-19.6**	**58.8**	**2.2E-01**	**1.4E-02**	**7.3E-02**	**4.3E-06**
Heating & Cooling								
Basement	11.2%	11.2%	11.3%	11.2%	11.1%	11.2%	11.3%	11.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	20.0%	20.0%	20.1%	20.0%	19.9%	20.0%	20.1%	19.6%
Roof	22.8%	22.8%	22.9%	22.8%	22.6%	22.8%	22.9%	22.4%
Windows	5.6%	5.6%	5.6%	5.6%	5.5%	5.6%	5.6%	5.5%
Ventilation	19.1%	19.1%	19.2%	19.1%	19.0%	19.1%	19.2%	18.8%
Others	20.7%	20.7%	20.8%	20.7%	20.6%	20.7%	20.8%	20.3%
Cooling Energy	0.7%	0.6%	0.0%	0.7%	1.3%	0.8%	0.2%	2.4%

* Total = Use Phase

Z1_SI_005_ex



Annex C 6 Building type Z1_SI_005

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof

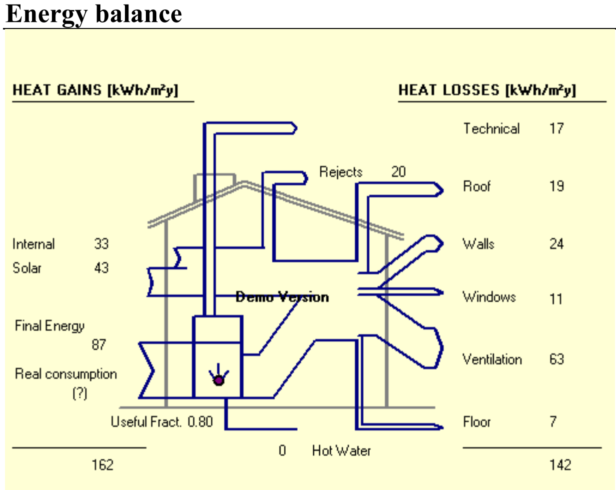
Statistics Proportion of Z1_SI_005 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	101.4	58.6	20.1	20.8	52.4		
Number of buildings [1 000]	67.6	39.1	13.4	13.9	34.9		
Stock in Mio. m^2	9	5	2	2	5		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	3.6	3.9	4.2	4.4	4.4		

Description of the building type **NEW**

Zone	1
Building type	Single-family house
Number	005
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 20° (10 cm insulation)
Roof cladding	Brick
Exterior wall	Brick masonry 30 cm (10 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete 20 cm (5 cm insulation)
Foundation	Reinforced concrete 20 cm
Window	Plastic frame and double-glazing

Energy balance



Z1_SI_005

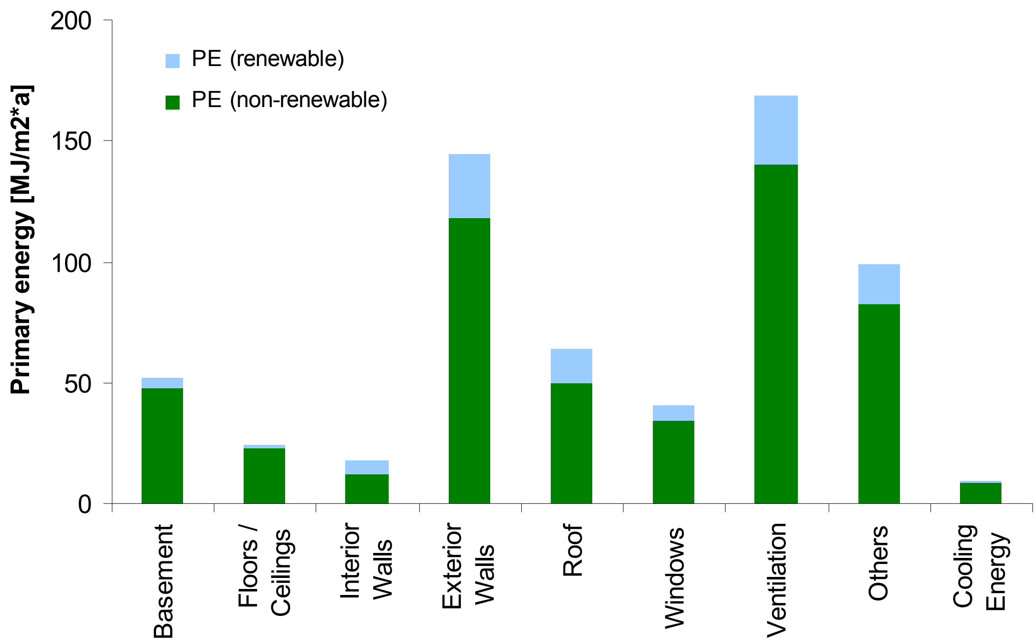
	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**168**	**13.3**	**-2.4**	**10.9**	**4.0E-02**	**4.5E-03**	**4.1E-03**	**4.5E-07**
Use Phase	**457**	**28.9**	**-7.1**	**21.8**	**8.2E-02**	**5.2E-03**	**2.7E-02**	**1.6E-06**
Refurbishment	17	1.2	-0.3	0.9	4.7E-03	4.1E-04	9.0E-04	5.6E-08
Heating & cooling	440	27.7	-6.8	20.9	7.7E-02	4.8E-03	2.6E-02	1.6E-06
End-of-Life	**-5**	**0.9**	**0.0**	**0.9**	**1.0E-03**	**1.5E-04**	**8.0E-05**	**-1.4E-08**
Construction	-3	0.7	0.0	0.7	9.5E-04	1.3E-04	7.5E-05	-8.8E-09
Refurbishment	-2	0.2	0.0	0.2	6.3E-05	1.4E-05	4.7E-06	-5.1E-09
Total*	**625**	**42.3**	**-9.5**	**32.7**	**1.2E-01**	**9.7E-03**	**3.1E-02**	**2.1E-06**

Heating & Cooling								
Basement	4.3%	4.3%	4.3%	4.3%	4.2%	4.3%	4.3%	4.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	14.6%	14.7%	14.9%	14.6%	14.4%	14.6%	14.8%	13.9%
Roof	11.6%	11.6%	11.8%	11.6%	11.4%	11.5%	11.7%	11.0%
Windows	6.7%	6.7%	6.8%	6.7%	6.6%	6.7%	6.8%	6.4%
Ventilation	38.3%	38.5%	39.1%	38.3%	37.8%	38.3%	38.9%	36.6%
Others	22.5%	22.6%	23.0%	22.5%	22.2%	22.5%	22.8%	21.5%
Cooling Energy	2.1%	1.6%	0.1%	2.1%	3.5%	2.2%	0.6%	6.5%

Construction Phase								
Basement	19.1%	27.7%	1.9%	33.3%	26.3%	30.8%	23.9%	26.2%
Floors/ceilings	13.5%	17.8%	1.9%	21.2%	16.4%	18.9%	15.1%	20.8%
Interior Walls	8.7%	7.1%	17.0%	5.0%	6.8%	6.3%	6.2%	8.0%
Exterior Walls	44.8%	37.8%	57.7%	33.5%	37.3%	33.6%	42.3%	31.0%
Roof	8.8%	5.6%	21.2%	2.2%	6.7%	5.4%	7.7%	9.4%
Windows	5.1%	4.0%	0.3%	4.8%	6.5%	5.0%	4.9%	4.7%

* Total = Construction Phase + Use Phase

Z1_SI_005



Annex C 7 Building type Z1_SI_006_ex

Single-family house
Brick cavity wall,
reinforced concrete
flooring, flat roof

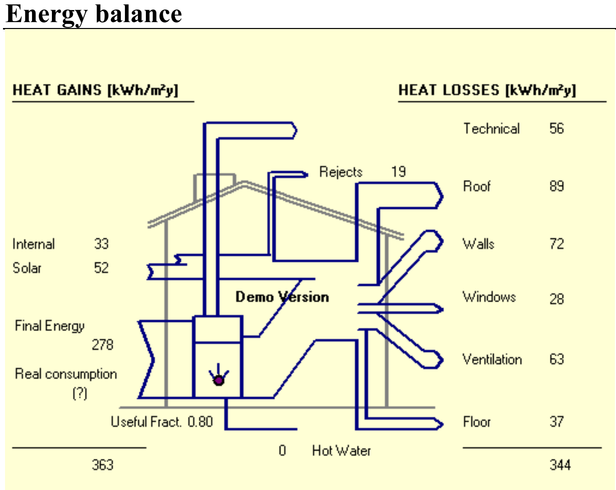
Statistics Proportion of Z1_SI_006_ex in the EU-25: 2.4%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	885.0	1325.0	825.0	795.0	1045.0		
Number of buildings [1 000]	590.0	883.3	550.0	530.0	696.7		
Stock in Mio. m^2	79	120	68	66	94		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	3.6	3.9	4.2	4.4	4.4		

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	006_ex
Year of construction	Since 1965
Residual service life	20 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Gravel
Exterior wall	Brick masonry 30 cm
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and single-glazing

Energy balance

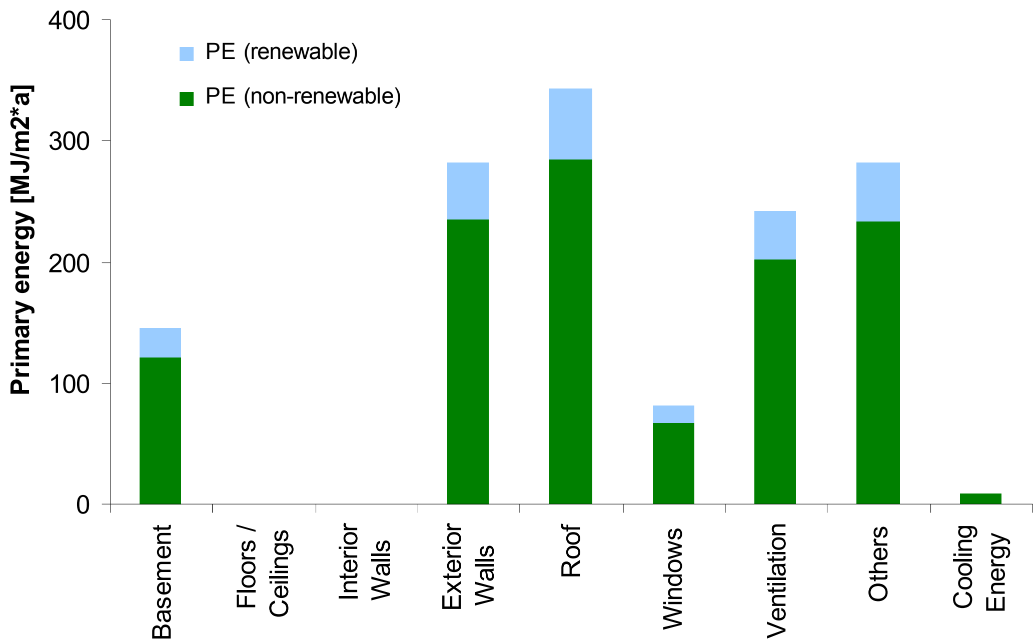


Z1_SI_006_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 382**	**87.4**	**-21.8**	**65.6**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.8E-06**
Refurbishment	7	0.4	-0.1	0.3	3.3E-03	1.6E-04	1.1E-03	2.7E-08
Heating & cooling	1 375	87.0	-21.6	65.4	2.4E-01	1.5E-02	8.2E-02	4.8E-06
End-of-Life	**1**	**0.8**	**0.0**	**0.8**	**2.7E-03**	**2.9E-04**	**2.1E-04**	**3.8E-09**
Construction	2	0.6	0.0	0.6	2.6E-03	2.9E-04	2.1E-04	7.3E-09
Refurbishment	-1	0.1	0.0	0.1	1.9E-05	-6.1E-07	-1.6E-06	-3.5E-09
Total*	**1 382**	**87.4**	**-21.8**	**65.6**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.8E-06**
Heating & Cooling								
Basement	10.4%	10.4%	10.4%	10.4%	10.3%	10.4%	10.4%	10.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	20.2%	20.2%	20.3%	20.2%	20.1%	20.2%	20.3%	19.9%
Roof	24.9%	25.0%	25.1%	24.9%	24.8%	24.9%	25.1%	24.6%
Windows	5.7%	5.7%	5.8%	5.7%	5.7%	5.7%	5.8%	5.6%
Ventilation	17.7%	17.7%	17.8%	17.7%	17.6%	17.6%	17.7%	17.4%
Others	20.5%	20.5%	20.6%	20.5%	20.4%	20.5%	20.6%	20.2%
Cooling Energy	0.7%	0.5%	0.0%	0.7%	1.1%	0.7%	0.2%	2.2%

* Total = Use Phase

Z1_SI_006_ex



Annex C 8 Building type Z1_SI_006

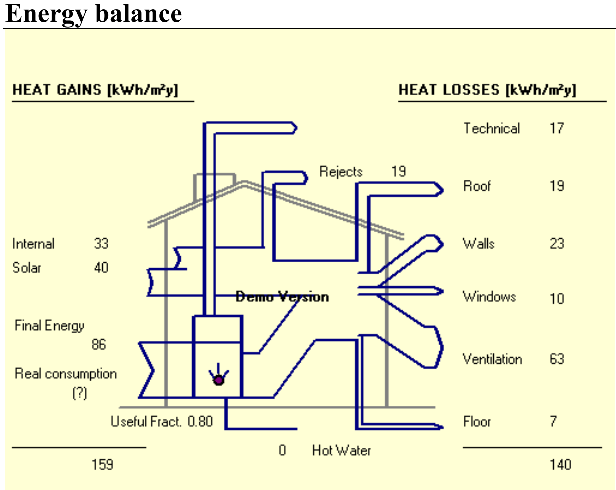
Single-family house
Brick cavity wall,
reinforced concrete
flooring, flat roof

Statistics Proportion of Z1_SI_006 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	101.4	58.6	20.1	20.8	52.4		
Number of buildings [1 000]	67.6	39.1	13.4	13.9	34.9		
Stock in Mio. m^2	9	5	2	2	5		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	3.6	3.9	4.2	4.4	4.4		

Description of the building type	**NEW**
Zone	1
Building type	Single-family house
Number	006
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Flat roof (10 cm insulation)
Roof cladding	Gravel
Exterior wall	Brick masonry 30 cm (10 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

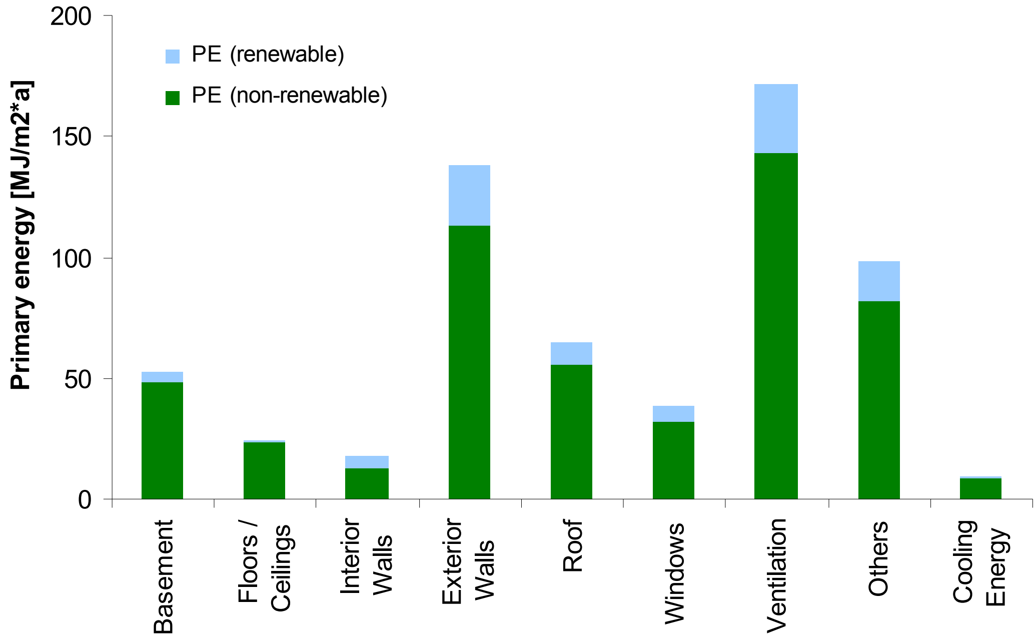


Z1_SI_006

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**162**	**13.6**	**-1.8**	**11.8**	**4.0E-02**	**4.6E-03**	**4.0E-03**	**4.5E-07**
Use Phase	**454**	**28.7**	**-7.1**	**21.6**	**8.1E-02**	**5.1E-03**	**2.7E-02**	**1.6E-06**
Refurbishment	14	0.9	-0.3	0.7	3.8E-03	3.3E-04	7.7E-04	4.7E-08
Heating & cooling	440	27.7	-6.8	20.9	7.7E-02	4.8E-03	2.6E-02	1.6E-06
End-of-Life	**-1**	**0.5**	**0.0**	**0.5**	**1.3E-03**	**1.6E-04**	**1.1E-04**	**-1.9E-09**
Construction	1	0.3	0.0	0.3	1.3E-03	1.4E-04	1.0E-04	2.4E-09
Refurbishment	-1	0.2	0.0	0.2	6.2E-05	1.3E-05	4.6E-06	-4.3E-09
Total*	**616**	**42.2**	**-8.9**	**33.3**	**1.2E-01**	**9.8E-03**	**3.1E-02**	**2.1E-06**
Heating & Cooling								
Basement	4.3%	4.4%	4.4%	4.3%	4.3%	4.3%	4.4%	4.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	14.3%	14.3%	14.5%	14.3%	14.0%	14.2%	14.5%	13.6%
Roof	11.8%	11.8%	12.0%	11.8%	11.6%	11.8%	12.0%	11.2%
Windows	6.2%	6.2%	6.3%	6.2%	6.1%	6.2%	6.3%	5.9%
Ventilation	39.1%	39.2%	39.8%	39.0%	38.5%	39.0%	39.6%	37.3%
Others	22.3%	22.4%	22.8%	22.3%	22.0%	22.3%	22.7%	21.3%
Cooling Energy	2.1%	1.6%	0.1%	2.1%	3.5%	2.2%	0.6%	6.5%
Construction Phase								
Basement	19.7%	27.4%	2.5%	31.2%	26.4%	30.0%	24.4%	26.4%
Floors/ceilings	14.0%	17.6%	2.6%	19.9%	16.4%	18.4%	15.4%	20.9%
Interior Walls	9.2%	7.0%	22.7%	4.6%	6.8%	6.2%	6.3%	8.1%
Exterior Walls	43.7%	34.6%	70.4%	29.2%	34.9%	30.5%	40.3%	29.0%
Roof	7.9%	9.3%	1.3%	10.6%	9.0%	10.1%	8.6%	10.8%
Windows	5.3%	4.0%	0.4%	4.5%	6.5%	4.8%	5.0%	4.7%

* Total = Construction Phase + Use Phase

Z1_SI_006



Annex C 9 Building type Z1_SI_007_ex

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof

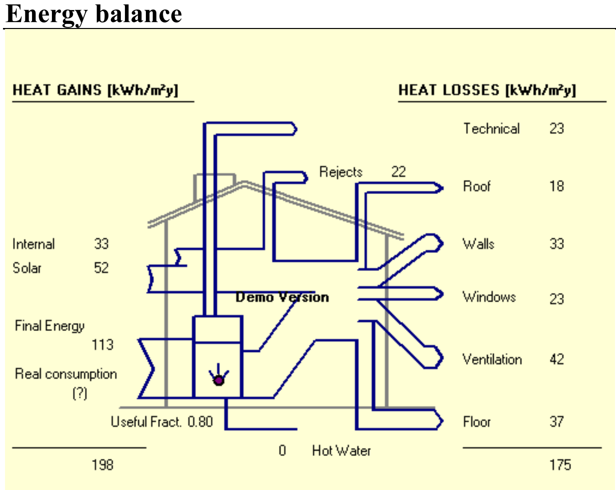
Statistics Proportion of Z1_SI_007_ex in the EU-25: 1.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	1475.0	1325.0	165.0	159.0	627.0		
Number of buildings [1 000]	983.3	883.3	110.0	106.0	418.0		
Stock in Mio. m^2	132	120	14	13	56		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	3.6	3.9	4.2	4.4	4.4		

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	007_ex
Year of construction	Since 1950
Residual service life	30 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick masonry 30 cm (5 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 25 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

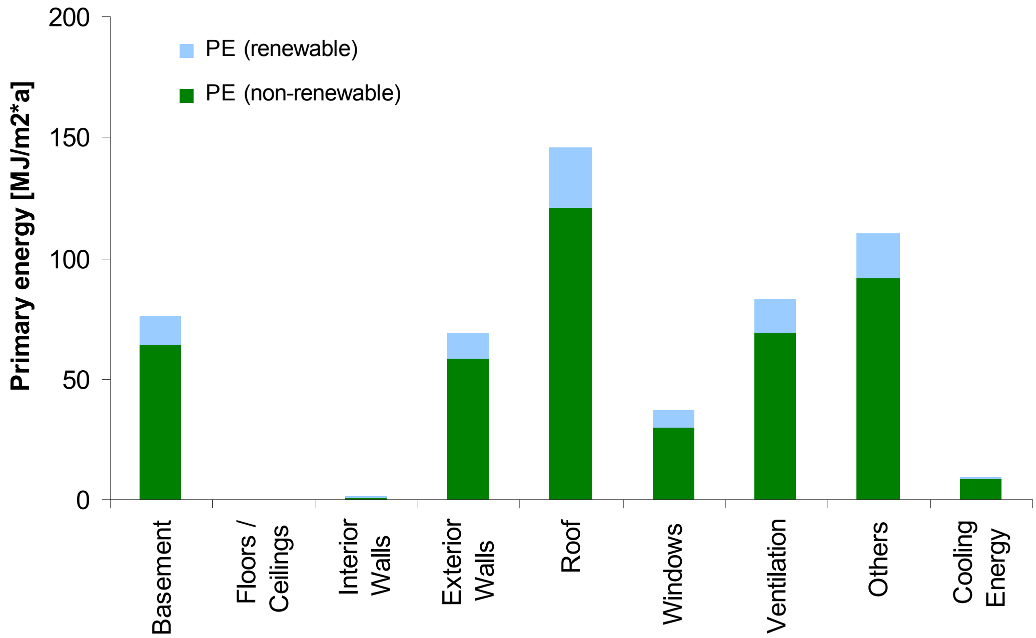


Z1_SI_007_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**537**	**33.9**	**-8.5**	**25.5**	**9.6E-02**	**6.0E-03**	**3.2E-02**	**1.9E-06**
Refurbishment	14	0.9	-0.3	0.6	4.0E-03	3.4E-04	7.9E-04	5.0E-08
Heating & cooling	523	33.0	-8.1	24.9	9.2E-02	5.7E-03	3.1E-02	1.9E-06
End-of-Life	**-4**	**1.1**	**0.0**	**1.1**	**2.1E-03**	**2.7E-04**	**1.8E-04**	**-1.1E-08**
Construction	-2	1.0	0.0	1.0	2.2E-03	2.7E-04	1.8E-04	-7.1E-09
Refurbishment	-2	0.2	0.0	0.2	-2.0E-05	6.8E-06	-2.5E-06	-4.4E-09
Total*	**537**	**33.9**	**-8.5**	**25.5**	**9.6E-02**	**6.0E-03**	**3.2E-02**	**1.9E-06**
Heating & Cooling								
Basement	14.0%	14.1%	14.3%	14.0%	13.9%	14.0%	14.2%	13.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	12.5%	12.6%	12.7%	12.5%	12.4%	12.5%	12.7%	12.0%
Roof	28.5%	28.6%	29.0%	28.5%	28.2%	28.5%	28.9%	27.4%
Windows	6.2%	6.2%	6.3%	6.2%	6.1%	6.2%	6.3%	6.0%
Ventilation	15.9%	16.0%	16.2%	15.9%	15.7%	15.9%	16.1%	15.3%
Others	21.1%	21.2%	21.4%	21.1%	20.8%	21.1%	21.3%	20.3%
Cooling Energy	1.7%	1.3%	0.1%	1.7%	3.0%	1.8%	0.5%	5.5%

* Total = Use Phase

Z1_SI_007_ex



Annex C 10 Building type Z1_SI_007

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof

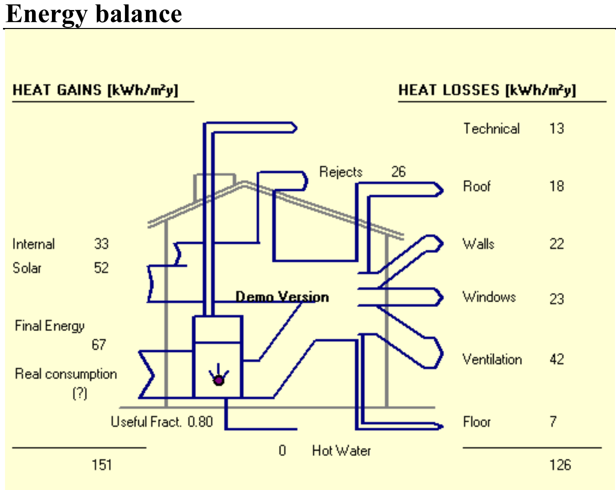
Statistics Proportion of Z1_SI_007 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	101.4	58.6	20.1	20.8	52.4		
Number of buildings [1 000]	67.6	39.1	13.4	13.9	34.9		
Stock in Mio. m^2	9	5	2	2	5		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	3.6	3.9	4.2	4.4	4.4		

Description of the building type **NEW**

Zone	1
Building type	Single-family house
Number	007
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick masonry 30 cm (10 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 25 cm
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

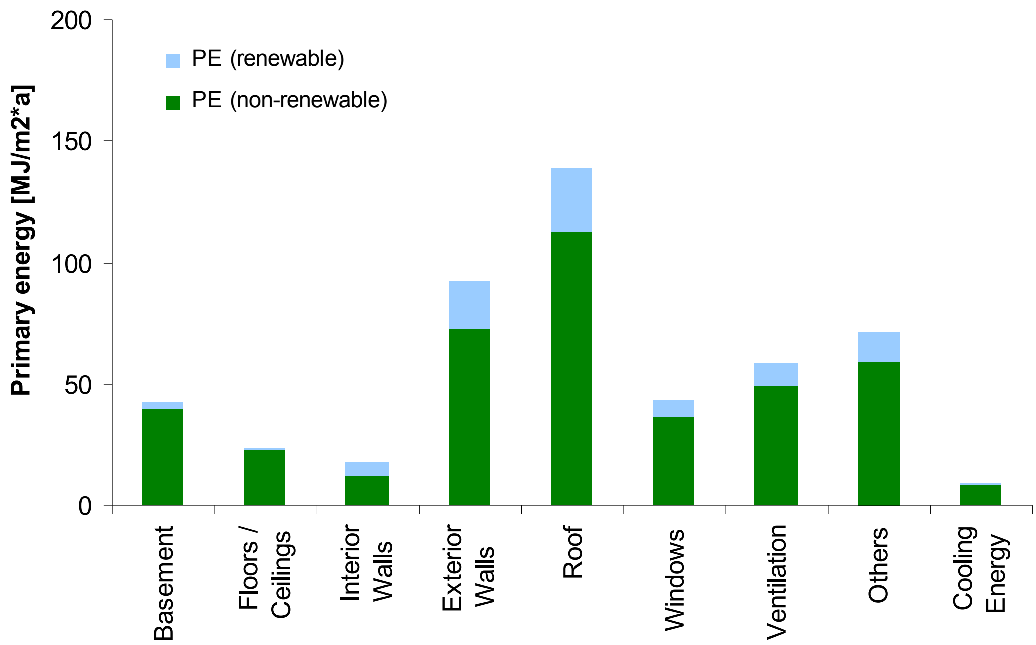


Z1_SI_007

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**149**	**12.4**	**-2.4**	**10.0**	**3.6E-02**	**4.2E-03**	**3.6E-03**	**4.2E-07**
Use Phase	**354**	**22.4**	**-5.5**	**16.9**	**6.5E-02**	**4.2E-03**	**2.1E-02**	**1.3E-06**
Refurbishment	21	1.4	-0.3	1.1	5.9E-03	5.3E-04	9.9E-04	6.4E-08
Heating & cooling	333	21.0	-5.1	15.9	5.9E-02	3.6E-03	2.0E-02	1.2E-06
End-of-Life	**-5**	**0.9**	**0.0**	**0.9**	**1.0E-03**	**1.4E-04**	**8.0E-05**	**-1.4E-08**
Construction	-3	0.7	0.0	0.7	9.5E-04	1.3E-04	7.5E-05	-8.7E-09
Refurbishment	-2	0.2	0.0	0.2	6.7E-05	1.4E-05	5.0E-06	-5.1E-09
Total*	**503**	**34.8**	**-7.8**	**27.0**	**1.0E-01**	**8.3E-03**	**2.4E-02**	**1.7E-06**
Heating & Cooling								
Basement	2.9%	3.0%	3.0%	2.9%	2.9%	2.9%	3.0%	2.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.4%	8.4%	8.6%	8.4%	8.2%	8.4%	8.6%	7.9%
Roof	37.3%	37.6%	38.3%	37.3%	36.6%	37.3%	38.1%	35.1%
Windows	9.6%	9.7%	9.9%	9.6%	9.5%	9.6%	9.8%	9.1%
Ventilation	17.6%	17.7%	18.1%	17.6%	17.3%	17.6%	18.0%	16.6%
Others	21.4%	21.5%	21.9%	21.4%	21.0%	21.3%	21.8%	20.1%
Cooling Energy	2.7%	2.1%	0.2%	2.7%	4.6%	2.9%	0.8%	8.5%
Construction Phase								
Basement	21.4%	29.5%	1.9%	36.0%	28.5%	33.0%	26.5%	28.0%
Floors/ceilings	15.2%	18.9%	1.9%	22.9%	17.7%	20.2%	16.7%	22.2%
Interior Walls	9.7%	7.6%	17.0%	5.4%	7.3%	6.8%	6.9%	8.6%
Exterior Walls	38.8%	34.0%	57.5%	28.5%	32.5%	29.3%	36.5%	26.5%
Roof	9.2%	5.7%	21.3%	2.0%	6.9%	5.4%	8.0%	9.7%
Windows	5.8%	4.3%	0.3%	5.2%	7.0%	5.3%	5.4%	5.0%

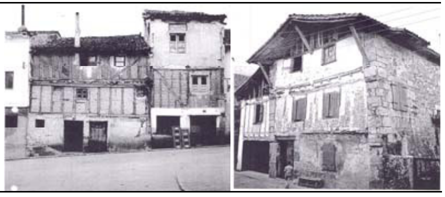
* Total = Construction Phase + Use Phase

Z1_SI_007



Annex C 11 Building type Z1_SI_008

Single-family house
Wooden frame with stone filler, wooden flooring, pitched roof



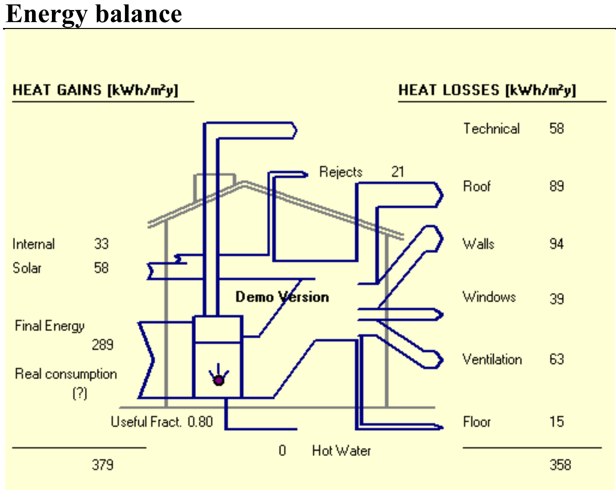
Statistics Proportion of Z1_SI_008 in the EU-25: 0.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	590.0	530.0			418.0		
Number of buildings [1 000]	393.3	353.3			278.7		
Stock in Mio. m^2	53	48			38		
Density in m^2/occupant	37.3	34.7			31.0		
Occupants per building	3.6	3.9			4.4		

Description of the building type **EXISTING**

Zone	1
Building type	Single-family house
Number	008
Year of construction	Until 1900
Residual service life	20 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Wooden frame 16 cm, loam/stone filler 16 cm
Interior load-bearing wall	Wooden frame 16 cm, loam/stone filler 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Wooden construction and stoneboard
Foundation	Natural stone
Window	Wooden frame and single-glazing

Energy balance

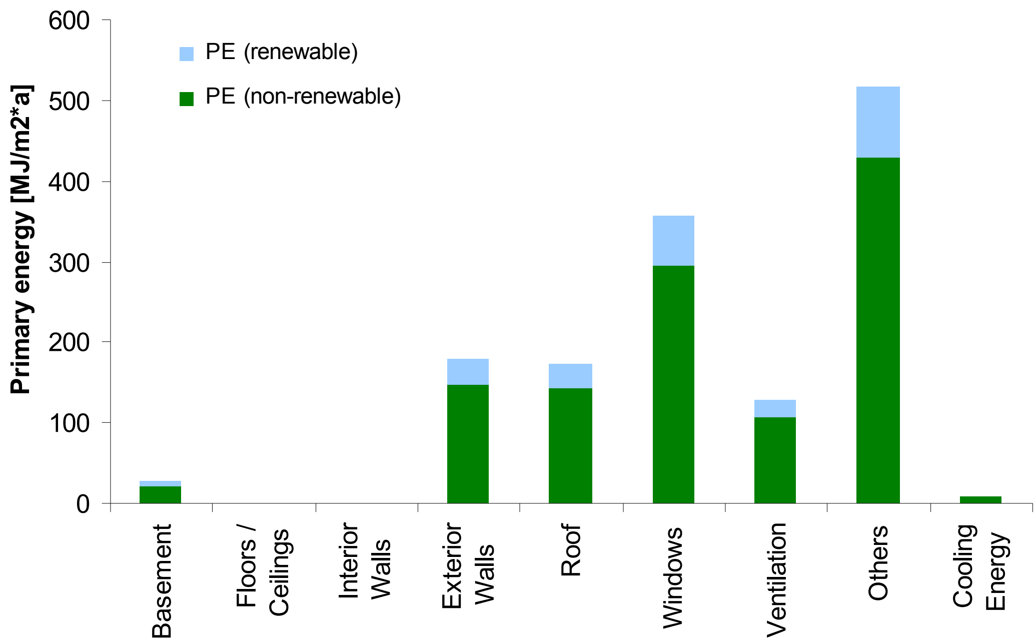


Z1_SI_008

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 413**	**89.4**	**-22.3**	**67.1**	**2.5E-01**	**1.5E-02**	**8.4E-02**	**4.9E-06**
Refurbishment	6	0.3	-0.1	0.2	1.8E-03	1.3E-04	4.0E-04	2.1E-08
Heating & cooling	1 407	89.1	-22.1	66.9	2.4E-01	1.5E-02	8.4E-02	4.9E-06
End-of-Life	**-62**	**6.2**	**0.0**	**6.2**	**-1.8E-03**	**2.1E-04**	**-1.4E-04**	**-1.8E-07**
Construction	-62	6.2	0.0	6.2	-1.8E-03	2.1E-04	-1.4E-04	-1.8E-07
Refurbishment	-1	0.1	0.0	0.1	-2.4E-05	2.4E-06	-2.5E-06	-1.8E-09
Total*	**1 413**	**89.4**	**-22.3**	**67.1**	**2.5E-01**	**1.5E-02**	**8.4E-02**	**4.9E-06**
Heating & Cooling								
Basement	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	13.5%	13.6%	13.6%	13.5%	13.5%	13.5%	13.6%	13.3%
Roof	12.8%	12.8%	12.9%	12.8%	12.8%	12.8%	12.9%	12.6%
Windows	25.0%	25.1%	25.2%	25.0%	24.9%	25.0%	25.1%	24.7%
Ventilation	9.1%	9.1%	9.1%	9.1%	9.0%	9.1%	9.1%	8.9%
Others	36.7%	36.8%	36.9%	36.7%	36.5%	36.7%	36.9%	36.2%
Cooling Energy	0.6%	0.5%	0.0%	0.6%	1.1%	0.7%	0.2%	2.1%

* Total = Use Phase

Z1_SI_008



Annex C 12 Building type Z1_MF_001

Multi-family house
Brick masonry, wooden flooring, pitched roof

Statistics

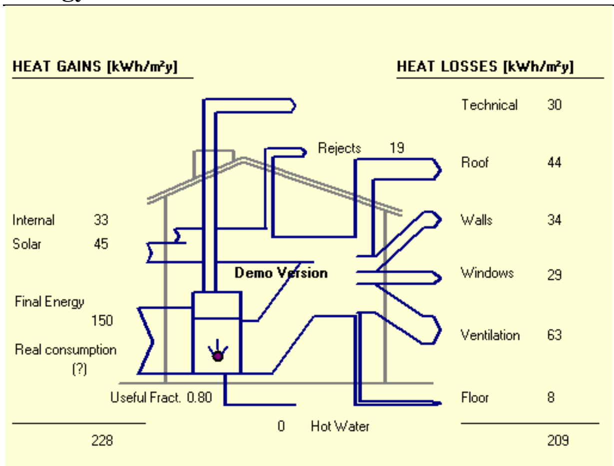
Proportion of Z1_MF_001 in the EU-25: 1.9%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	2065.0	1325.0	110.0	53.0	418.0	6.5	15.0
Number of buildings [1 000]	129.1	82.8	6.9	3.3	26.1	0.4	0.9
Stock in Mio. m^2	185	120	9	4	38	1	3
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	38.4	41.6	44.8	46.4	46.4	50.0	52.0

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	001
Year of construction	Until 1945
Residual service life	30 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Brick
Window	Wooden frame and single-glazing

Energy balance

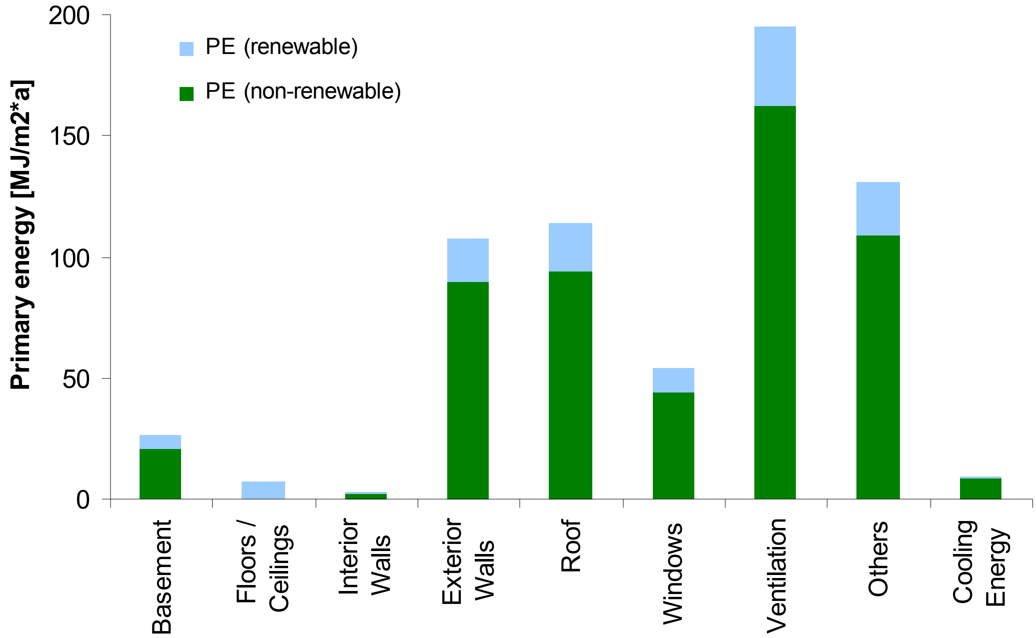


Z1_MF_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**654**	**40.9**	**-10.9**	**30.1**	**1.1E-01**	**7.2E-03**	**3.8E-02**	**2.3E-06**
Refurbishment	24	1.1	-1.0	0.1	4.0E-03	3.6E-04	6.6E-04	7.4E-08
Heating & cooling	630	39.8	-9.8	30.0	1.1E-01	6.9E-03	3.7E-02	2.2E-06
End-of-Life	**-24**	**2.7**	**0.0**	**2.7**	**2.6E-04**	**2.0E-04**	**3.5E-05**	**-7.4E-08**
Construction	-17	2.1	0.0	2.1	8.0E-04	2.2E-04	8.3E-05	-5.3E-08
Refurbishment	-7	0.6	0.0	0.6	-5.4E-04	-1.4E-05	-4.7E-05	-2.0E-08
Total*	**654**	**40.9**	**-10.9**	**30.1**	**1.1E-01**	**7.2E-03**	**3.8E-02**	**2.3E-06**
Heating & Cooling								
Basement	3.9%	3.9%	4.0%	3.9%	3.9%	3.9%	4.0%	3.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	16.7%	16.8%	16.9%	16.7%	16.5%	16.7%	16.9%	16.2%
Roof	18.3%	18.3%	18.5%	18.2%	18.1%	18.2%	18.5%	17.7%
Windows	8.0%	8.0%	8.1%	8.0%	7.9%	8.0%	8.1%	7.7%
Ventilation	31.0%	31.1%	31.4%	30.9%	30.6%	30.9%	31.3%	29.9%
Others	20.8%	20.8%	21.0%	20.7%	20.5%	20.7%	21.0%	20.1%
Cooling Energy	1.5%	1.1%	0.1%	1.4%	2.5%	1.5%	0.4%	4.6%

* Total = Use Phase

Z1_MF_001



Annex C 13 Building type Z1_MF_002

Multi-family house
Limestone/fieldstone masonry, wooden flooring, pitched roof

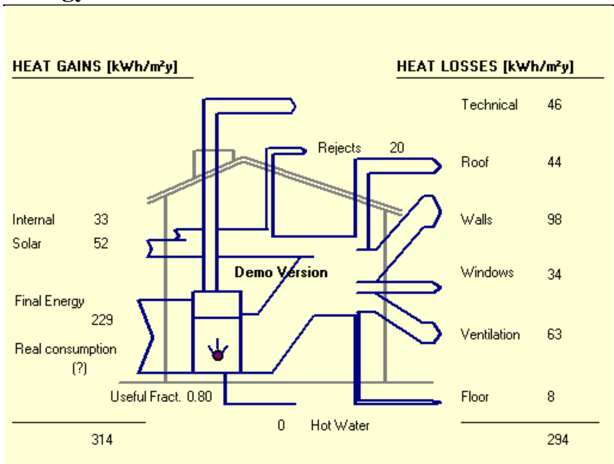
Statistics Proportion of Z1_MF_002 in the EU-25: 0.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	590.0	530.0	110.0	53.0	418.0	19.5	15.0
Number of buildings [1 000]	36.9	33.1	6.9	3.3	26.1	1.2	0.9
Stock in Mio. m^2	53	48	9	4	38	2	3
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	38.4	41.6	44.8	46.4	46.4	50.0	52.0

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	002
Year of construction	1900-1945
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3.5 m
Roof	Pitched roof 20°/Flat roof
Roof cladding	Brick
Exterior wall	Limestone/fieldstone 50 cm
Interior load-bearing wall	Limestone/fieldstone 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Limestone/fieldstone 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Fieldstone
Window	Wooden frame and single-glazing

Energy balance

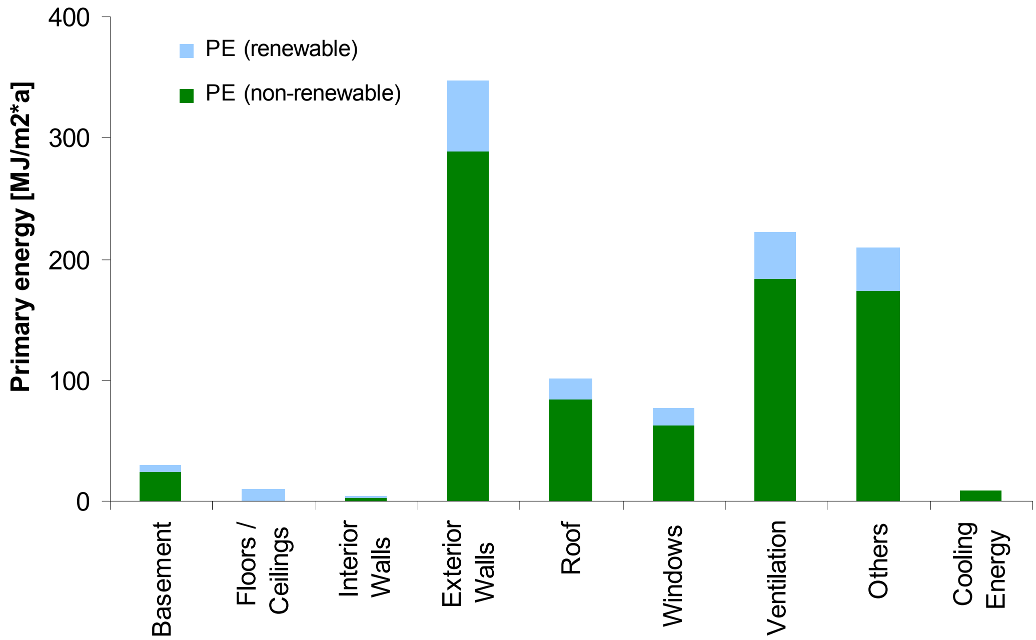


Z1_MF_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 021**	**64.0**	**-17.0**	**47.1**	**1.8E-01**	**1.1E-02**	**6.0E-02**	**3.6E-06**
Refurbishment	36	1.7	-1.5	0.2	5.8E-03	5.4E-04	9.2E-04	1.1E-07
Heating & cooling	986	62.4	-15.5	46.9	1.7E-01	1.1E-02	5.9E-02	3.5E-06
End-of-Life	**-23**	**2.5**	**0.0**	**2.5**	**1.2E-06**	**1.6E-04**	**1.1E-05**	**-7.0E-08**
Construction	-12	1.6	0.0	1.6	7.8E-04	1.8E-04	7.9E-05	-3.9E-08
Refurbishment	-11	0.9	0.0	0.9	-7.8E-04	-1.9E-05	-6.8E-05	-3.1E-08
Total*	**1 021**	**64.0**	**-17.0**	**47.1**	**1.8E-01**	**1.1E-02**	**6.0E-02**	**3.6E-06**
Heating & Cooling								
Basement	2.9%	2.9%	2.9%	2.8%	2.8%	2.9%	2.9%	2.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	35.0%	35.0%	35.3%	34.9%	34.7%	34.9%	35.2%	34.2%
Roof	10.2%	10.2%	10.3%	10.2%	10.2%	10.2%	10.3%	10.0%
Windows	7.3%	7.3%	7.4%	7.3%	7.3%	7.3%	7.4%	7.2%
Ventilation	22.5%	22.5%	22.7%	22.4%	22.3%	22.5%	22.6%	22.0%
Others	21.3%	21.3%	21.4%	21.2%	21.1%	21.3%	21.4%	20.8%
Cooling Energy	0.9%	0.7%	0.1%	0.9%	1.6%	1.0%	0.3%	3.0%

* Total = Use Phase

Z1_MF_002



Annex C 14 Building type Z1_MF_003

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

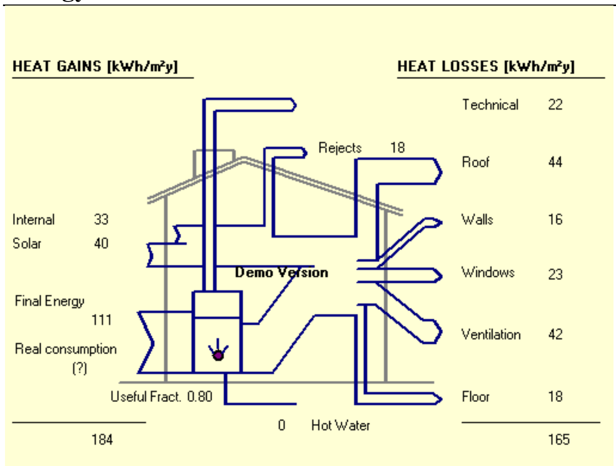
Statistics Proportion of Z1_MF_003 in the EU-25: 4.6%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	1475.0	3975.0	1100.0	371.0	2508.0	13.0	30.0
Number of buildings [1 000]	92.2	248.4	68.8	23.2	156.8	0.8	1.9
Stock in Mio. m^2	132	359	91	31	226	1	6
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0	34.0	59.0
Occupants per building	38.4	41.6	44.8	46.4	46.4	50.0	52.0

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	003
Year of construction	1945-1990
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Brick
Exterior wall	Brick masonry 35 cm
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

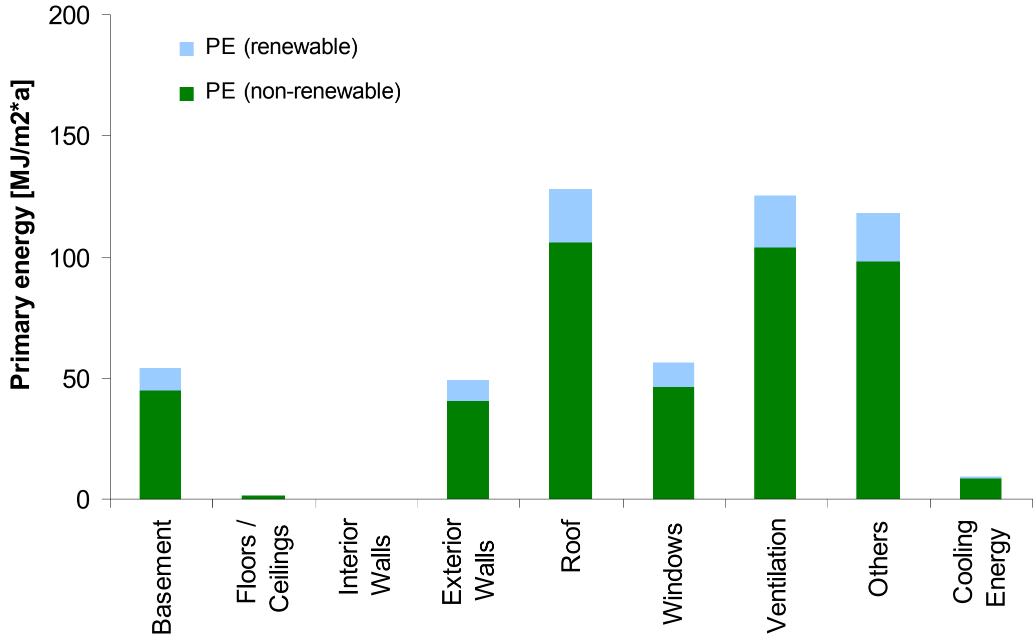


Z1_MF_003

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**543**	**34.3**	**-8.5**	**25.8**	**9.6E-02**	**6.0E-03**	**3.2E-02**	**1.9E-06**
Refurbishment	4	0.2	-0.1	0.1	1.2E-03	9.5E-05	2.2E-04	1.5E-08
Heating & cooling	539	34.0	-8.4	25.6	9.5E-02	5.9E-03	3.2E-02	1.9E-06
End-of-Life	**-2**	**0.9**	**0.0**	**0.9**	**1.8E-03**	**2.4E-04**	**1.7E-04**	**-1.1E-08**
Construction	-2	0.8	0.0	0.8	1.8E-03	2.4E-04	1.7E-04	-1.0E-08
Refurbishment	0	0.0	0.0	0.0	-2.1E-05	2.1E-06	-1.9E-06	-1.2E-09
Total*	**543**	**34.3**	**-8.5**	**25.8**	**9.6E-02**	**6.0E-03**	**3.2E-02**	**1.9E-06**
Heating & Cooling								
Basement	10.0%	10.0%	10.1%	10.0%	9.8%	10.0%	10.1%	9.6%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.9%	8.9%	9.0%	8.9%	8.8%	8.8%	9.0%	8.5%
Roof	24.4%	24.5%	24.7%	24.4%	24.1%	24.3%	24.7%	23.4%
Windows	10.0%	10.0%	10.2%	10.0%	9.9%	10.0%	10.1%	9.6%
Ventilation	23.3%	23.3%	23.6%	23.2%	23.0%	23.2%	23.5%	22.4%
Others	21.9%	22.0%	22.2%	21.9%	21.6%	21.9%	22.2%	21.1%
Cooling Energy	1.7%	1.3%	0.1%	1.7%	2.9%	1.8%	0.5%	5.4%

* Total = Use Phase

Z1_MF_003



Annex C 15 Building type Z1_MF_004_ex

Multi-family house
Breeze concrete, reinforced concrete flooring, pitched roof

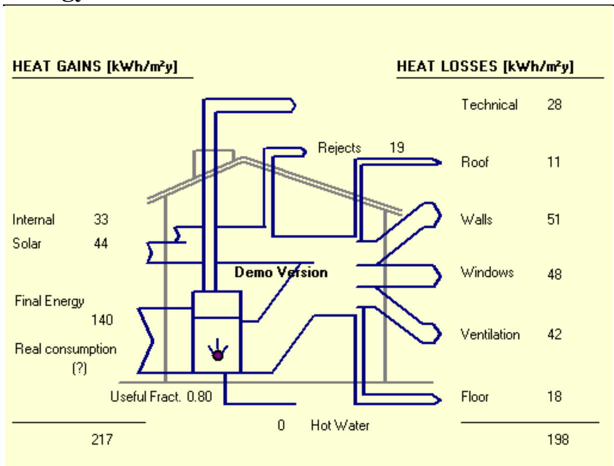
Statistics Proportion of Z1_MF_004_ex in the EU-25: 1.2%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	1180.0	1325.0					
Number of buildings [1 000]	73.8	82.8					
Stock in Mio. m^2	106	120					
Density in m^2/occupant	37.3	34.7					
Occupants per building	38.4	41.6					

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	004_ex
Year of construction	Since 1950
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Bitumen layer
Exterior wall	Breeze concrete 30 cm
Interior load-bearing wall	Breeze concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and single-glazing

Energy balance

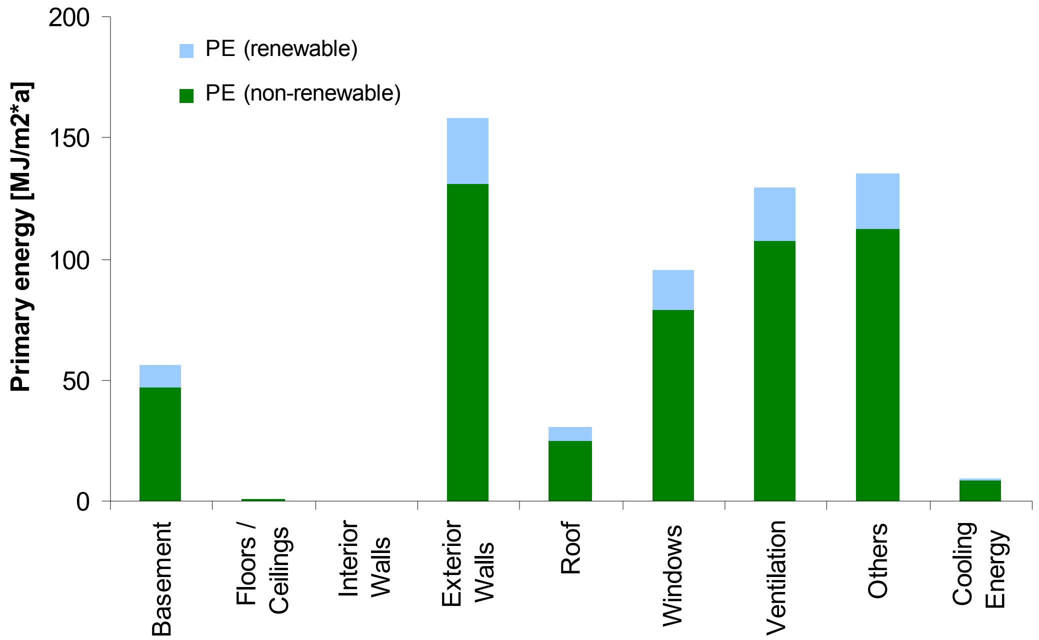


Z1_MF_004_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**619**	**39.1**	**-9.7**	**29.4**	**1.1E-01**	**6.8E-03**	**3.7E-02**	**2.2E-06**
Refurbishment	4	0.2	-0.1	0.1	1.3E-03	1.1E-04	2.3E-04	1.6E-08
Heating & cooling	614	38.8	-9.6	29.2	1.1E-01	6.7E-03	3.6E-02	2.2E-06
End-of-Life	**-5**	**0.7**	**0.0**	**0.7**	**6.5E-04**	**1.0E-04**	**4.1E-05**	**-9.7E-09**
Construction	-4	0.6	0.0	0.6	6.4E-04	9.7E-05	4.0E-05	-8.6E-09
Refurbishment	0	0.0	0.0	0.0	7.4E-06	5.2E-06	7.6E-07	-1.1E-09
Total*	**619**	**39.1**	**-9.7**	**29.4**	**1.1E-01**	**6.8E-03**	**3.7E-02**	**2.2E-06**
Heating & Cooling								
Basement	9.0%	9.1%	9.2%	9.0%	8.9%	9.0%	9.1%	8.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	25.6%	25.7%	25.9%	25.6%	25.3%	25.6%	25.8%	24.7%
Roof	5.5%	5.5%	5.6%	5.5%	5.5%	5.5%	5.6%	5.3%
Windows	15.3%	15.3%	15.5%	15.3%	15.1%	15.3%	15.4%	14.8%
Ventilation	21.1%	21.1%	21.4%	21.1%	20.8%	21.0%	21.3%	20.4%
Others	22.1%	22.1%	22.4%	22.1%	21.8%	22.0%	22.3%	21.3%
Cooling Energy	1.5%	1.1%	0.1%	1.5%	2.5%	1.6%	0.4%	4.7%

* Total = Use Phase

Z1_MF_004_ex



Annex C 16 Building type Z1_MF_004

Multi-family house
Breeze concrete, reinforced concrete flooring, pitched roof

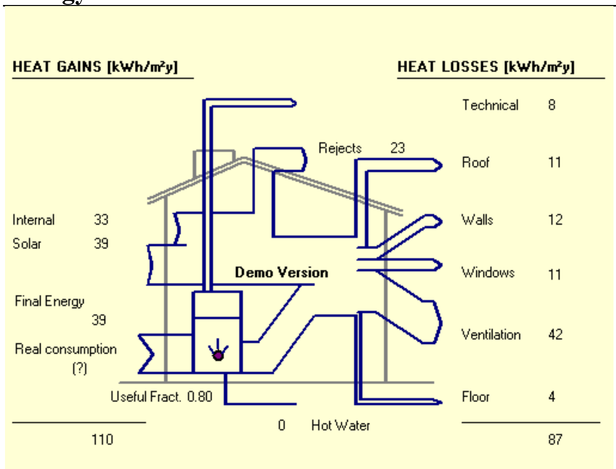
Statistics Proportion of Z1_MF_004 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	51.6	67.4	14.0	6.8	53.8		
Number of buildings [1 000]	3.2	4.2	0.9	0.4	3.4		
Stock in Mio. m^2	5	6	1	1	5		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	38.4	41.6	44.8	46.4	46.4		

Description of the building type **NEW**

Zone	1
Building type	Multi-family house
Number	004
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 20°
Roof cladding	Bitumen layer
Exterior wall	Breeze concrete 30 cm (5 cm insulation)
Interior load-bearing wall	Breeze concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

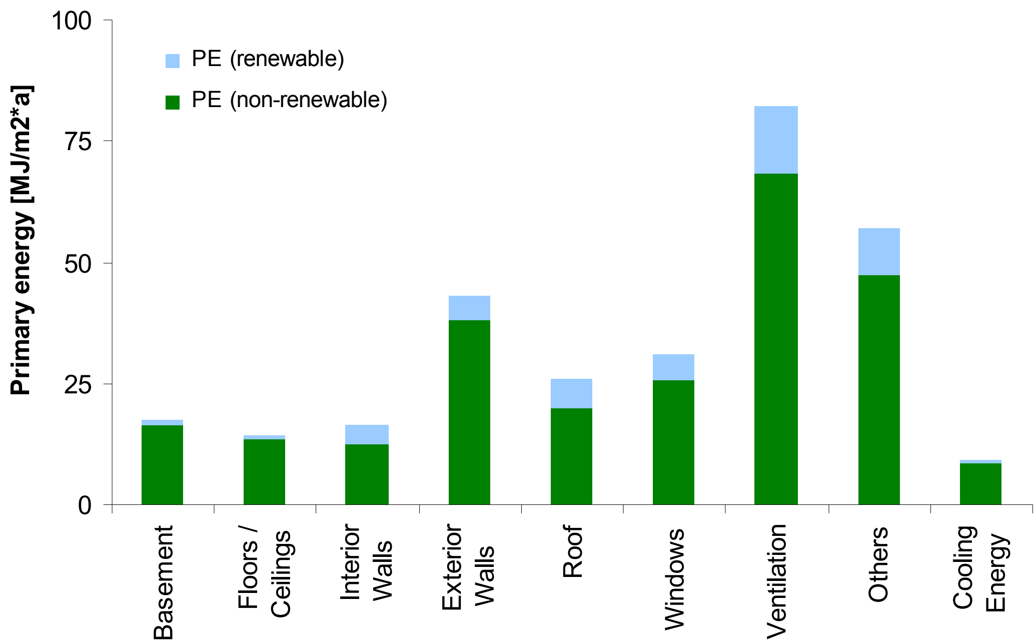


Z1_MF_004

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**69**	**6.3**	**-0.5**	**5.8**	**2.3E-02**	**2.4E-03**	**2.1E-03**	**2.3E-07**
Use Phase	**231**	**14.5**	**-3.6**	**10.8**	**4.2E-02**	**2.7E-03**	**1.3E-02**	**8.7E-07**
Refurbishment	14	0.8	-0.3	0.5	3.4E-03	3.1E-04	5.3E-04	4.9E-08
Heating & cooling	217	13.6	-3.3	10.3	3.9E-02	2.4E-03	1.3E-02	8.2E-07
End-of-Life	**-4**	**0.5**	**0.0**	**0.5**	**2.9E-04**	**5.8E-05**	**1.8E-05**	**-9.2E-09**
Construction	-2	0.3	0.0	0.3	3.1E-04	4.8E-05	1.9E-05	-4.8E-09
Refurbishment	-1	0.2	0.0	0.2	-1.3E-05	9.5E-06	-1.1E-06	-4.5E-09
Total*	**300**	**20.8**	**-4.2**	**16.6**	**6.5E-02**	**5.1E-03**	**1.5E-02**	**1.1E-06**
Heating & Cooling								
Basement	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	0.9%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	10.9%	10.9%	11.3%	10.8%	10.5%	10.8%	11.2%	9.9%
Roof	9.9%	10.0%	10.3%	9.9%	9.6%	9.9%	10.2%	9.1%
Windows	9.9%	10.0%	10.3%	9.9%	9.6%	9.9%	10.2%	9.1%
Ventilation	38.0%	38.3%	39.5%	37.9%	36.8%	37.8%	39.1%	34.6%
Others	26.2%	26.4%	27.3%	26.2%	25.4%	26.1%	27.0%	23.9%
Cooling Energy	4.2%	3.3%	0.3%	4.2%	7.0%	4.4%	1.2%	12.7%
Construction Phase								
Basement	21.1%	26.6%	4.2%	28.7%	20.3%	25.3%	21.2%	24.9%
Floors/ceilings	19.0%	22.0%	4.9%	23.6%	16.5%	20.3%	17.3%	24.2%
Interior Walls	17.4%	15.1%	41.0%	12.7%	21.0%	22.5%	17.7%	15.2%
Exterior Walls	25.9%	26.4%	13.3%	27.6%	30.5%	22.2%	32.0%	22.6%
Roof	7.2%	3.9%	35.6%	1.0%	3.8%	3.2%	4.9%	6.5%
Windows	8.8%	6.0%	1.0%	6.5%	8.0%	6.5%	6.8%	6.6%

* Total = Construction Phase + Use Phase

Z1_MF_004



Annex C 17 Building type Z1_MF_005

Multi-family house
Concrete wall, reinforced concrete flooring, flat roof

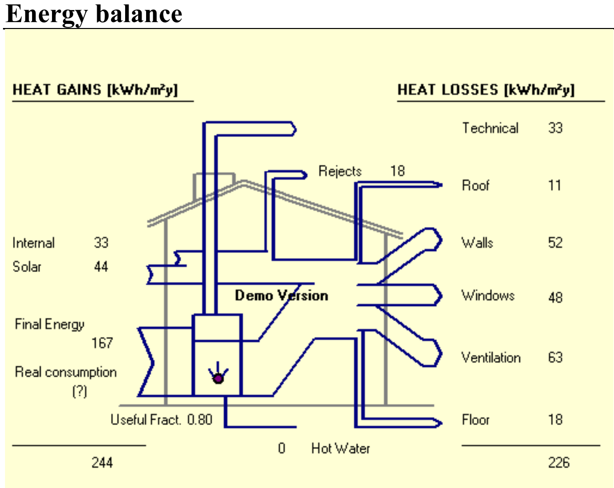
Statistics Proportion of Z1_MF_005 in the EU-25: 1.7%

	France	**Italy**	**Greece**	**Portugal**	**Spain**	**Malta**	**Cyprus**
Number of dwellings [1 000]	590.0	1325.0	275.0	265.0	1045.0		
Number of buildings [1 000]	36.9	82.8	17.2	16.6	65.3		
Stock in Mio. m^2	53	120	23	22	94		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	38.4	41.6	44.8	46.4	46.4		

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	005
Year of construction	Since 1965
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Concrete 20 cm (5 cm insulation)
Interior load-bearing wall	Concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and single-glazing

Energy balance

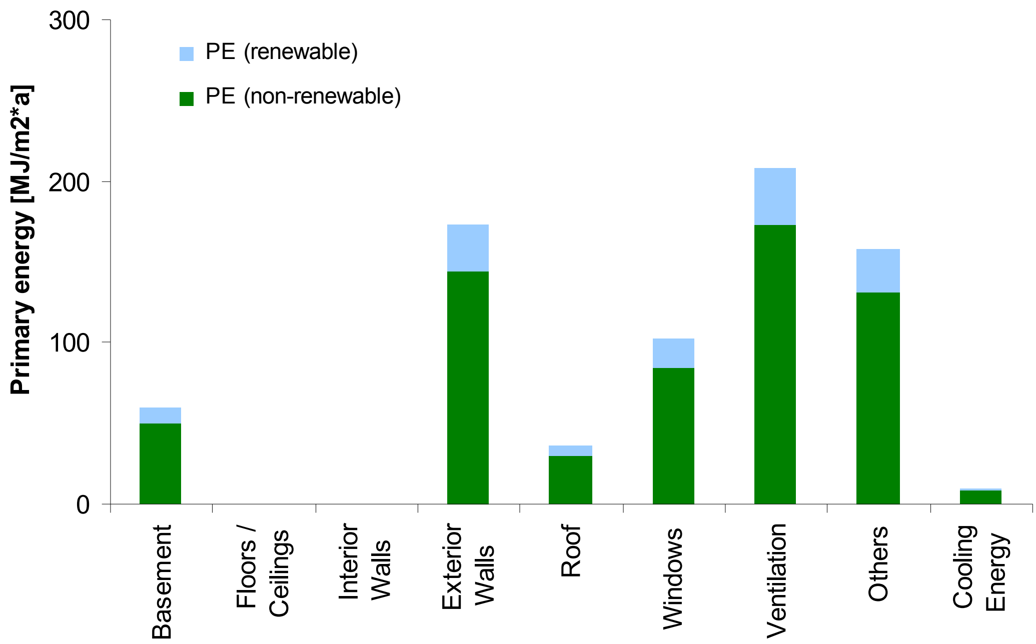


Z1_MF_005

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**748**	**47.3**	**-11.8**	**35.5**	**1.3E-01**	**8.2E-03**	**4.4E-02**	**2.6E-06**
Refurbishment	4	0.2	-0.1	0.1	1.0E-03	9.3E-05	1.6E-04	1.4E-08
Heating & cooling	744	47.0	-11.6	35.4	1.3E-01	8.1E-03	4.4E-02	2.6E-06
End-of-Life	**-1**	**0.5**	**0.0**	**0.5**	**1.1E-03**	**1.4E-04**	**8.2E-05**	**-8.8E-11**
Construction	-1	0.5	0.0	0.5	1.1E-03	1.3E-04	8.4E-05	9.4E-10
Refurbishment	0	0.0	0.0	0.0	-2.6E-05	2.4E-06	-2.0E-06	-1.0E-09
Total*	**748**	**47.3**	**-11.8**	**35.5**	**1.3E-01**	**8.2E-03**	**4.4E-02**	**2.6E-06**
Heating & Cooling								
Basement	8.0%	8.0%	8.1%	8.0%	7.9%	8.0%	8.1%	7.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	23.1%	23.2%	23.4%	23.1%	22.9%	23.1%	23.3%	22.5%
Roof	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.8%
Windows	13.6%	13.6%	13.7%	13.6%	13.4%	13.5%	13.7%	13.2%
Ventilation	28.0%	28.1%	28.3%	28.0%	27.8%	28.0%	28.3%	27.3%
Others	21.2%	21.2%	21.4%	21.2%	21.0%	21.2%	21.4%	20.6%
Cooling Energy	1.2%	0.9%	0.1%	1.2%	2.1%	1.3%	0.3%	3.9%

* Total = Use Phase

Z1_MF_005



Annex C 18 Building type Z1_MF_006_ex

Multi-family house
Brick wall, reinforced concrete flooring, flat roof

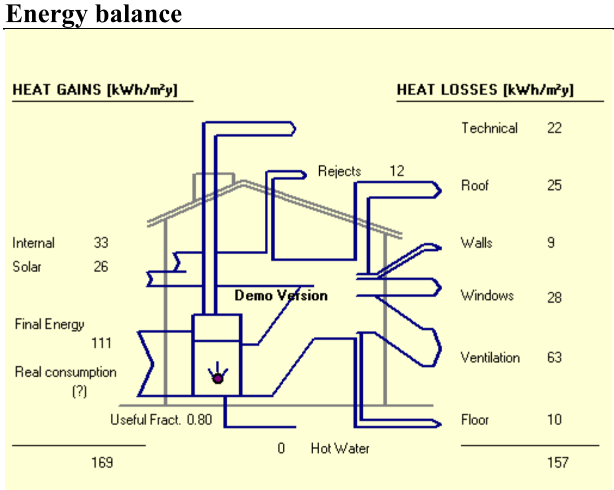
Statistics Proportion of Z1_MF_006_ex in the EU-25: 1.3%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	1180.0	795.0	110.0	106.0	418.0		
Number of buildings [1 000]	73.8	49.7	6.9	6.6	26.1		
Stock in Mio. m^2	106	72	9	9	38		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	38.4	41.6	44.8	46.4	46.4		

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	006_ex
Year of construction	Since 1945
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Brick
Exterior wall	Brick masonry 35 cm
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and single-glazing

Energy balance

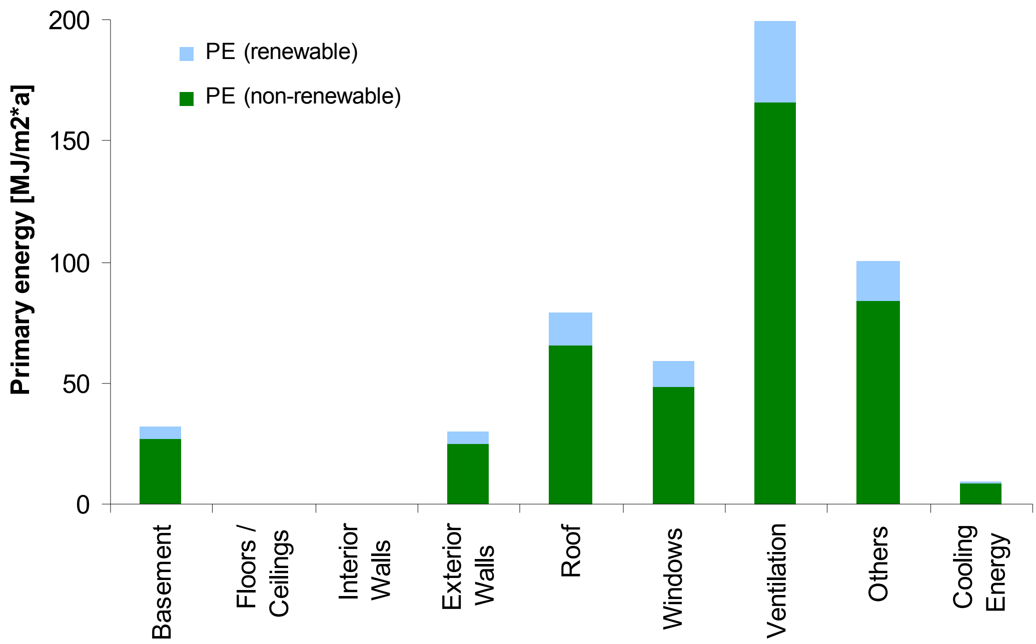


Z1_MF_006_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**509**	**32.1**	**-8.0**	**24.1**	**9.0E-02**	**5.6E-03**	**3.0E-02**	**1.8E-06**
Refurbishment	4	0.2	-0.1	0.1	1.2E-03	9.5E-05	2.2E-04	1.5E-08
Heating & cooling	505	31.9	-7.9	24.0	8.9E-02	5.5E-03	3.0E-02	1.8E-06
End-of-Life	**-1**	**0.5**	**0.0**	**0.5**	**1.3E-03**	**1.5E-04**	**9.8E-05**	**4.2E-10**
Construction	0	0.5	0.0	0.5	1.3E-03	1.5E-04	1.0E-04	1.6E-09
Refurbishment	0	0.0	0.0	0.0	-2.2E-05	2.1E-06	-1.9E-06	-1.2E-09
Total*	**509**	**32.1**	**-8.0**	**24.1**	**9.0E-02**	**5.6E-03**	**3.0E-02**	**1.8E-06**
Heating & Cooling								
Basement	6.3%	6.3%	6.4%	6.3%	6.2%	6.3%	6.3%	6.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	5.6%	5.7%	5.7%	5.6%	5.6%	5.6%	5.7%	5.4%
Roof	15.6%	15.7%	15.9%	15.6%	15.4%	15.6%	15.9%	15.0%
Windows	11.3%	11.4%	11.5%	11.3%	11.2%	11.3%	11.5%	10.9%
Ventilation	39.4%	39.6%	40.1%	39.4%	38.9%	39.4%	39.9%	37.9%
Others	19.9%	20.0%	20.3%	19.9%	19.7%	19.9%	20.2%	19.1%
Cooling Energy	1.8%	1.4%	0.1%	1.8%	3.1%	1.9%	0.5%	5.7%

* Total = Use Phase

Z1_MF_006_ex



Annex C 19 Building type Z1_MF_006

Multi-family house
Brick wall, reinforced
concrete flooring, flat roof

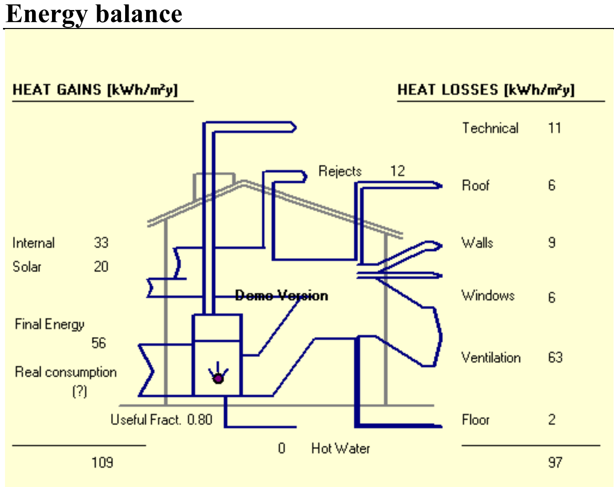

Statistics Proportion of Z1_MF_006 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	51.6	67.4	14.0	6.8	53.8		
Number of buildings [1 000]	3.2	4.2	0.9	0.4	3.3		
Stock in Mio. m^2	5	6	1	1	5		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	38.4	41.6	44.8	46.4	46.4		

Description of the building type **NEW**

Zone	1
Building type	Multi-family house
Number	006
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Flat roof (10 cm insulation)
Roof cladding	Brick
Exterior wall	Brick masonry 35 cm (5 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

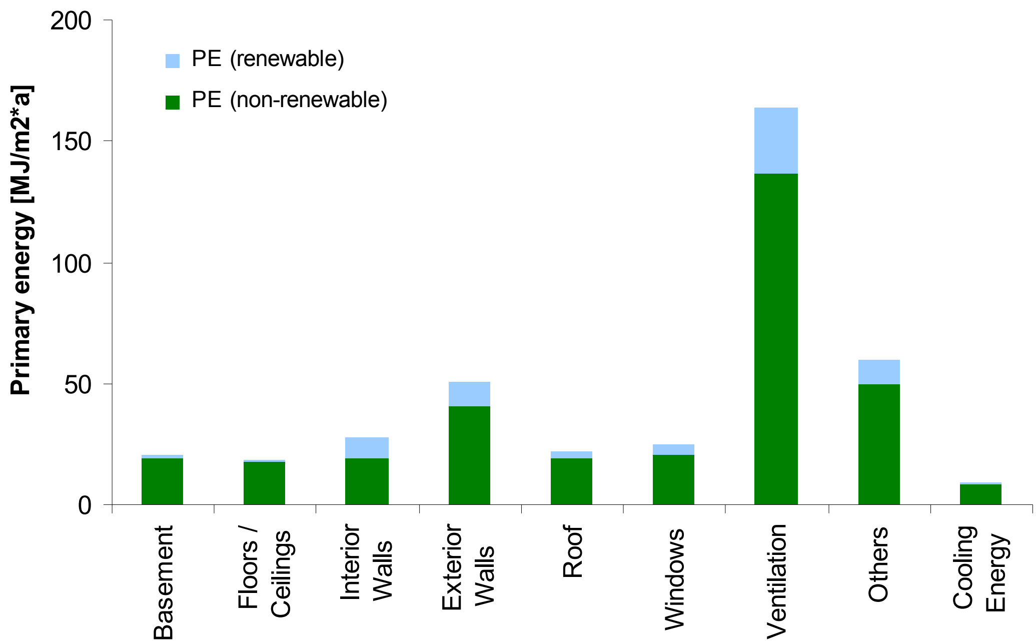


Z1_MF_006

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**93**	**7.7**	**-1.2**	**6.5**	**2.2E-02**	**2.6E-03**	**2.2E-03**	**2.7E-07**
Use Phase	**306**	**19.2**	**-4.8**	**14.4**	**5.5E-02**	**3.5E-03**	**1.8E-02**	**1.1E-06**
Refurbishment	14	0.8	-0.3	0.4	3.1E-03	2.8E-04	4.9E-04	4.7E-08
Heating & cooling	293	18.4	-4.5	13.9	5.2E-02	3.2E-03	1.7E-02	1.1E-06
End-of-Life	**-2**	**0.4**	**0.0**	**0.4**	**6.4E-04**	**8.2E-05**	**4.7E-05**	**-4.0E-09**
Construction	0	0.3	0.0	0.3	6.5E-04	7.4E-05	4.9E-05	3.1E-10
Refurbishment	-2	0.2	0.0	0.2	-9.1E-06	7.7E-06	-1.6E-06	-4.3E-09
Total*	**400**	**26.9**	**-6.1**	**20.8**	**7.7E-02**	**6.1E-03**	**2.0E-02**	**1.4E-06**
Heating & Cooling								
Basement	1.8%	1.8%	1.8%	1.8%	1.7%	1.8%	1.8%	1.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.0%	8.1%	8.2%	8.0%	7.8%	8.0%	8.2%	7.5%
Roof	5.3%	5.4%	5.5%	5.3%	5.2%	5.3%	5.5%	5.0%
Windows	5.3%	5.4%	5.5%	5.3%	5.2%	5.3%	5.5%	5.0%
Ventilation	56.0%	56.4%	57.7%	56.0%	54.8%	55.9%	57.3%	52.2%
Others	20.4%	20.6%	21.1%	20.4%	20.0%	20.4%	20.9%	19.1%
Cooling Energy	3.1%	2.4%	0.2%	3.1%	5.2%	3.3%	0.9%	9.6%
Construction Phase								
Basement	16.0%	21.9%	1.8%	25.7%	21.2%	24.1%	20.4%	21.3%
Floors/ceilings	19.2%	24.1%	2.9%	28.2%	22.9%	25.8%	22.2%	27.6%
Interior Walls	25.0%	19.9%	50.5%	14.0%	19.2%	17.6%	18.6%	20.6%
Exterior Walls	27.3%	22.9%	43.5%	18.9%	22.3%	19.8%	26.1%	17.7%
Roof	5.9%	6.3%	0.7%	7.3%	6.0%	6.6%	6.1%	7.1%
Windows	6.7%	5.0%	0.4%	5.8%	8.3%	6.2%	6.6%	5.7%

* Total = Construction Phase + Use Phase

Z1_MF_006



Annex C 20 Building type Z1_MF_007

Multi-family house
Concrete wall, reinforced concrete flooring, flat roof

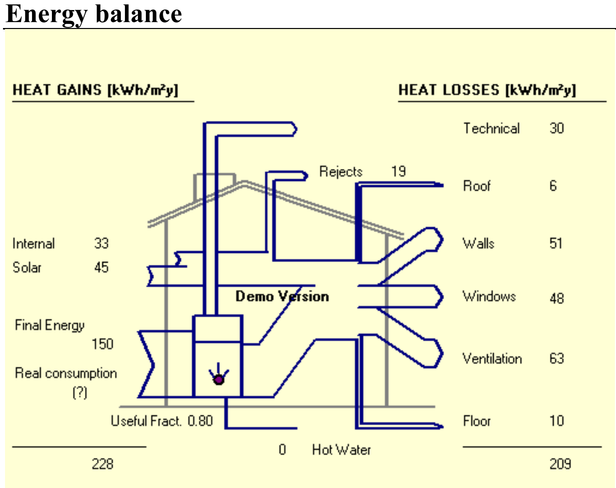
Statistics Proportion of Z1_MF_007 in the EU-25: 0.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	590.0	530.0			418.0		
Number of buildings [1 000]	21.1	18.9			14.9		
Stock in Mio. m^2	53	48			38		
Density in m^2/occupant	37.3	34.7			31.0		
Occupants per building	67.2	72.8			81.2		

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	007
Year of construction	1950-1980
Residual service life	20 a
Dimension	32 m * 12 m
Storey	7
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Concrete 30 cm
Interior load-bearing wall	Concrete 30 cm
Interior wall	Plasterboard 10 cm
Plaster	
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and single-glazing

Energy balance

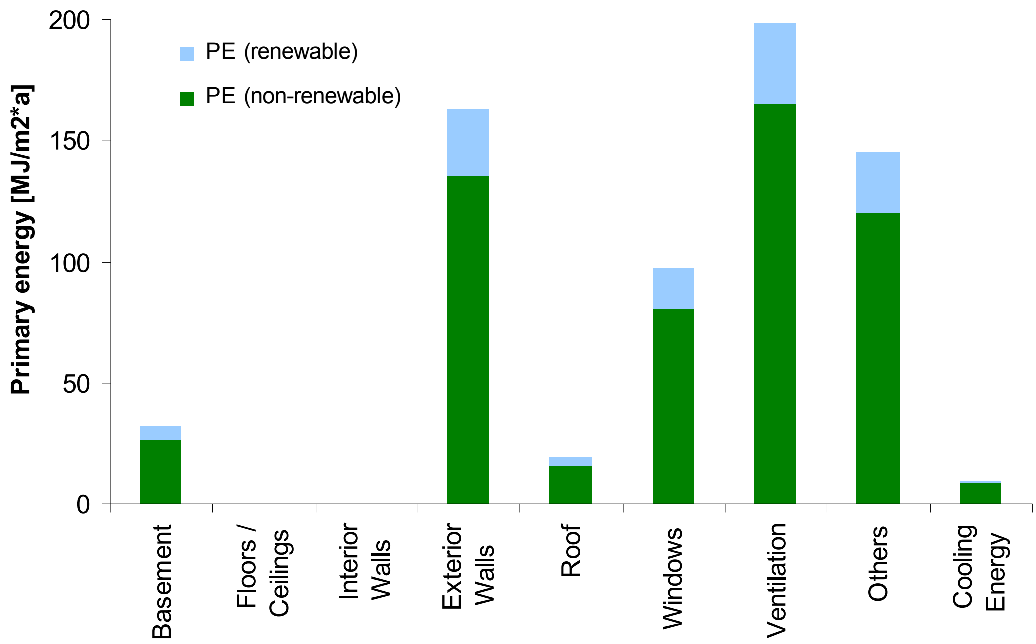


Z1_MF_007

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**663**	**41.9**	**-10.4**	**31.5**	**1.2E-01**	**7.3E-03**	**3.9E-02**	**2.4E-06**
Refurbishment	3	0.2	-0.1	0.1	9.3E-04	8.3E-05	1.4E-04	1.3E-08
Heating & cooling	660	41.7	-10.3	31.4	1.2E-01	7.2E-03	3.9E-02	2.3E-06
End-of-Life	**0**	**0.5**	**0.0**	**0.5**	**1.4E-03**	**1.6E-04**	**1.1E-04**	**1.4E-09**
Construction	0	0.4	0.0	0.4	1.4E-03	1.6E-04	1.1E-04	2.3E-09
Refurbishment	0	0.0	0.0	0.0	-2.3E-05	2.2E-06	-1.8E-06	-9.2E-10
Total*	**663**	**41.9**	**-10.4**	**31.5**	**1.2E-01**	**7.3E-03**	**3.9E-02**	**2.4E-06**
Heating & Cooling								
Basement	4.8%	4.8%	4.8%	4.8%	4.7%	4.8%	4.8%	4.6%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	24.4%	24.4%	24.7%	24.4%	24.1%	24.3%	24.6%	23.6%
Roof	2.9%	2.9%	2.9%	2.9%	2.8%	2.9%	2.9%	2.8%
Windows	14.6%	14.6%	14.8%	14.6%	14.4%	14.5%	14.7%	14.1%
Ventilation	30.1%	30.2%	30.5%	30.1%	29.8%	30.1%	30.4%	29.2%
Others	22.0%	22.0%	22.3%	22.0%	21.8%	22.0%	22.2%	21.3%
Cooling Energy	1.4%	1.1%	0.1%	1.4%	2.3%	1.5%	0.4%	4.4%

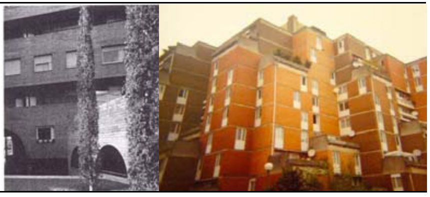
* Total = Use Phase

Z1_MF_007



Annex C 21 Building type Z1_MF_008_ex

Multi-family house
Brick wall, reinforced concrete flooring, flat roof



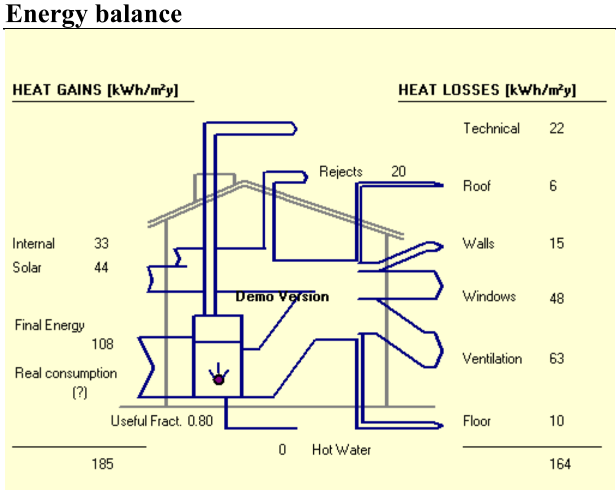
Statistics Proportion of Z1_MF_008_ex in the EU-25: 0.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	590.0	530.0			418.0		
Number of buildings [1 000]	21.1	18.9			14.9		
Stock in Mio. m^2	53	48			38		
Density in m^2/occupant	37.3	34.7			31.0		
Occupants per building	67.2	72.8			81.2		

Description of the building type **EXISTING**

Zone	1
Building type	Multi-family house
Number	008_ex
Year of construction	Since 1970
Residual service life	30 a
Dimension	32 m * 12 m
Storey	7
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 20 cm (5 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and single-glazing

Energy balance



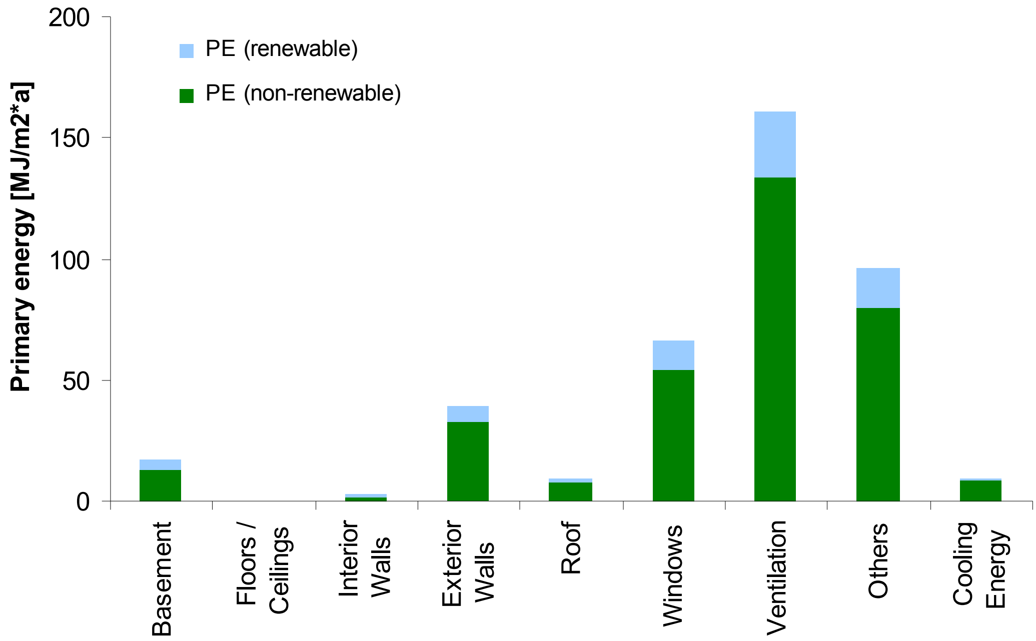
Z1_MF_008_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**414**	**26.0**	**-6.5**	**19.5**	**7.3E-02**	**4.6E-03**	**2.4E-02**	**1.5E-06**
Refurbishment	9	0.5	-0.2	0.3	2.3E-03	2.3E-04	2.8E-04	3.4E-08
Heating & cooling	404	25.5	-6.3	19.2	7.1E-02	4.4E-03	2.4E-02	1.5E-06
End-of-Life	**-31**	**0.1**	**0.0**	**0.1**	**-4.0E-05**	**4.5E-06**	**-3.4E-06**	**-2.8E-09**
Construction	-30	0.0	0.0	0.0	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Refurbishment	-1	0.1	0.0	0.1	-4.0E-05	4.5E-06	-3.4E-06	-2.8E-09
Total*	**414**	**26.0**	**-6.5**	**19.5**	**7.3E-02**	**4.6E-03**	**2.4E-02**	**1.5E-06**

Heating & Cooling								
Basement	6.3%	6.3%	6.4%	6.3%	6.2%	6.3%	6.4%	6.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	9.5%	9.5%	9.7%	9.5%	9.3%	9.4%	9.6%	9.0%
Roof	2.9%	3.0%	3.0%	2.9%	2.9%	2.9%	3.0%	2.8%
Windows	15.5%	15.6%	15.9%	15.5%	15.3%	15.5%	15.8%	14.8%
Ventilation	39.7%	39.9%	40.6%	39.7%	39.1%	39.7%	40.4%	37.8%
Others	23.8%	23.9%	24.3%	23.8%	23.4%	23.7%	24.2%	22.6%
Cooling Energy	2.3%	1.7%	0.1%	2.2%	3.8%	2.4%	0.6%	7.1%

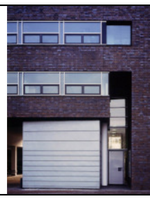
* Total = Use Phase

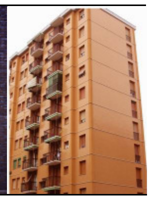
Z1_MF_008_ex



Annex C 22 Building type Z1_MF_008

Multi-family house
Brick wall, reinforced
concrete flooring, flat roof





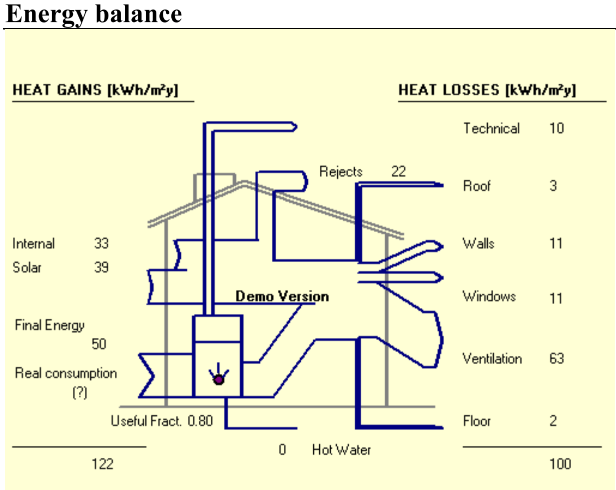
Statistics Proportion of Z1_MF_008 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	51.6	67.4	14.0	6.8	53.8		
Number of buildings [1 000]	1.8	2.4	0.5	0.2	1.9		
Stock in Mio. m^2	5	6	1	1	5		
Density in m^2/occupant	37.3	34.7	29.5	28.6	31.0		
Occupants per building	67.2	72.8	78.4	81.2	81.2		

Description of the building type **NEW**

Zone	1
Building type	Multi-family house
Number	008_ex
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	7
Floor to floor height	3 m
Roof	Flat roof (10 cm insulation)
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 20 cm (10 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

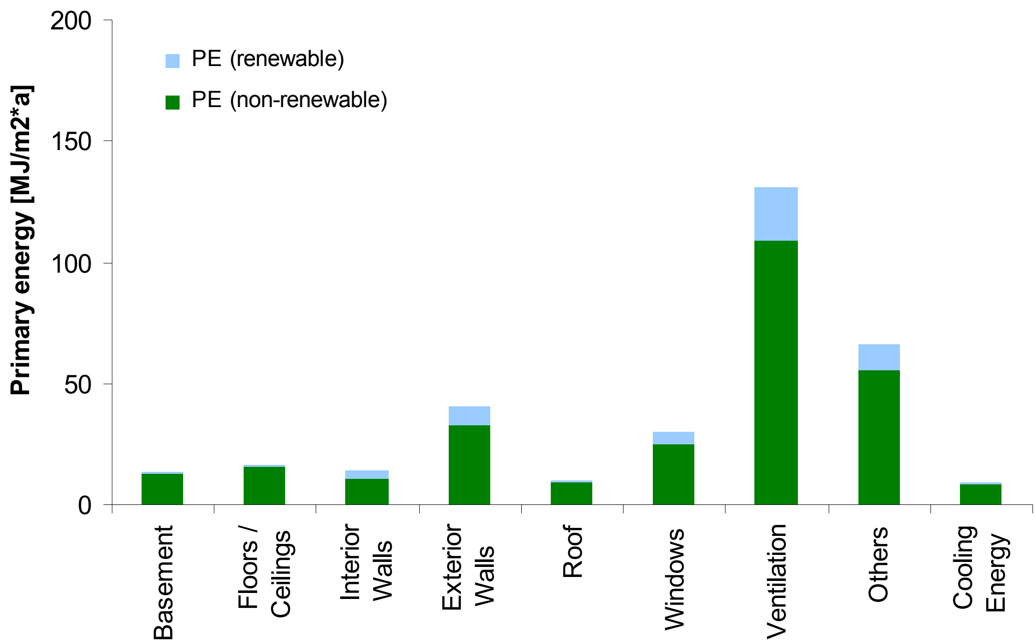


Z1_MF_008

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**59**	**5.2**	**-0.6**	**4.7**	**1.7E-02**	**2.0E-03**	**1.6E-03**	**1.8E-07**
Use Phase	**274**	**17.2**	**-4.2**	**12.9**	**5.0E-02**	**3.2E-03**	**1.6E-02**	**1.0E-06**
Refurbishment	11	0.7	-0.2	0.5	3.1E-03	2.9E-04	4.3E-04	3.6E-08
Heating & cooling	262	16.5	-4.0	12.5	4.7E-02	2.9E-03	1.5E-02	9.8E-07
End-of-Life	**-2**	**0.3**	**0.0**	**0.3**	**4.6E-04**	**6.0E-05**	**3.3E-05**	**-3.4E-09**
Construction	-1	0.2	0.0	0.2	4.6E-04	5.4E-05	3.3E-05	-1.0E-11
Refurbishment	-1	0.1	0.0	0.1	5.4E-06	6.4E-06	-1.2E-07	-3.4E-09
Total*	**332**	**22.4**	**-4.8**	**17.6**	**6.7E-02**	**5.2E-03**	**1.7E-02**	**1.2E-06**
Heating & Cooling								
Basement	1.6%	1.6%	1.6%	1.6%	1.5%	1.6%	1.6%	1.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.7%	8.8%	9.0%	8.7%	8.5%	8.7%	8.9%	8.1%
Roof	2.4%	2.4%	2.5%	2.4%	2.3%	2.4%	2.4%	2.2%
Windows	8.7%	8.8%	9.0%	8.7%	8.5%	8.7%	8.9%	8.1%
Ventilation	49.9%	50.3%	51.5%	49.8%	48.6%	49.8%	51.1%	46.1%
Others	25.3%	25.5%	26.2%	25.3%	24.7%	25.3%	26.0%	23.4%
Cooling Energy	3.5%	2.7%	0.2%	3.5%	5.8%	3.7%	1.0%	10.6%
Construction Phase								
Basement	15.3%	20.0%	2.3%	22.2%	16.8%	19.0%	17.0%	18.7%
Floors/ceilings	25.8%	30.3%	5.3%	33.4%	24.9%	27.7%	25.6%	34.7%
Interior Walls	19.5%	17.7%	34.8%	15.6%	27.2%	26.4%	22.4%	17.7%
Exterior Walls	24.4%	20.1%	55.8%	15.7%	17.2%	15.0%	22.2%	15.4%
Roof	5.3%	5.3%	0.9%	5.8%	4.4%	4.7%	4.7%	5.9%
Windows	9.5%	6.6%	0.9%	7.3%	9.6%	7.1%	8.0%	7.5%

* Total = Construction Phase + Use Phase

Z1_MF_008



Annex C 23 Building type Z1_HR_001_ex

High-rise building
Brick wall, reinforced
concrete flooring, flat roof

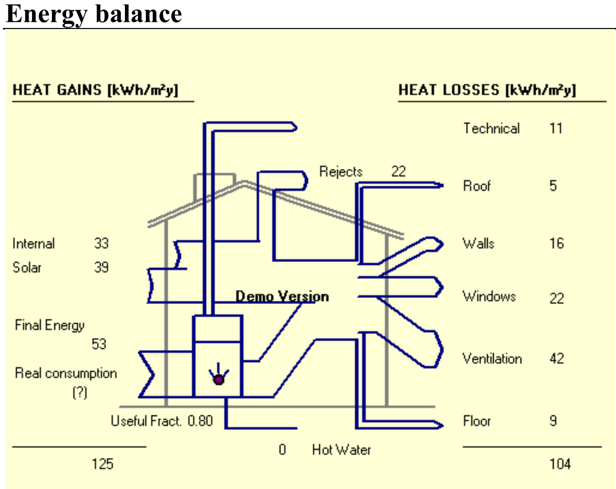
Statistics Proportion of Z1_HR_001_ex in the EU-25: 2.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	1180.0	1060.0		371.0	3135.0		
Number of buildings [1 000]	23.6	21.2		7.4	62.7		
Stock in Mio. m^2	106	96		31	282		
Density in m^2/occupant	37.3	34.7		28.6	31.0		
Occupants per building	120	130		145	145		

Description of the building type **EXISTING**

Zone	1
Building type	High-rise building
Number	001_ex
Year of construction	Since 1975
Residual service life	30 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 35 cm
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

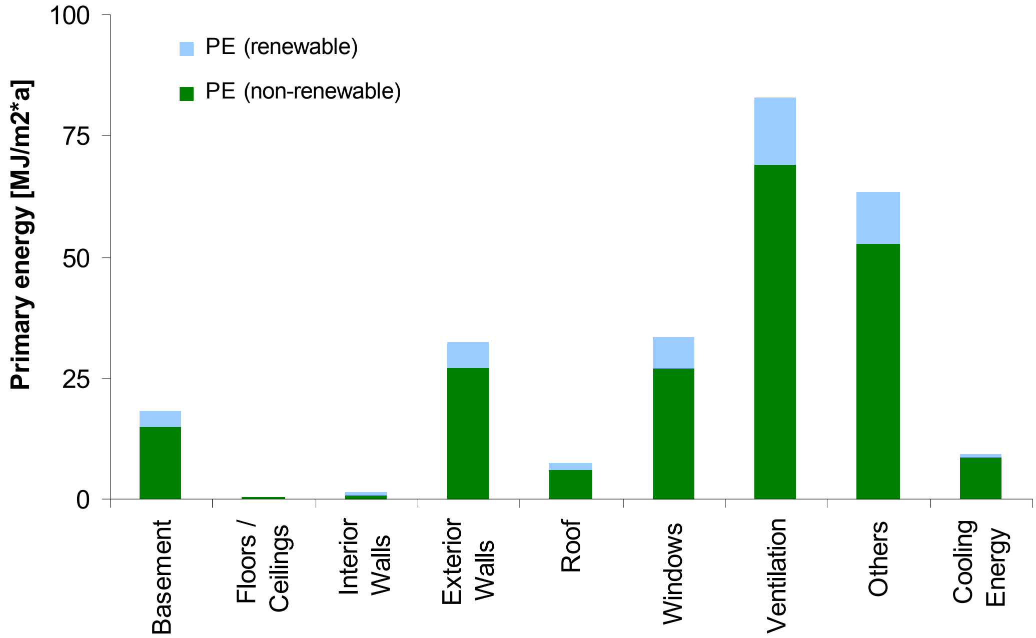


Z1_HR_001_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**250**	**15.6**	**-3.9**	**11.7**	**4.5E-02**	**2.8E-03**	**1.4E-02**	**9.3E-07**
Refurbishment	7	0.4	-0.2	0.2	1.6E-03	1.5E-04	2.2E-04	2.6E-08
Heating & cooling	243	15.3	-3.7	11.5	4.3E-02	2.7E-03	1.4E-02	9.1E-07
End-of-Life	**-1**	**0.3**	**0.0**	**0.3**	**4.4E-04**	**6.0E-05**	**3.0E-05**	**-1.2E-09**
Construction	0	0.2	0.0	0.2	4.9E-04	5.7E-05	3.3E-05	1.1E-09
Refurbishment	-1	0.1	0.0	0.1	-4.6E-05	3.0E-06	-3.9E-06	-2.3E-09
Total*	**250**	**15.6**	**-3.9**	**11.7**	**4.5E-02**	**2.8E-03**	**1.4E-02**	**9.3E-07**
Heating & Cooling								
Basement	7.3%	7.4%	7.6%	7.3%	7.1%	7.3%	7.5%	6.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	13.0%	13.2%	13.5%	13.0%	12.7%	13.0%	13.4%	12.0%
Roof	3.0%	3.0%	3.1%	3.0%	2.9%	3.0%	3.1%	2.7%
Windows	12.5%	12.7%	13.0%	12.5%	12.2%	12.5%	12.9%	11.5%
Ventilation	34.2%	34.5%	35.5%	34.2%	33.3%	34.1%	35.2%	31.5%
Others	26.1%	26.3%	27.1%	26.1%	25.4%	26.1%	26.8%	24.0%
Cooling Energy	3.8%	2.9%	0.2%	3.7%	6.3%	4.0%	1.1%	11.4%

* Total = Use Phase

Z1_HR_001_ex



Annex C 24 Building type Z1_HR_001

High-rise building
Brick wall, reinforced
concrete flooring, flat roof

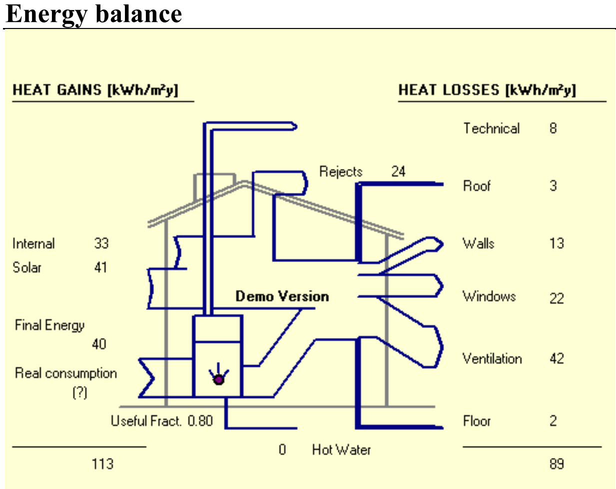
Statistics Proportion of Z1_HR_001 in the EU-25: 0.1%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	56.7	61.6		19.4	106.2		
Number of buildings [1 000]	1.1	1.2		0.4	2.1		
Stock in Mio. m^2	5	6		2	10		
Density in m^2/occupant	37.3	34.7		28.6	31.0		
Occupants per building	120	130		145	145		

Description of the building type **NEW**

Zone	1
Building type	High-rise building
Number	001
Year of construction	Since 2006
Residual service life	40 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof (10 cm insulation)
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 35 cm (10 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (10 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance



Z1_HR_001

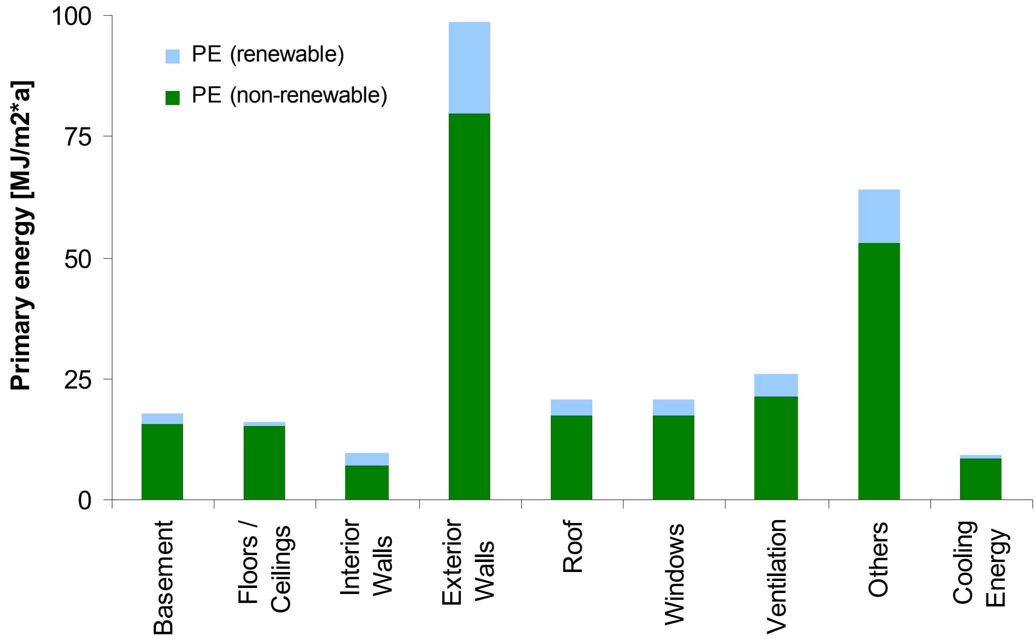
	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**53**	**4.6**	**-0.6**	**3.9**	**1.4E-02**	**1.7E-03**	**1.3E-03**	**1.6E-07**
Use Phase	**230**	**14.4**	**-3.6**	**10.8**	**4.1E-02**	**2.6E-03**	**1.3E-02**	**8.5E-07**
Refurbishment	13	0.8	-0.3	0.5	2.6E-03	2.7E-04	2.9E-04	3.6E-08
Heating & cooling	217	13.6	-3.3	10.3	3.9E-02	2.4E-03	1.3E-02	8.2E-07
End-of-Life	**-1**	**0.2**	**0.0**	**0.2**	**4.4E-04**	**5.7E-05**	**3.2E-05**	**-1.3E-09**
Construction	0	0.1	0.0	0.1	3.7E-04	4.4E-05	2.6E-05	7.3E-10
Refurbishment	-1	0.1	0.0	0.1	6.4E-05	1.3E-05	6.1E-06	-2.0E-09
Total*	**283**	**19.0**	**-4.2**	**14.7**	**5.6E-02**	**4.3E-03**	**1.4E-02**	**1.0E-06**

Heating & Cooling								
Basement	5.7%	5.7%	5.9%	5.7%	5.5%	5.7%	5.8%	5.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	34.0%	34.3%	35.4%	34.0%	33.0%	33.9%	35.1%	31.0%
Roof	8.5%	8.6%	8.9%	8.5%	8.3%	8.5%	8.8%	7.8%
Windows	6.2%	6.3%	6.5%	6.2%	6.1%	6.2%	6.4%	5.7%
Ventilation	11.9%	12.0%	12.4%	11.9%	11.6%	11.9%	12.3%	10.9%
Others	29.5%	29.8%	30.7%	29.5%	28.6%	29.4%	30.4%	26.9%
Cooling Energy	4.2%	3.3%	0.3%	4.2%	7.0%	4.4%	1.2%	12.7%

Construction Phase								
Basement	10.0%	13.9%	1.2%	15.8%	12.4%	14.2%	12.7%	12.6%
Floors/ceilings	28.5%	34.8%	5.0%	39.4%	30.3%	33.9%	31.9%	40.0%
Interior Walls	12.8%	11.5%	22.2%	9.9%	18.4%	17.8%	15.7%	12.9%
Exterior Walls	34.5%	28.4%	70.2%	21.9%	24.0%	21.8%	26.1%	21.4%
Roof	3.9%	4.0%	0.6%	4.6%	3.5%	3.8%	3.9%	4.6%
Windows	10.3%	7.4%	0.8%	8.5%	11.4%	8.5%	9.8%	8.5%

* Total = Construction Phase + Use Phase

Z1_HR_001



Annex C 25 Building type Z1_HR_002

High-rise building
Concrete wall, reinforced concrete flooring, flat roof

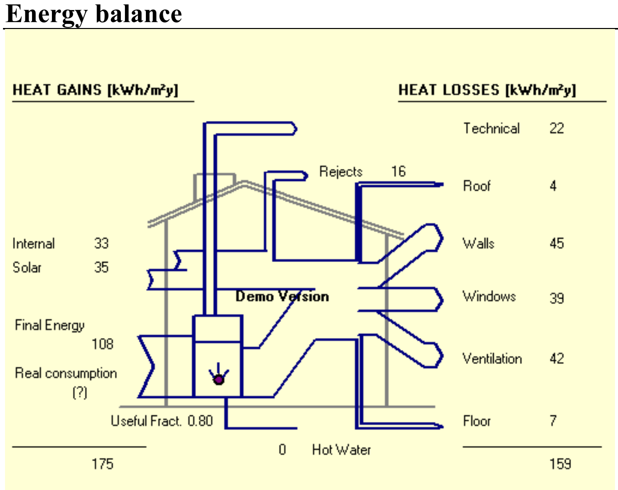
Statistics Proportion of Z1_HR_002 in the EU-25: 2.8%

	France	Italy	Greece	Portugal	Spain	Malta	Cyprus
Number of dwellings [1 000]	1770.0	2120.0	0	371.0	1463.0		
Number of buildings [1 000]	35.4	42.4	0	7.4	29.3		
Stock in Mio. m^2	159	191	0	31	132		
Density in m^2/occupant	37.3	34.7	0	28.6	31.0		
Occupants per building	120	130	0	145	145		

Description of the building type **EXISTING**

Zone	1
Building type	High-rise building
Number	002
Year of construction	1970
Residual service life	20 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Concrete 30 cm
Interior load-bearing wall	Concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and single-glazing

Energy balance

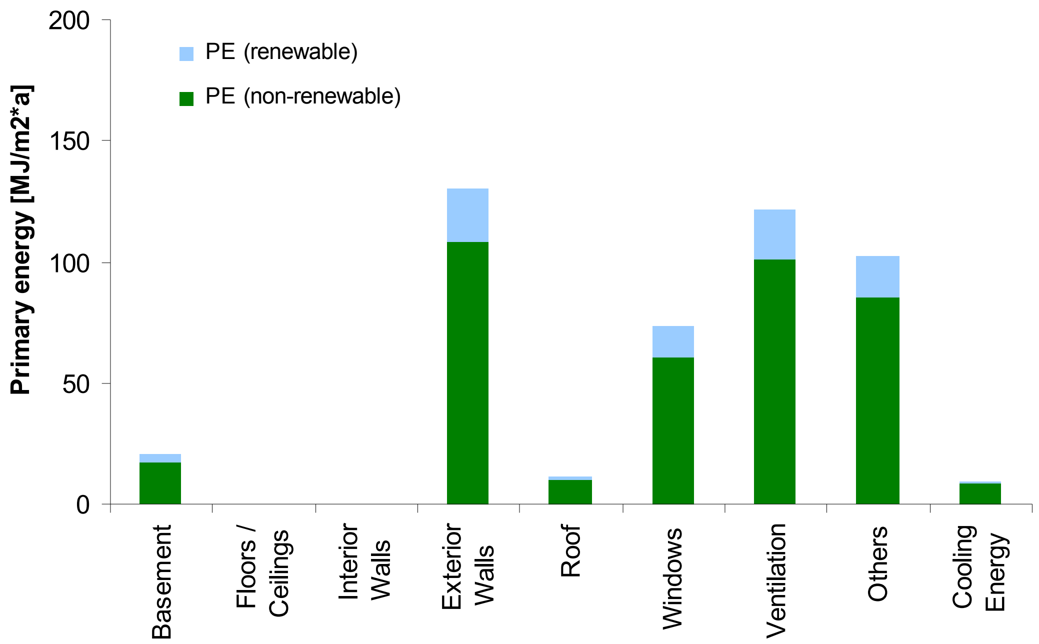


Z1_HR_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**469**	**29.6**	**-7.3**	**22.3**	**8.3E-02**	**5.1E-03**	**2.8E-02**	**1.7E-06**
Refurbishment	2	0.1	-0.1	0.1	5.2E-04	4.7E-05	8.0E-05	7.3E-09
Heating & cooling	468	29.5	-7.3	22.2	8.2E-02	5.1E-03	2.8E-02	1.7E-06
End-of-Life	**0**	**0.1**	**0.0**	**0.1**	**2.7E-04**	**3.2E-05**	**1.5E-05**	**1.7E-09**
Construction	0	0.1	0.0	0.1	2.9E-04	3.0E-05	1.6E-05	2.2E-09
Refurbishment	0	0.0	0.0	0.0	-1.3E-05	1.2E-06	-1.0E-06	-5.2E-10
Total*	**469**	**29.6**	**-7.3**	**22.3**	**8.3E-02**	**5.1E-03**	**2.8E-02**	**1.7E-06**
Heating & Cooling								
Basement	4.3%	4.4%	4.4%	4.3%	4.3%	4.3%	4.4%	4.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	27.8%	28.0%	28.4%	27.8%	27.5%	27.8%	28.2%	26.6%
Roof	2.5%	2.5%	2.5%	2.5%	2.4%	2.5%	2.5%	2.4%
Windows	15.4%	15.5%	15.7%	15.4%	15.2%	15.4%	15.7%	14.8%
Ventilation	26.0%	26.1%	26.5%	26.0%	25.6%	25.9%	26.3%	24.9%
Others	22.0%	22.1%	22.4%	22.0%	21.7%	22.0%	22.3%	21.0%
Cooling Energy	1.9%	1.5%	0.1%	2.0%	3.3%	2.1%	0.6%	6.2%

* Total = Use Phase

Z1_HR_002



Annex C 26 Building type Z2_SI_001

Single-family house
Brick masonry, wooden flooring, pitched roof

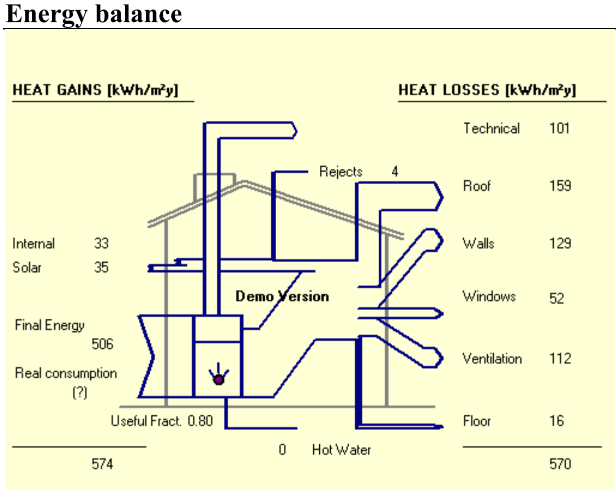
Statistics Proportion of Z2_SI_001 in the EU-25: 5.5%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	960.0	3890.0	160.0	340.0	260.0	320.00	3840.0	264.0	590.0	57.0	40.0	220.0	410.0
Number of buildings [1 000]	640.0	2593.3	106.7	226.7	173.3	213.3	2560.0	176.0	393.3	38.0	26.7	146.7	273.3
Stock in Mio. m^2	83	349	2	33	28	33	334	25	40	3	3	17	31
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	001
Year of construction	Until 1945
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Solid brick
Window	Wooden frame and single-glazing

Energy balance

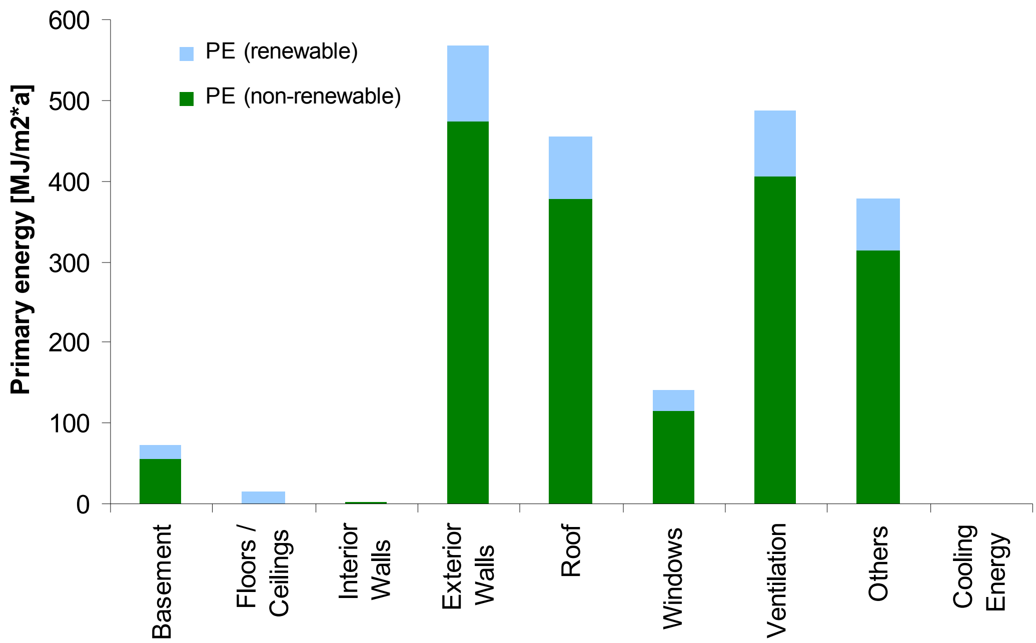


Z2_SI_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 138**	**134.6**	**-35.2**	**99.4**	**3.7E-01**	**2.4E-02**	**1.3E-01**	**7.3E-06**
Refurbishment	56	2.6	-2.3	0.4	9.6E-03	8.7E-04	1.7E-03	1.7E-07
Heating & cooling	2 082	132.0	-33.0	99.0	3.6E-01	2.3E-02	1.2E-01	7.2E-06
End-of-Life	**-36**	**4.1**	**0.0**	**4.1**	**3.7E-04**	**2.9E-04**	**5.0E-05**	**-1.1E-07**
Construction	-20	2.7	0.0	2.7	1.5E-03	3.2E-04	1.5E-04	-6.4E-08
Refurbishment	-16	1.4	0.0	1.4	-1.2E-03	-3.1E-05	-1.0E-04	-4.7E-08
Total*	**2 138**	**134.6**	**-35.2**	**99.4**	**3.7E-01**	**2.4E-02**	**1.3E-01**	**7.3E-06**
Heating & Cooling								
Basement	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%	26.9%
Roof	21.8%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%	21.7%
Windows	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
Ventilation	23.4%	23.4%	23.4%	23.4%	23.4%	23.4%	23.4%	23.4%
Others	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_SI_001



Annex C 27 Building type Z2_SI_002

Single-family house
Rubble stone masonry, wooden flooring, pitched roof

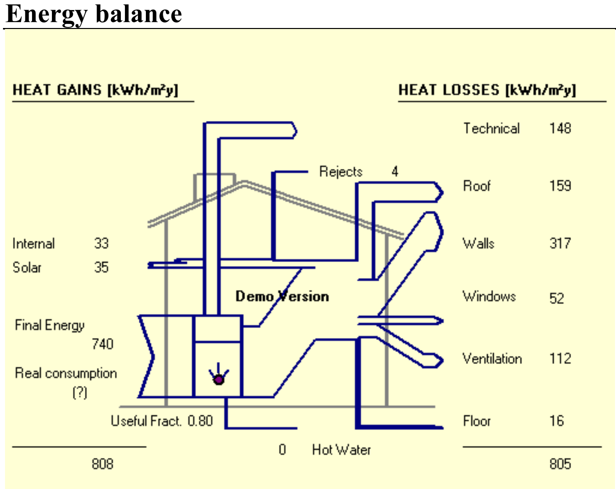
Statistics Proportion of Z2_SI_002 in the EU-25: 3.1%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	240.0	1945.0	10.0	136.0	130.0	160.0	2560.0	990.	590.0	57.0	40.0	220.0	205.0
Number of buildings [1 000]	160.0	1296.7	6.7	90.7	86.7	106.7	1706.7	660.0	393.3	38.0	26.7	146.7	136.7
Stock in Mio. m^2	21	174	1	13	14	17	222	9	40	3	3	17	15
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	002
Year of construction	Until 1900
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Rubble stone 50 cm
Interior load-bearing wall	Rubble stone 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Limestone/fieldstone 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Rubble stone
Window	Wooden frame and single-glazing

Energy balance

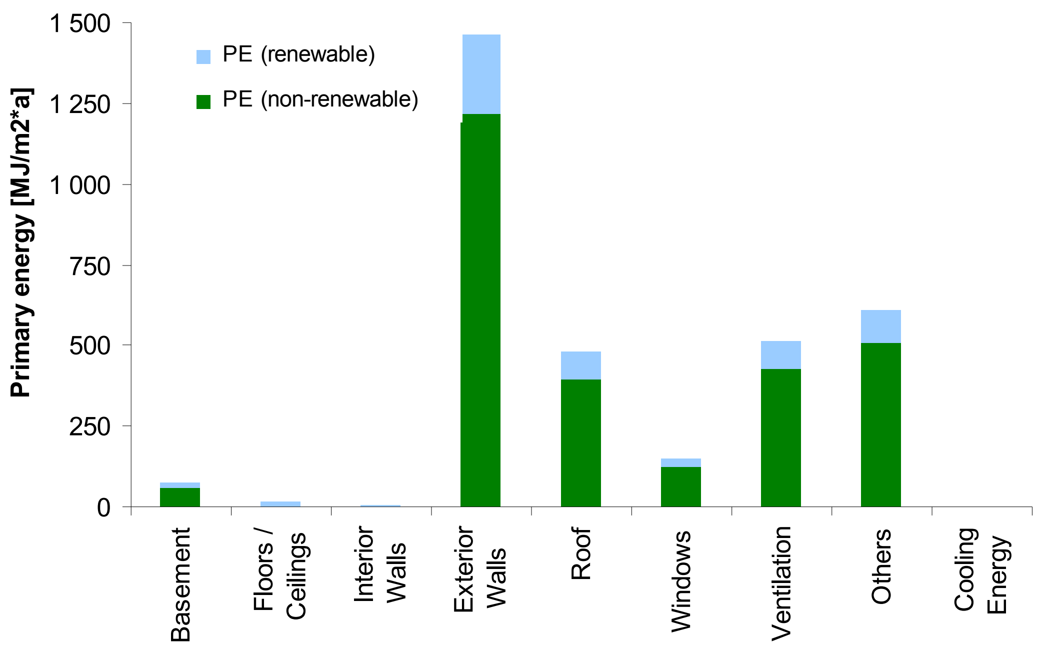


Z2_SI_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**3 327**	**210.0**	**-54.1**	**155.9**	**5.8E-01**	**3.7E-02**	**2.0E-01**	**1.1E-05**
Refurbishment	57	2.7	-2.3	0.4	9.9E-03	8.9E-04	1.7E-03	1.7E-07
Heating & cooling	3 270	207.3	-51.8	155.5	5.7E-01	3.6E-02	2.0E-01	1.1E-05
End-of-Life	**-38**	**4.2**	**0.0**	**4.2**	**1.3E-05**	**2.6E-04**	**1.7E-05**	**-1.1E-07**
Construction	-21	2.7	0.0	2.7	1.2E-03	2.9E-04	1.2E-04	-6.7E-08
Refurbishment	-17	1.4	0.0	1.4	-1.2E-03	-3.1E-05	-1.1E-04	-4.8E-08
Total*	**3 327**	**210.0**	**-54.1**	**155.9**	**5.8E-01**	**3.7E-02**	**2.0E-01**	**1.1E-05**
Heating & Cooling								
Basement	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	44.4%	44.4%	44.4%	44.4%	44.4%	44.4%	44.4%	44.4%
Roof	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%	14.6%
Windows	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%
Ventilation	15.7%	15.7%	15.7%	15.7%	15.7%	15.7%	15.7%	15.7%
Others	18.7%	18.7%	18.7%	18.7%	18.7%	18.7%	18.7%	18.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z2_SI_002



Annex C 28 Building type Z2_SI_003

Single-family house
Wooden frame with stone filler, wooden flooring, pitched roof

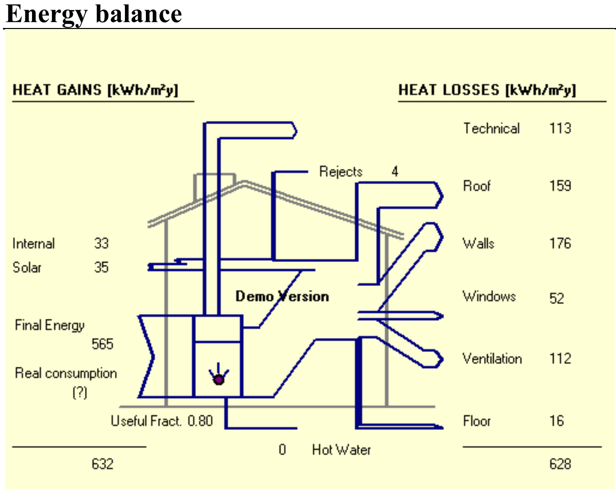
Statistics Proportion of Z2_SI_003 in the EU-25: 1.3%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	96.0	1167.0	4.0	136.0	52.0	48.0	768.0	99.0	236.0	38.0	16.0		82.0
Number of buildings [1 000]	64.0	778.0	2.7	90.7	34.7	32.0	512.0	66.0	157.3	25.3	10.7		54.7
Stock in Mio. m^2	8	105	1	13	6	5	67	9	16	2	1		6
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0		30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	0.0	4.0

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	003
Year of construction	Until 1900
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 50°
Roof cladding	Brick
Exterior wall	Wooden frame 16 cm, stone filler 16 cm
Interior load-bearing wall	Wooden frame 16 cm, stone filler 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Wooden construction and stoneboard
Foundation	Natural stone
Window	Wooden frame and single-glazing

Energy balance

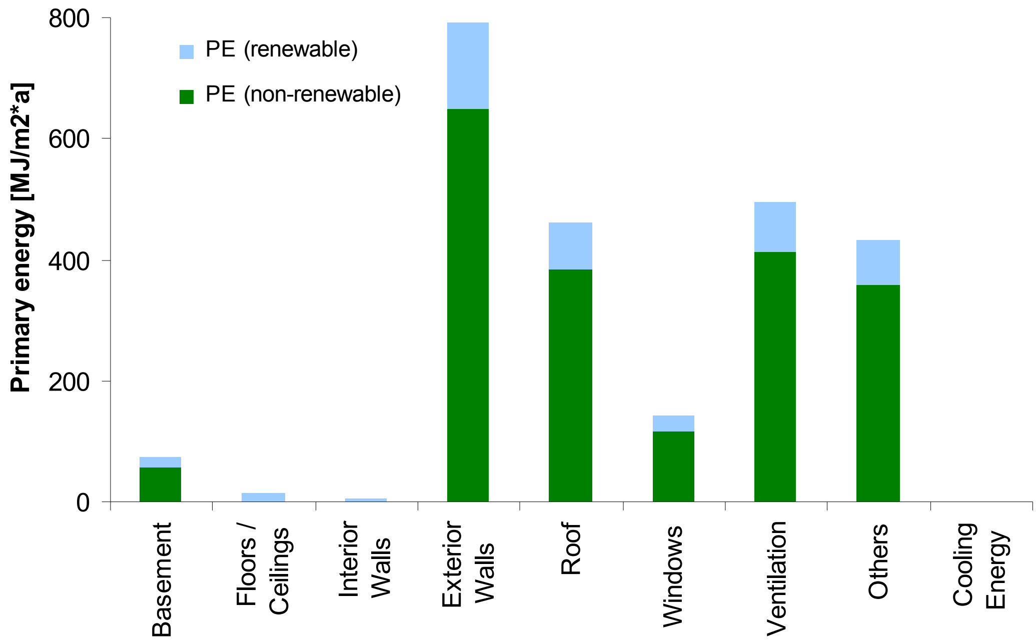


Z2_SI_003

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 465**	**154.8**	**-41.4**	**113.3**	**4.3E-01**	**2.7E-02**	**1.4E-01**	**8.4E-06**
Refurbishment	89	4.1	-3.8	0.3	1.4E-02	1.3E-03	2.2E-03	2.6E-07
Heating & cooling	2 377	150.7	-37.6	113.0	4.1E-01	2.6E-02	1.4E-01	8.2E-06
End-of-Life	**-59**	**5.5**	**0.0**	**5.5**	**-2.8E-03**	**6.2E-05**	**-2.4E-04**	**-1.7E-07**
Construction	-33	3.3	0.0	3.3	-9.4E-04	1.1E-04	-7.3E-05	-9.8E-08
Refurbishment	-26	2.2	0.0	2.2	-1.9E-03	-5.1E-05	-1.7E-04	-7.4E-08
Total*	**2 465**	**154.8**	**-41.4**	**113.3**	**4.3E-01**	**2.7E-02**	**1.4E-01**	**8.4E-06**
Heating & Cooling								
Basement	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	32.8%	32.8%	32.8%	32.7%	32.8%	32.8%	32.8%	32.8%
Roof	19.4%	19.4%	19.4%	19.3%	19.4%	19.4%	19.4%	19.4%
Windows	5.8%	5.8%	5.8%	5.7%	5.8%	5.8%	5.8%	5.8%
Ventilation	20.9%	20.9%	20.9%	20.8%	20.9%	20.9%	20.9%	20.8%
Others	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z2_SI_003



Annex C 29 Building type Z2_SI_004

Single-family house
Brick masonry, hollow
brick flooring, pitched roof

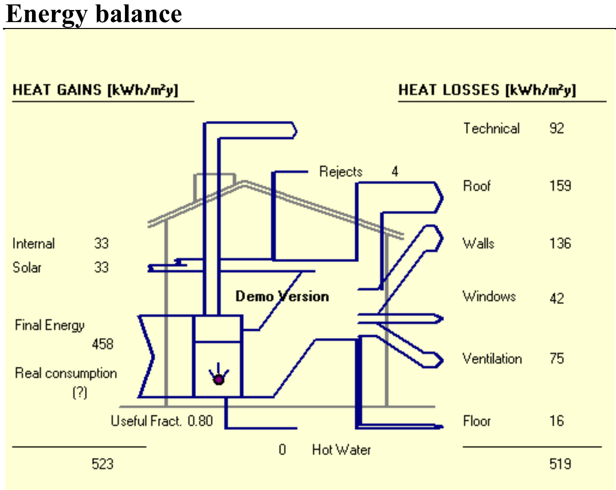
Statistics Proportion of Z2_SI_004 in the EU-25: 0.7%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]								165.0		190.0	160.0	220.0	615.0
Number of buildings [1 000]								110.0		126.7	106.7	146.7	410.0
Stock in Mio. m^2								15		11	12	17	46
Density in m^2/occupant								39.1		21.6	30	30.5	30
Occupants per building								3.6		3.9	3.8	3.8	4.0

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	004
Year of construction	1945-1970
Residual service life	30 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Brick masonry 30 cm
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Hollow brick flooring
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Wooden frame and double-glazing

Energy balance



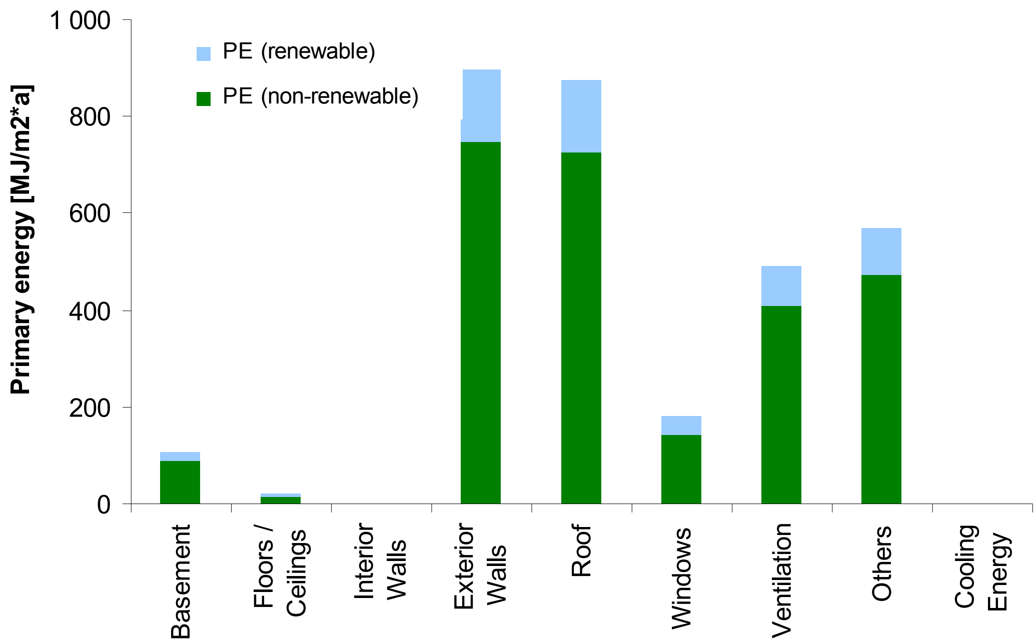
Z2_SI_004

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**3 176**	**201.5**	**-50.6**	**150.9**	**5.5E-01**	**3.5E-02**	**1.9E-01**	**1.1E-05**
Refurbishment	39	2.6	-0.9	1.7	9.7E-03	8.6E-04	1.7E-03	1.1E-07
Heating & cooling	3 136	198.8	-49.7	149.1	5.4E-01	3.4E-02	1.9E-01	1.1E-05
End-of-Life	**-32**	**2.0**	**0.0**	**2.0**	**3.3E-03**	**4.5E-04**	**3.1E-04**	**-3.1E-08**
Construction	-30	1.7	0.0	1.7	3.2E-03	4.2E-04	3.0E-04	-2.4E-08
Refurbishment	-2	0.3	0.0	0.3	1.5E-04	3.2E-05	1.3E-05	-7.0E-09
Total*	**3 176**	**201.5**	**-50.6**	**150.9**	**5.5E-01**	**3.5E-02**	**1.9E-01**	**1.1E-05**

Heating & Cooling								
Basement	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%	28.4%
Roof	28.1%	28.1%	28.1%	28.1%	28.1%	28.1%	28.1%	28.1%
Windows	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%
Ventilation	15.7%	15.7%	15.7%	15.7%	15.7%	15.7%	15.7%	15.7%
Others	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_SI_004



Annex C 30 Building type Z2_SI_005

Single-family house
Brick wall, reinforced concrete flooring, pitched roof

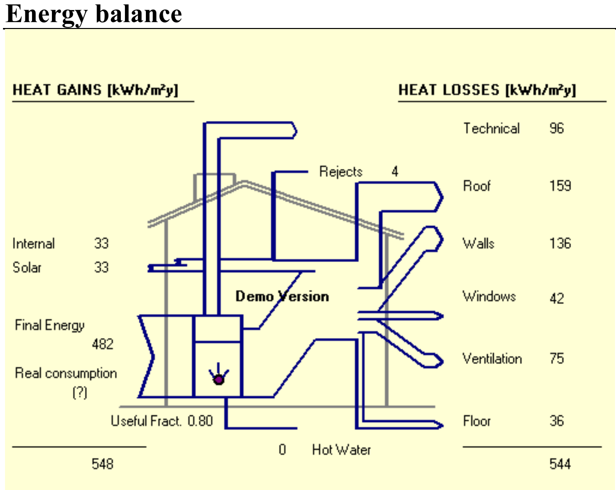
Statistics Proportion of Z2_SI_005 in the EU-25: 7.2%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	480.0	389.00	20.0	1224.0	390.0	320.0	5120.0	330.0	1770.0	380.0	80.0	440.0	205.0
Number of buildings [1 000]	320.0	2593.3	13.3	816.0	260.0	213.3	3413.3	220.0	1180.0	253.3	53.3	293.3	136.7
Stock in Mio. m^2	41	349	3	120	43	33	445	31	121	21	6	34	15
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	005
Year of construction	1945-1980
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Brick masonry 35 cm
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

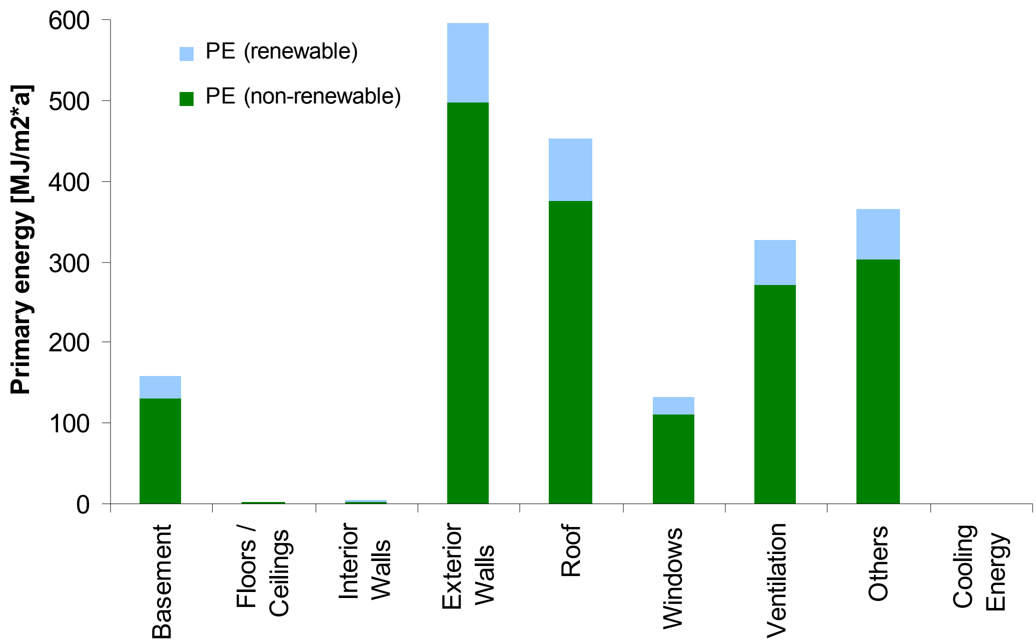


Z2_SI_005

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 042**	**129.5**	**-32.1**	**97.4**	**3.6E-01**	**2.3E-02**	**1.2E-01**	**7.0E-06**
Refurbishment	27	1.8	-0.2	1.6	7.6E-03	6.7E-04	1.1E-03	7.5E-08
Heating & cooling	2 014	127.7	-31.9	95.8	3.5E-01	2.2E-02	1.2E-01	6.9E-06
End-of-Life	**-7**	**0.8**	**0.0**	**0.8**	**6.7E-04**	**1.0E-04**	**2.8E-05**	**-1.2E-08**
Construction	-4	0.6	0.0	0.6	7.4E-04	1.1E-04	5.4E-05	-9.3E-09
Refurbishment	-3	0.2	0.0	0.2	-7.6E-05	-5.3E-06	-2.7E-05	-2.4E-09
Total*	**2 042**	**129.5**	**-32.1**	**97.4**	**3.6E-01**	**2.3E-02**	**1.2E-01**	**7.0E-06**
Heating & Cooling								
Basement	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%	7.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	29.3%	29.3%	29.3%	29.3%	29.3%	29.3%	29.3%	29.3%
Roof	22.5%	22.5%	22.5%	22.5%	22.5%	22.5%	22.5%	22.5%
Windows	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%
Ventilation	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%
Others	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_SI_005



Annex C 31 Building type Z2_SI_006_ex

Single-family house
Brick wall, reinforced concrete flooring, pitched roof

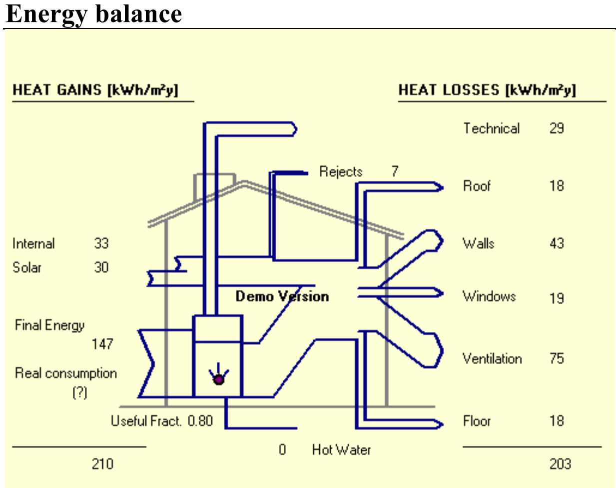
Statistics Proportion of Z2_SI_006_ex in the EU-25: 4.3%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	816.0	3890.0	20.0	1020.0	130.0	240.0	1280.0	330.0	590.0	95.0	40.0	132.0	205.0
Number of buildings [1 000]	544.0	2593.3	13.3	680.0	86.7	160.0	853.3	220.0	393.3	63.3	26.7	88.0	136.7
Stock in Mio. m^2	70	349	3	100	14	25	111	31	40	5	3	10	15
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	006_ex
Year of construction	Since 1980
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick masonry 25 cm (10 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance



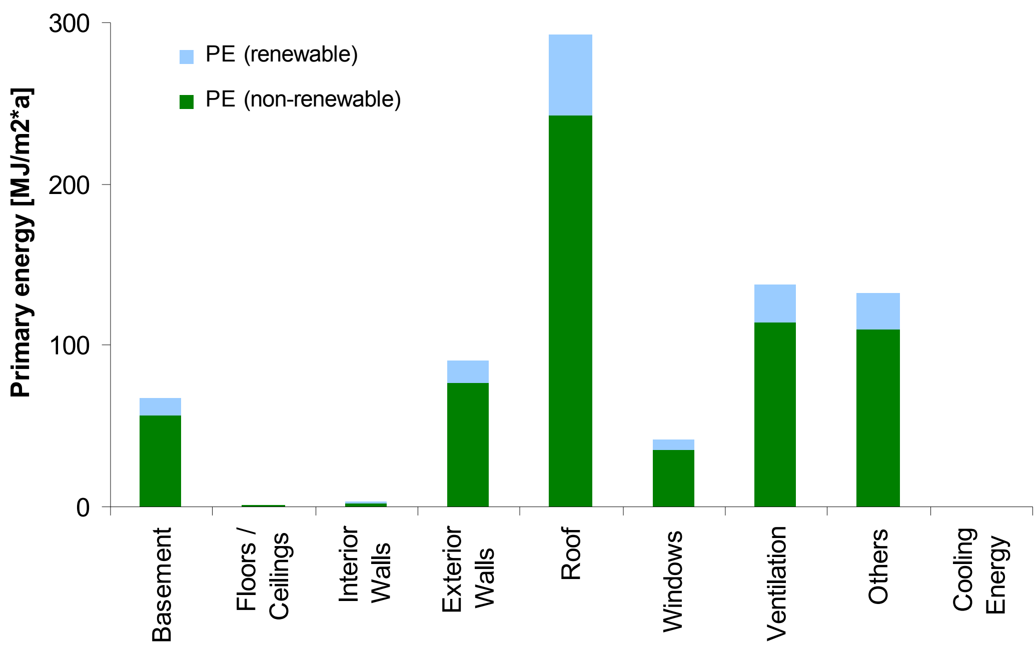
Z2_SI_006_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**773**	**49.0**	**-12.0**	**37.0**	**1.4E-01**	**8.8E-03**	**4.6E-02**	**2.6E-06**
Refurbishment	31	2.0	-0.2	1.7	8.3E-03	7.4E-04	1.2E-03	8.1E-08
Heating & cooling	742	47.0	-11.7	35.3	1.3E-01	8.1E-03	4.4E-02	2.6E-06
End-of-Life	**-6**	**0.9**	**0.0**	**0.9**	**1.1E-03**	**1.5E-04**	**6.8E-05**	**-1.0E-08**
Construction	-3	0.7	0.0	0.7	1.2E-03	1.5E-04	9.4E-05	-7.9E-09
Refurbishment	-3	0.2	0.0	0.2	-7.2E-05	-5.0E-06	-2.5E-05	-2.3E-09
Total*	**773**	**49.0**	**-12.0**	**37.0**	**1.4E-01**	**8.8E-03**	**4.6E-02**	**2.6E-06**

Heating & Cooling								
Basement	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%	8.9%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	10.7%	10.7%	10.7%	10.7%	10.7%	10.7%	10.7%	10.6%
Roof	39.4%	39.4%	39.4%	39.4%	39.4%	39.4%	39.4%	39.4%
Windows	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Ventilation	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%
Others	17.8%	17.8%	17.9%	17.8%	17.8%	17.8%	17.9%	17.8%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.2%

* Total = Use Phase

Z2_SI_006_ex



Annex C 32 Building type Z2_SI_006

Single-family house
Brick wall, reinforced concrete flooring, pitched roof

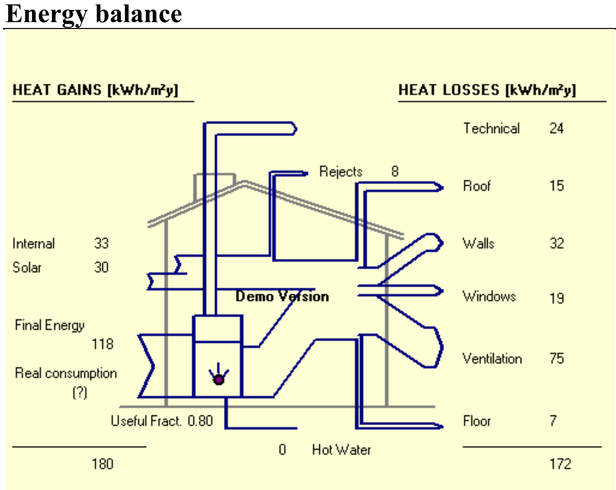
Statistics Proportion of Z2_SI_006 in the EU-25:0.1%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	20.5	72.8	0.9	23.4	5.1	12.4	105.1	8.6	34.9	6.6	3.2	10.0	13.6
Number of buildings [1 000]	13.7	48.5	0.6	15.6	3.4	8.3	70.3	5.7	23.3	4.4	2.1	6.6	9.1
Stock in Mio. m^2	2	7	0.1	2	1	1	9	1	2	0.4	0.2	1	1
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **NEW**

Zone	2
Building type	Single-family house
Number	006
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick masonry 25 cm (15 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

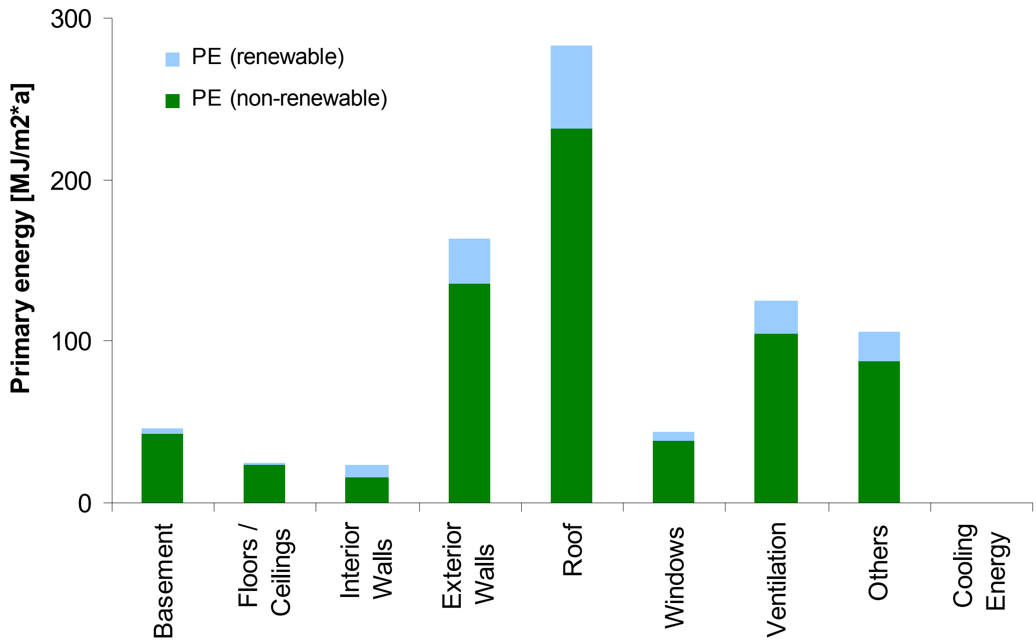


Z2_SI_006

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**197**	**15.1**	**-2.8**	**12.3**	**4.5E-02**	**5.1E-03**	**4.7E-03**	**5.0E-07**
Use Phase	**623**	**39.4**	**-9.6**	**29.8**	**1.1E-01**	**7.1E-03**	**3.7E-02**	**2.1E-06**
Refurbishment	29	1.8	-0.2	1.6	7.3E-03	6.6E-04	1.1E-03	7.4E-08
Heating & cooling	593	37.6	-9.4	28.2	1.0E-01	6.5E-03	3.5E-02	2.0E-06
End-of-Life	**-5**	**0.9**	**0.0**	**0.9**	**1.2E-03**	**1.6E-04**	**8.3E-05**	**-1.2E-08**
Construction	-3	0.7	0.0	0.7	1.1E-03	1.5E-04	9.3E-05	-8.4E-09
Refurbishment	-2	0.2	0.0	0.2	8.1E-06	3.4E-06	-9.4E-06	-3.3E-09
Total*	**820**	**54.5**	**-12.4**	**42.1**	**1.6E-01**	**1.2E-02**	**4.1E-02**	**2.6E-06**
Heating & Cooling								
Basement	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Roof	44.8%	44.8%	44.8%	44.8%	44.7%	44.8%	44.8%	44.7%
Windows	5.3%	5.3%	5.4%	5.3%	5.3%	5.3%	5.4%	5.3%
Ventilation	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%
Construction Phase								
Basement	16.6%	24.9%	1.7%	30.2%	23.5%	27.8%	21.3%	23.8%
Floors/ceilings	11.8%	16.0%	1.7%	19.2%	14.6%	17.1%	13.4%	18.9%
Interior Walls	10.1%	8.7%	19.2%	6.3%	8.1%	7.6%	7.4%	9.1%
Exterior Walls	48.4%	41.2%	58.7%	37.2%	41.1%	37.4%	45.7%	34.7%
Roof	8.7%	5.7%	18.5%	2.8%	6.8%	5.6%	7.8%	9.2%
Windows	4.5%	3.6%	0.3%	4.4%	5.8%	4.5%	4.3%	4.2%

* Total = Construction Phase + Use Phase

Z2_SI_006



Annex C 33 Building type Z2_SI_007_ex

Single-family house
Sandlime brick masonry, reinforced concrete flooring, pitched roof

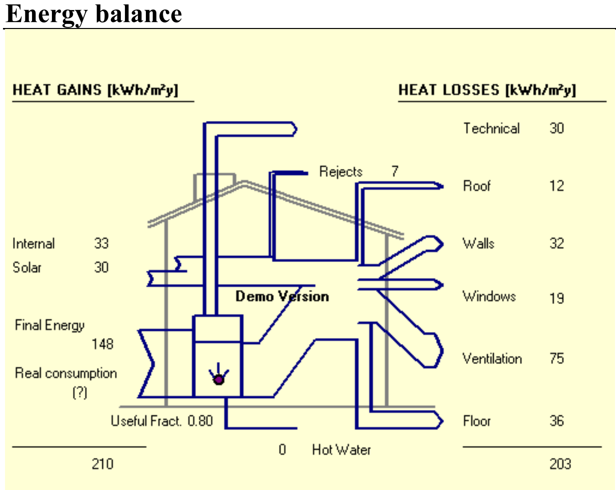
Statistics Proportion of Z2_SI_007_ex in the EU-25: 1.5%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	336.0	1945.0	10.0	340.0				66.0	354.0				
Number of buildings [1 000]	224.0	1296.7	6.7	226.7				44.0	236.0				
Stock in Mio. m^2	29	174	1	33				6	24				
Density in m^2/occupant	36.0	40.8	50.0	40.8				39.1	22.7				
Occupants per building	3.6	3.3	3.8	3.6				3.6	4.5				

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	007_ex
Year of construction	Since 1970
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Concrete tile
Exterior wall	Sandlime brick masonry 20 cm (12 cm insulation)
Interior load-bearing wall	Sandlime brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

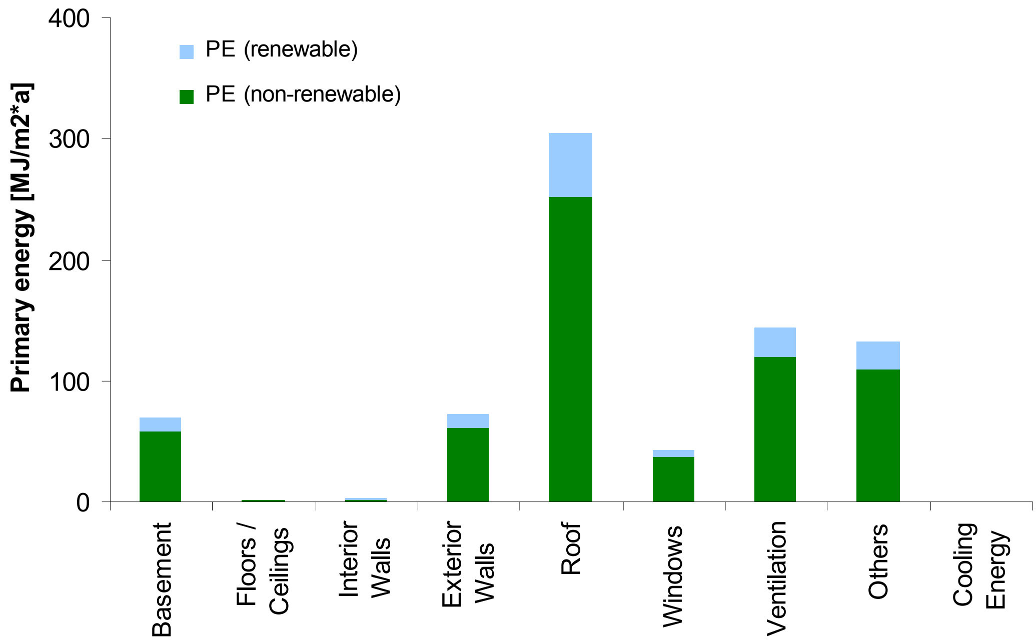


Z2_SI_007_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**775**	**49.1**	**-12.0**	**37.1**	**1.4E-01**	**8.8E-03**	**4.6E-02**	**2.6E-06**
Refurbishment	31	2.0	-0.2	1.7	8.2E-03	7.3E-04	1.1E-03	8.0E-08
Heating & cooling	744	47.2	-11.8	35.4	1.3E-01	8.1E-03	4.5E-02	2.6E-06
End-of-Life	**-5**	**0.8**	**0.0**	**0.8**	**9.8E-04**	**1.3E-04**	**5.9E-05**	**-9.7E-09**
Construction	-3	0.6	0.0	0.6	1.1E-03	1.4E-04	8.4E-05	-7.4E-09
Refurbishment	-3	0.2	0.0	0.2	-7.1E-05	-4.9E-06	-2.5E-05	-2.3E-09
Total*	**775**	**49.1**	**-12.0**	**37.1**	**1.4E-01**	**8.8E-03**	**4.6E-02**	**2.6E-06**
Heating & Cooling								
Basement	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.2%	8.2%	8.2%	8.2%	8.2%	8.2%	8.2%	8.2%
Roof	40.8%	40.8%	40.8%	40.8%	40.8%	40.8%	40.8%	40.8%
Windows	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
Ventilation	19.3%	19.3%	19.3%	19.2%	19.2%	19.2%	19.3%	19.2%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.2%

* Total = Use Phase

Z2_SI_007_ex



Annex C 34 Building type Z2_SI_007

Single-family house
Sandlime brick masonry, reinforced concrete flooring, pitched roof

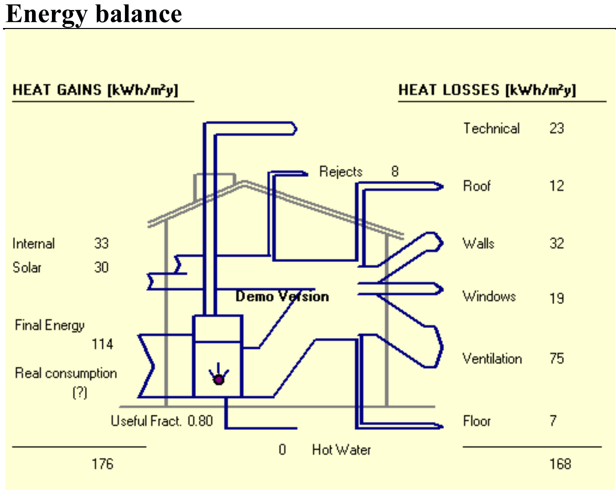
Statistics Proportion of Z2_SI_007 in the EU-25: 0.1%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	20.5	72.8	0.9	23.4	5.1	12.4	105.4	8.6	34.9	6.6	3.2	10.0	13.6
Number of buildings [1 000]	13.7	48.5	0.6	15.6	3.4	8.3	70.3	5.7	23.3	4.4	2.1	6.6	9.1
Stock in Mio. m^2	2	7	0.1	2	1	1	9	1	2	0.4	0.2	1	1
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **NEW**

Zone	2
Building type	Single-family house
Number	007
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Concrete tile
Exterior wall	Sandlime brick masonry 20 cm (15 cm insulation)
Interior load-bearing wall	Sandlime brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

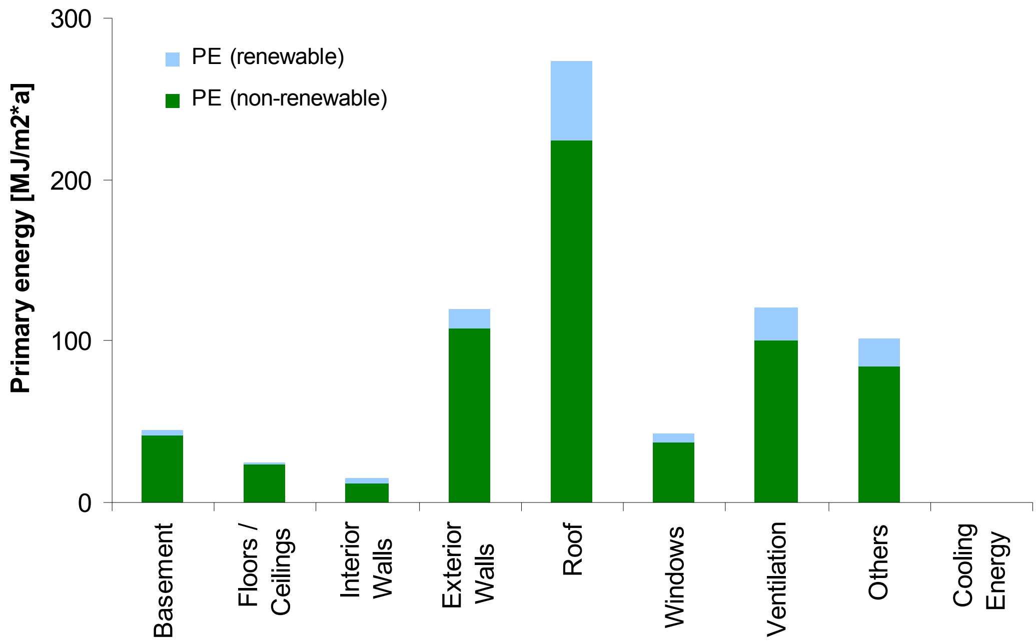


Z2_SI_007

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**145**	**12.6**	**-0.9**	**11.7**	**3.5E-02**	**4.3E-03**	**3.7E-03**	**4.0E-07**
Use Phase	**602**	**38.1**	**-9.3**	**28.8**	**1.1E-01**	**6.9E-03**	**3.5E-02**	**2.0E-06**
Refurbishment	29	1.8	-0.2	1.6	7.2E-03	6.5E-04	1.1E-03	7.3E-08
Heating & cooling	573	36.3	-9.1	27.2	9.9E-02	6.2E-03	3.4E-02	2.0E-06
End-of-Life	**-5**	**0.9**	**0.0**	**0.9**	**1.0E-03**	**1.4E-04**	**7.2E-05**	**-1.2E-08**
Construction	-3	0.7	0.0	0.7	1.0E-03	1.4E-04	8.1E-05	-8.7E-09
Refurbishment	-2	0.2	0.0	0.2	8.0E-06	3.4E-06	-9.3E-06	-3.3E-09
Total*	**747**	**50.7**	**-10.2**	**40.5**	**1.4E-01**	**1.1E-02**	**3.9E-02**	**2.4E-06**
Heating & Cooling								
Basement	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Roof	44.9%	44.8%	44.8%	44.8%	44.7%	44.8%	44.8%	44.7%
Windows	5.4%	5.3%	5.4%	5.3%	5.3%	5.3%	5.4%	5.3%
Ventilation	21.2%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%
Others	17.8%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%
Construction Phase								
Basement	21.8%	29.4%	4.9%	31.4%	29.6%	32.7%	26.7%	29.4%
Floors/ceilings	15.5%	18.9%	4.9%	20.0%	18.4%	20.1%	16.8%	23.4%
Interior Walls	7.6%	7.4%	20.1%	6.4%	5.6%	6.1%	4.8%	7.0%
Exterior Walls	36.2%	33.3%	14.2%	34.8%	30.4%	29.3%	36.5%	23.6%
Roof	11.9%	6.7%	55.0%	2.9%	8.6%	6.6%	9.8%	11.4%
Windows	5.9%	4.2%	0.8%	4.5%	7.3%	5.3%	5.4%	5.2%

* Total = Construction Phase + Use Phase

Z2_SI_007



Annex C 35 Building type Z2_SI_008_ex

Single-family house
Wooden frame, wooden flooring, pitched roof

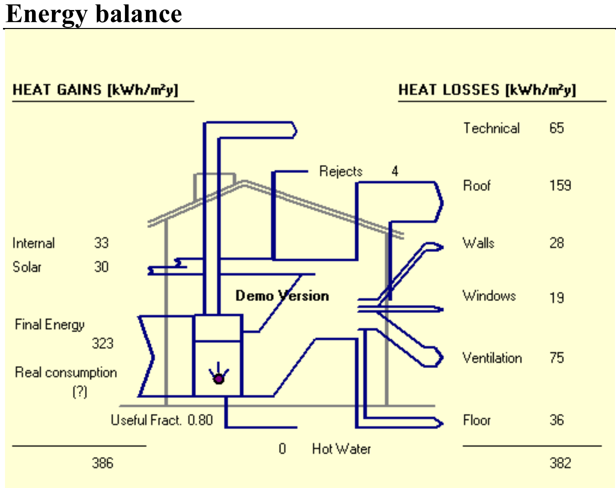

Statistics Proportion of Z2_SI_008_ex in the EU-25: 1.2%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	96.0	1945.0	4.0	204.0	78.0	32.0		99.0					
Number of buildings [1 000]	64.0	1296.7	2.7	136.0	52.0	21.3		66.0					
Stock in Mio. m^2	8	174	1	20	9	3		9					
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0		39.1					
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0		3.6					

Description of the building type **EXISTING**

Zone	2
Building type	Single-family house
Number	008_ex
Year of construction	Since 1980
Residual service life	30 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Wooden frame 16 cm (16 cm insulation)
Interior load-bearing wall	Wooden frame 16 cm (16 cm insulation)
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

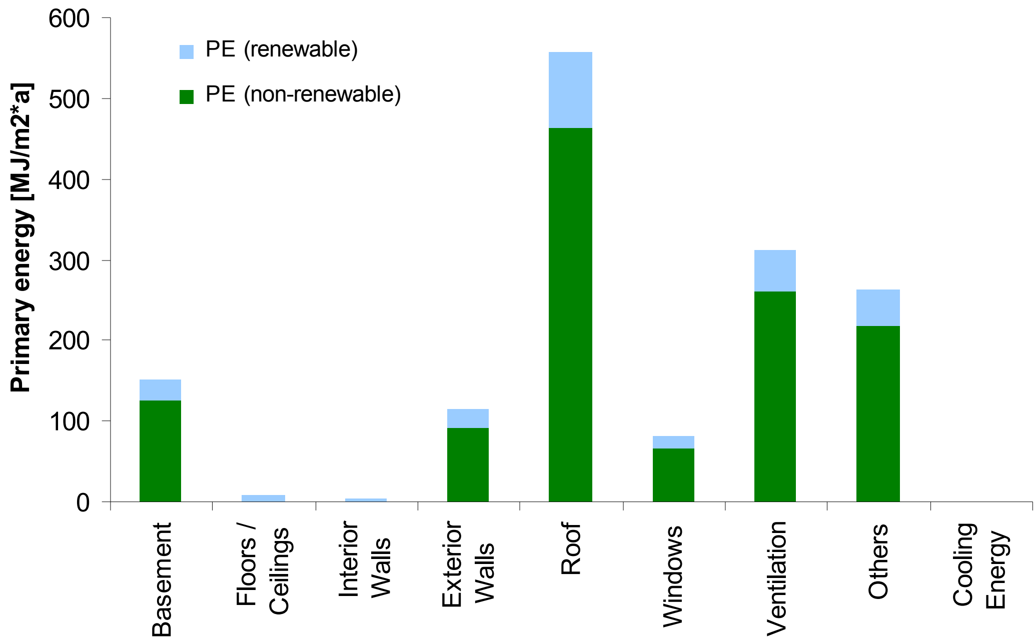


Z2_SI_008_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 524**	**95.7**	**-25.4**	**70.3**	**2.6E-01**	**1.7E-02**	**9.0E-02**	**5.2E-06**
Refurbishment	44	1.9	-2.0	-0.1	8.1E-03	6.3E-04	1.6E-03	1.4E-07
Heating & cooling	1 480	93.8	-23.4	70.4	2.6E-01	1.6E-02	8.9E-02	5.1E-06
End-of-Life	**-54**	**4.5**	**0.0**	**4.5**	**-3.5E-03**	**-7.6E-05**	**-3.1E-04**	**-1.5E-07**
Construction	-39	3.3	0.0	3.3	-2.5E-03	-3.7E-05	-2.1E-04	-1.1E-07
Refurbishment	-15	1.2	0.0	1.2	-1.1E-03	-3.9E-05	-9.8E-05	-4.1E-08
Total*	**1 524**	**95.7**	**-25.4**	**70.3**	**2.6E-01**	**1.7E-02**	**9.0E-02**	**5.2E-06**
Heating & Cooling								
Basement	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%
Roof	37.9%	37.9%	37.9%	37.8%	37.9%	37.9%	37.9%	37.9%
Windows	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
Ventilation	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%
Others	17.8%	17.7%	17.8%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_SI_008_ex



Annex C 36 Building type Z2_SI_008

Single-family house
Wooden frame, wooden flooring, pitched roof

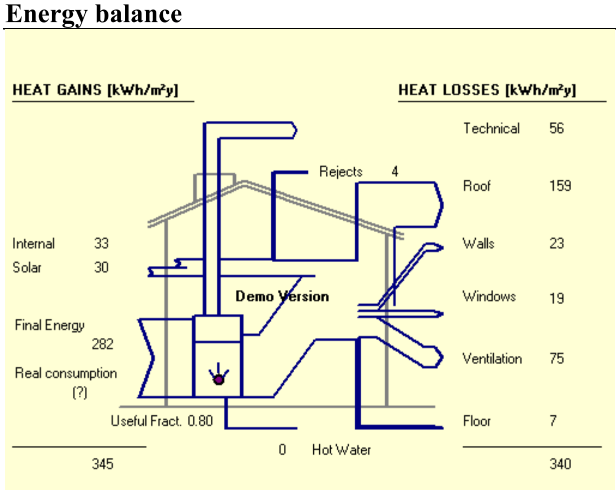
Statistics Proportion of Z2_SI_008 in the EU-25: 0.1%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	20.5	72.8	0.9	23.4	5.1	12.4	105.9	8.6	34.9	6.6	3.2	10.0	13.6
Number of buildings [1 000]	13.7	48.5	0.6	15.6	3.4	8.3	70.3	5.7	23.3	4.4	2.1	6.6	9.1
Stock in Mio. m^2	2	7	0.1	2	1	1	9	1	2	0.4	0.2	1	1
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	3.6	3.3	3.8	3.6	3.3	4.0	3.0	3.6	4.5	3.9	3.8	3.8	4.0

Description of the building type **NEW**

Zone	2
Building type	Single-family house
Number	008
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Wooden frame 16 cm (21cm insulation)
Interior load-bearing wall	Wooden frame 16 cm (16 cm insulation)
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

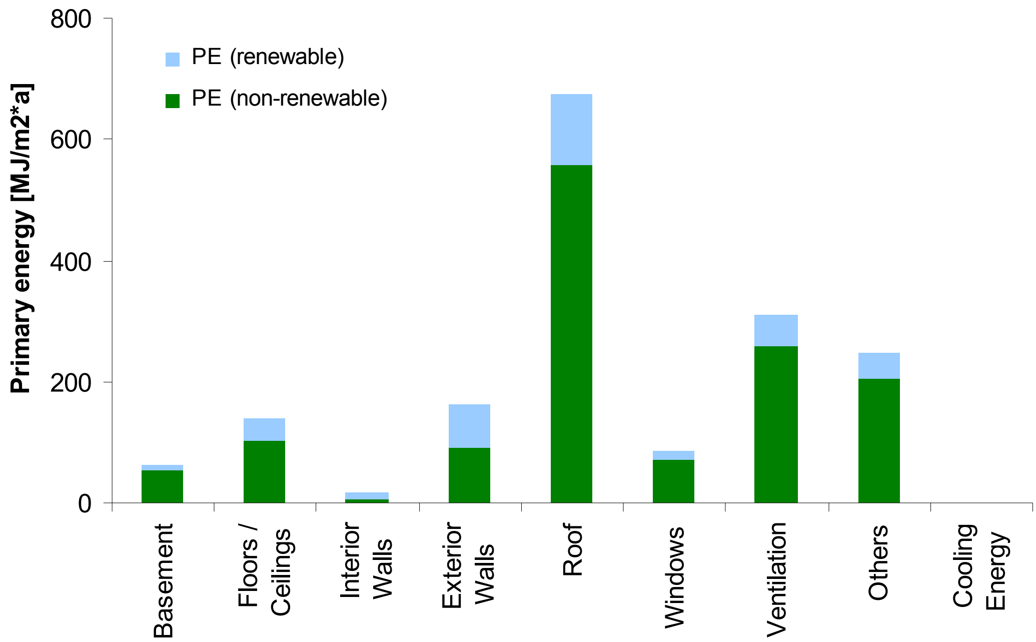


Z2_SI_008

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**289**	**14.6**	**-7.9**	**6.7**	**4.1E-02**	**4.7E-03**	**5.2E-03**	**9.3E-07**
Use Phase	**1 483**	**92.7**	**-25.2**	**67.4**	**2.6E-01**	**1.6E-02**	**8.7E-02**	**5.1E-06**
Refurbishment	64	2.7	-2.8	-0.1	1.0E-02	8.7E-04	1.6E-03	1.9E-07
Heating & cooling	1 419	90.0	-22.5	67.5	2.5E-01	1.5E-02	8.5E-02	4.9E-06
End-of-Life	**-74**	**6.1**	**0.0**	**6.1**	**-5.5E-03**	**-1.6E-04**	**-4.7E-04**	**-2.1E-07**
Construction	-53	4.4	0.0	4.4	-3.8E-03	-1.1E-04	-3.3E-04	-1.5E-07
Refurbishment	-21	1.7	0.0	1.7	-1.6E-03	-5.7E-05	-1.4E-04	-6.0E-08
Total*	**1 772**	**107.3**	**-33.2**	**74.1**	**3.0E-01**	**2.1E-02**	**9.2E-02**	**6.0E-06**
Heating & Cooling								
Basement	2.1%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%	2.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%
Roof	46.6%	46.3%	46.4%	46.3%	46.3%	46.3%	46.4%	46.3%
Windows	5.6%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%
Ventilation	22.0%	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%
Others	17.6%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Construction Phase								
Basement	11.1%	24.5%	0.6%	52.7%	24.6%	28.8%	18.2%	12.3%
Floors/ceilings	47.3%	41.6%	29.0%	56.4%	30.1%	37.3%	32.9%	47.8%
Interior Walls	4.1%	3.4%	7.3%	-1.2%	4.5%	3.7%	3.6%	4.8%
Exterior Walls	28.5%	22.9%	54.7%	-14.6%	30.4%	21.8%	34.2%	28.2%
Roof	5.3%	5.5%	6.2%	4.6%	6.9%	5.4%	6.5%	4.8%
Windows	1.8%	2.2%	2.2%	2.2%	3.5%	2.9%	4.7%	2.1%

* Total = Construction Phase + Use Phase

Z2_SI_008



Annex C 37 Building type Z2_MF_001

Multi-family house
Brick masonry, wooden flooring, pitched roof

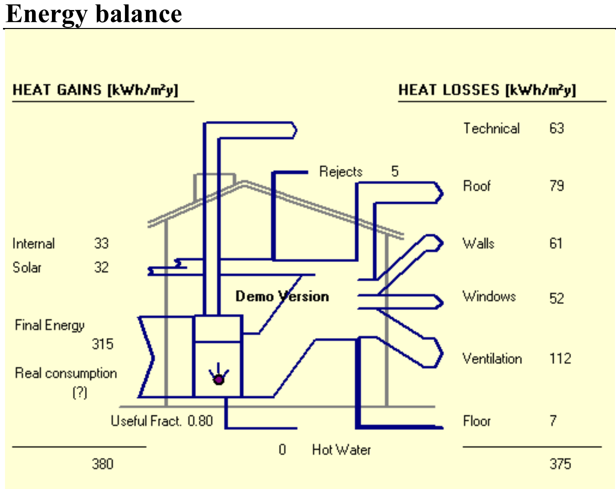
Statistics Proportion of Z2_MF_001 in the EU-25: 3.5%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	192.0	3890.0	8.0	272.0	260.0	32.0	1280.0	330.0	590.0	57.0	24.0	132.0	82.0
Number of buildings [1 000]	12.0	243.1	0.5	17.0	16.3	2.0	80.0	20.6	36.9	3.6	1.5	8.3	5.1
Stock in Mio. m^2	17	349	1	27	28	3	111	31	40	3	2	10	6
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2	46.0	37.0	38.4	48.0	41.6	40.0	40.0	40.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	001
Year of construction	Until 1945
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Brick 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Solid brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Brick
Window	Wooden frame and single-glazing

Energy balance

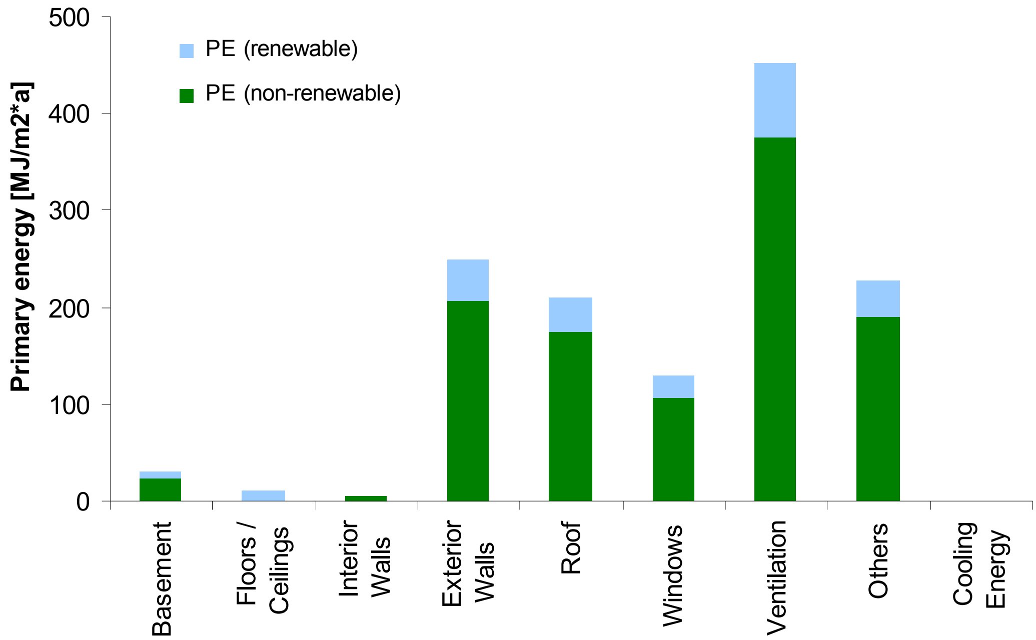


Z2_MF_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 323**	**83.3**	**-21.8**	**61.5**	**2.3E-01**	**1.5E-02**	**7.8E-02**	**4.5E-06**
Refurbishment	34	1.6	-1.4	0.2	5.7E-03	5.4E-04	9.2E-04	1.0E-07
Heating & cooling	1 289	81.7	-20.4	61.3	2.2E-01	1.4E-02	7.7E-02	4.4E-06
End-of-Life	**-21**	**2.4**	**0.0**	**2.4**	**1.9E-04**	**1.8E-04**	**2.8E-05**	**-6.6E-08**
Construction	-11	1.6	0.0	1.6	9.1E-04	1.9E-04	9.0E-05	-3.8E-08
Refurbishment	-10	0.8	0.0	0.8	-7.1E-04	-1.6E-05	-6.2E-05	-2.8E-08
Total*	**1 323**	**83.3**	**-21.8**	**61.5**	**2.3E-01**	**1.5E-02**	**7.8E-02**	**4.5E-06**
Heating & Cooling								
Basement	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	19.1%	19.1%	19.1%	19.1%	19.1%	19.1%	19.1%	19.1%
Roof	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%
Windows	9.7%	9.7%	9.7%	9.7%	9.7%	9.7%	9.7%	9.7%
Ventilation	35.1%	35.1%	35.1%	35.0%	35.1%	35.1%	35.1%	35.0%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_001



Annex C 38 Building type Z2_MF_002

Multi-family house
Rublle stone masonry, wooden flooring, pitched roof

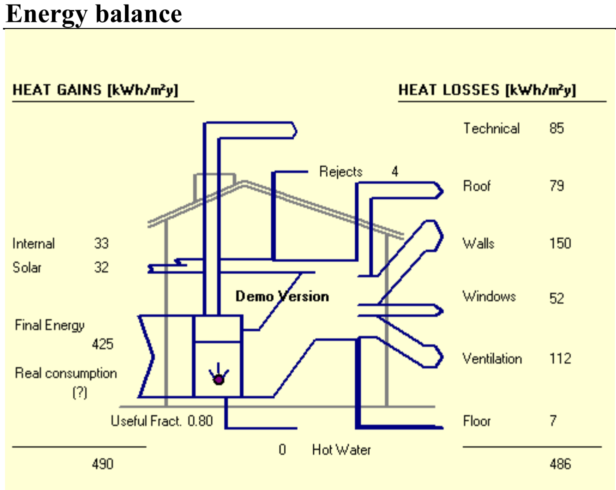
Statistics Proportion of Z2_MF_002 in the EU-25: 0.9%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	96.0	778.0	4.0	136.0	130.0			99.0	354.0		16.0	88.0	82.0
Number of buildings [1 000]	6.0	48.6	0.3	8.5	8.1			6.2	22.1		1.0	5.5	5.1
Stock in Mio. m^2	8	70	1	13	14			9	24		1	7	6
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6			39.1	22.7		30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2			38.4	48.0		40.0	40.0	40.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	002
Year of construction	Until 1900
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3.5 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Rubble stone 50 cm
Interior load-bearing wall	Rubble stone 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Rubble stone 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Rubble stone
Window	Wooden frame and single-glazing

Energy balance

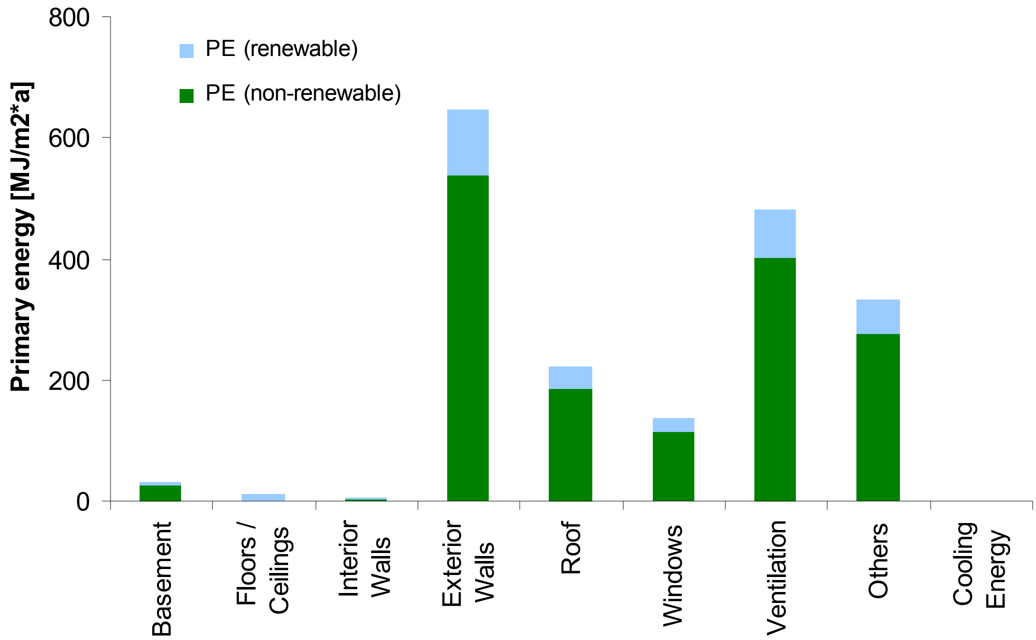


Z2_MF_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 882**	**118.7**	**-30.8**	**87.9**	**3.3E-01**	**2.1E-02**	**1.1E-01**	**6.5E-06**
Refurbishment	37	1.7	-1.6	0.2	6.1E-03	5.7E-04	9.7E-04	1.1E-07
Heating & cooling	1 845	116.9	-29.2	87.7	3.2E-01	2.0E-02	1.1E-01	6.4E-06
End-of-Life	**-24**	**2.6**	**0.0**	**2.6**	**-2.6E-04**	**1.4E-04**	**-1.3E-05**	**-7.4E-08**
Construction	-13	1.7	0.0	1.7	5.6E-04	1.6E-04	5.9E-05	-4.2E-08
Refurbishment	-11	0.9	0.0	0.9	-8.2E-04	-2.0E-05	-7.2E-05	-3.2E-08
Total*	**1 882**	**118.7**	**-30.8**	**87.9**	**3.3E-01**	**2.1E-02**	**1.1E-01**	**6.5E-06**
Heating & Cooling								
Basement	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	35.0%	35.0%	35.0%	34.9%	35.0%	35.0%	35.0%	34.9%
Roof	12.1%	12.1%	12.1%	12.1%	12.1%	12.1%	12.1%	12.1%
Windows	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%
Ventilation	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%	26.1%
Others	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%	18.0%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_002



Annex C 39 Building type Z2_MF_003

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

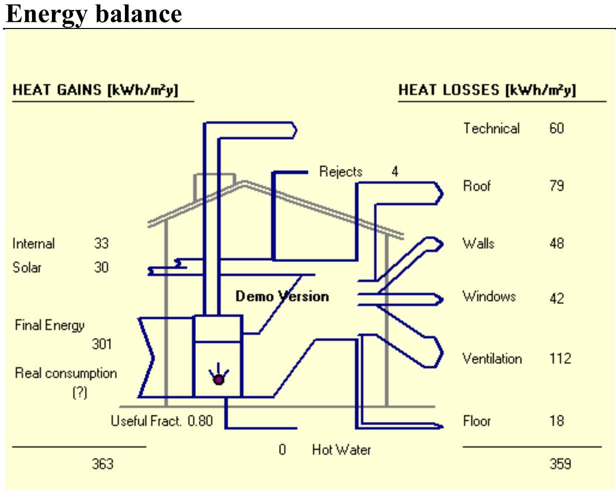
Statistics Proportion of Z2_MF_003 in the EU-25: 4.5%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	240.0	4668.0	10.0	680.0	260.0	32.0	1536.0	660.0	590.0	95.0	40.0	220.0	205.0
Number of buildings [1 000]	15.0	291.8	0.6	42.5	16.3	2.	96.0	41.3	36.9	5.9	2.5	13.8	12.8
Stock in Mio. m^2	21	419	1	67	28	3	133	62	40	5	3	17	15
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2	46.0	37.0	38.4	48.0	41.6	40.0	40.0	40.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	003
Year of construction	1945-1980
Residual service life	30 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Brick masonry 35 cm
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Wooden frame and double-glazing

Energy balance

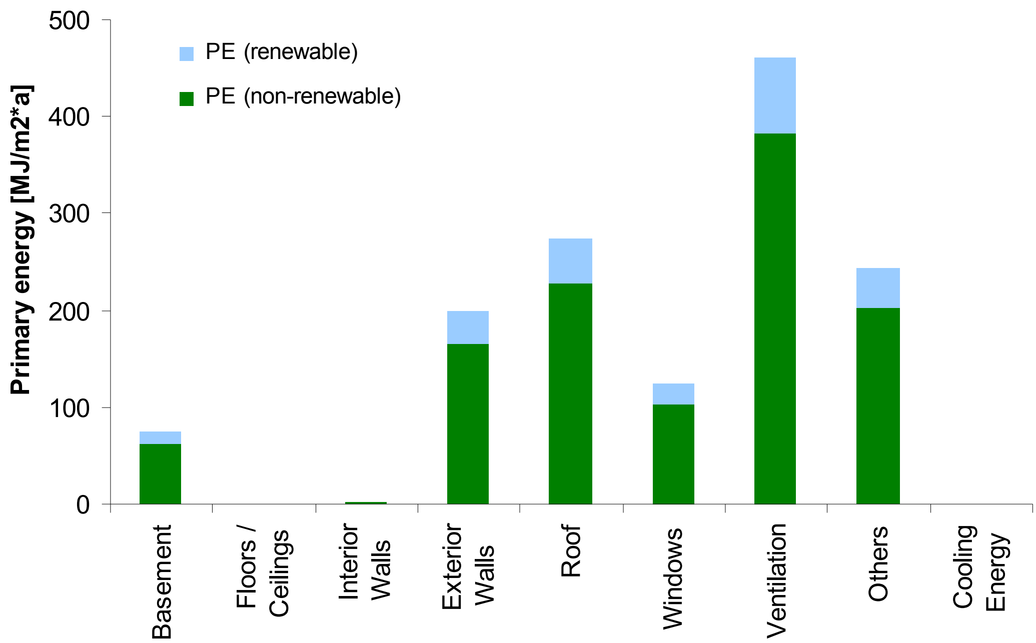


Z2_MF_003

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 384**	**87.7**	**-22.0**	**65.7**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.8E-06**
Refurbishment	10	0.6	-0.3	0.3	2.7E-03	2.4E-04	4.4E-04	3.9E-08
Heating & cooling	1 374	87.1	-21.8	65.3	2.4E-01	1.5E-02	8.2E-02	4.7E-06
End-of-Life	**-5**	**0.6**	**0.0**	**0.6**	**7.2E-04**	**1.2E-04**	**6.8E-05**	**-1.2E-08**
Construction	-4	0.5	0.0	0.5	7.7E-04	1.1E-04	7.3E-05	-8.3E-09
Refurbishment	-1	0.1	0.0	0.1	-5.1E-05	4.2E-06	-4.5E-06	-3.7E-09
Total*	**1 384**	**87.7**	**-22.0**	**65.7**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.8E-06**
Heating & Cooling								
Basement	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%	14.4%
Roof	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%
Windows	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%	9.0%
Ventilation	33.5%	33.5%	33.5%	33.5%	33.5%	33.5%	33.5%	33.5%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_003



Annex C 40 Building type Z2_MF_004

Multi-family house
Breeze concrete, reinforced concrete flooring, pitched roof

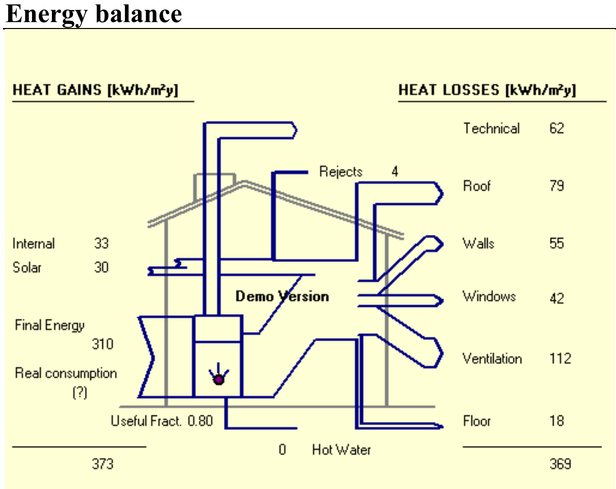

Statistics Proportion of Z2_MF_004 in the EU-25: 1.9%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	240.0	1945.0	4.0	340.0	78.0				944.0	95.0	40.0	220.0	82.0
Number of buildings [1 000]	15.0	121.6	0.3	21.3	4.9				59.0	5.9	2.5	13.8	5.1
Stock in Mio. m^2	21	174	1	33	9				64	5	3	17	6
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6				22.7	21.6	30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2				48.0	41.6	40.0	40.0	40.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	004
Year of construction	1945-1965
Residual service life	30 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Concrete pantile
Exterior wall	Breeze concrete 30 cm
Interior load-bearing wall	Breeze concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

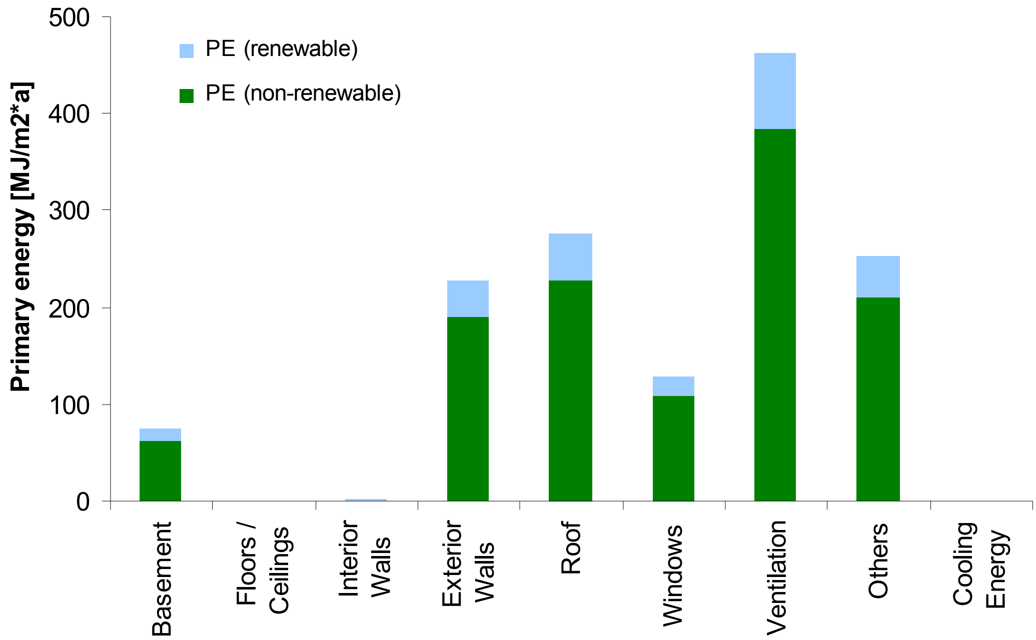


Z2_MF_004

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 431**	**90.7**	**-22.6**	**68.0**	**2.5E-01**	**1.6E-02**	**8.5E-02**	**4.9E-06**
Refurbishment	13	0.8	-0.2	0.6	3.4E-03	2.9E-04	3.9E-04	3.8E-08
Heating & cooling	1 419	89.9	-22.5	67.5	2.5E-01	1.5E-02	8.5E-02	4.9E-06
End-of-Life	**-5**	**0.5**	**0.0**	**0.5**	**5.3E-05**	**3.1E-05**	**-2.0E-05**	**-8.8E-09**
Construction	-4	0.4	0.0	0.4	1.9E-04	4.2E-05	3.9E-06	-7.4E-09
Refurbishment	-2	0.1	0.0	0.1	-1.3E-04	-1.0E-05	-2.4E-05	-1.3E-09
Total*	**1 431**	**90.7**	**-22.6**	**68.0**	**2.5E-01**	**1.6E-02**	**8.5E-02**	**4.9E-06**
Heating & Cooling								
Basement	5.2%	5.2%	5.3%	5.2%	5.2%	5.2%	5.2%	5.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%	16.0%
Roof	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%
Windows	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%
Ventilation	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.7%	32.6%
Others	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_004



Annex C 41 Building type Z2_MF_005_ex

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

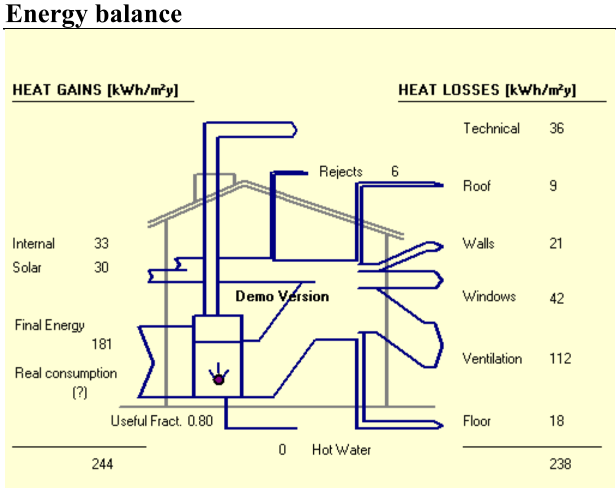

Statistics Proportion of Z2_MF_005_ex in the EU-25: 2.8%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	96.0	3890.0	4.0	340.0	130.0		512.0	330.0	236.0			88.0	82.0
Number of buildings [1 000]	6.0	243.1	0.3	21.3	8.1		32.0	20.6	14.8			5.5	5.1
Stock in Mio. m^2	8	349	1	33	14		44	31	16			7	6
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6		38.0	39.1	22.7			30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2		37.0	38.4	48.0			40.0	40.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	005_ex
Year of construction	Since 1980
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Concrete tile
Exterior wall	Brick masonry 25 cm (8 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

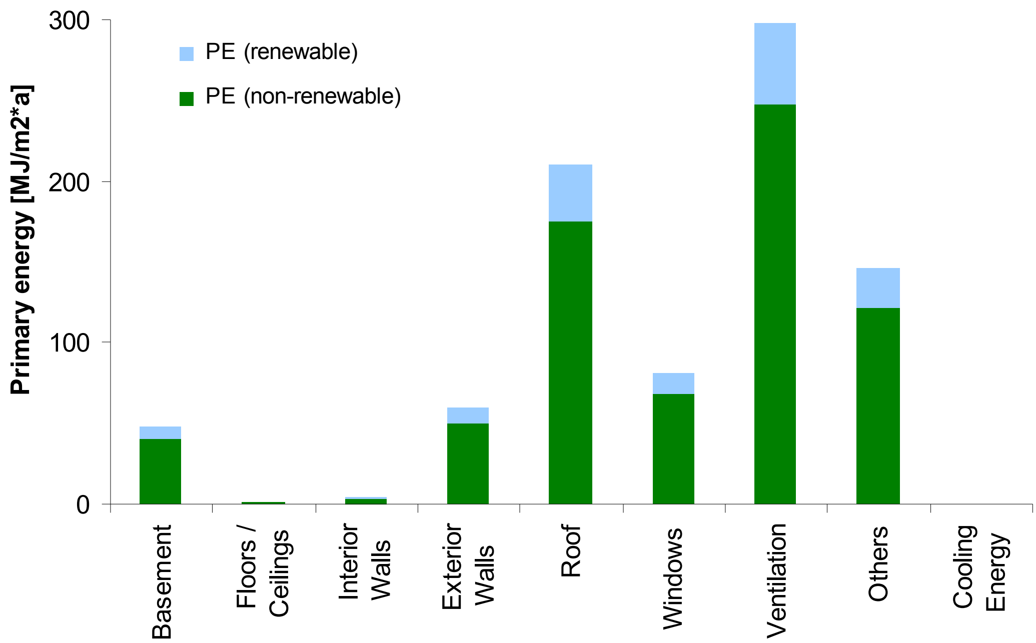


Z2_MF_005_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**853**	**54.0**	**-13.4**	**40.6**	**1.5E-01**	**9.5E-03**	**5.0E-02**	**2.9E-06**
Refurbishment	19	1.2	-0.2	0.9	4.8E-03	4.4E-04	5.6E-04	5.5E-08
Heating & cooling	834	52.9	-13.2	39.7	1.4E-01	9.1E-03	5.0E-02	2.9E-06
End-of-Life	**-4**	**0.5**	**0.0**	**0.5**	**4.1E-04**	**6.4E-05**	**1.6E-05**	**-6.0E-09**
Construction	-2	0.3	0.0	0.3	5.1E-04	6.9E-05	3.8E-05	-3.7E-09
Refurbishment	-2	0.1	0.0	0.1	-1.1E-04	-5.7E-06	-2.2E-05	-2.3E-09
Total*	**853**	**54.0**	**-13.4**	**40.6**	**1.5E-01**	**9.5E-03**	**5.0E-02**	**2.9E-06**
Heating & Cooling								
Basement	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%
Roof	25.2%	25.2%	25.2%	25.2%	25.2%	25.2%	25.2%	25.2%
Windows	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%	9.1%
Ventilation	35.7%	35.7%	35.8%	35.7%	35.7%	35.7%	35.7%	35.7%
Others	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_005_ex



Annex C 42 Building type Z2_MF_005

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

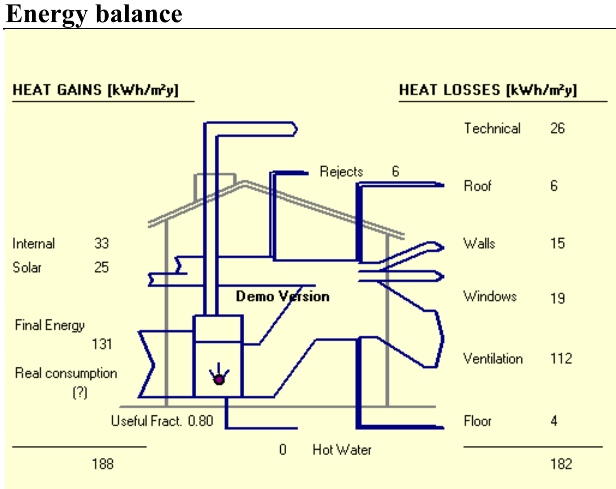
Statistics Proportion of Z2_MF_005 in the EU-25: 0.04%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	5.7	77.6	0.3	11.7	3.9	0.8	25.3	9.3	28.4	3.4	1.2	8.5	5.0
Number of buildings [1 000]	0.4	4.8	0.02	0.7	0.2	0.05	1.6	0.6	1.8	0.2	0.07	0.5	0.3
Stock in Mio. m^2	0.5	7	0.04	1	0.4	0.1	2	1	2	0.2	0.1	1	0.4
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2	46.4	37.0	38.4	48.0	41.6	40.0	40.0	40.0

Description of the building type **NEW**

Zone	2
Building type	Multi-family house
Number	005
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30° (15 cm insulation)
Roof cladding	Concrete tile
Exterior wall	Brick masonry 25 cm (15 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete 20 cm
Basement wall	Reinforced concrete 20 cm
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

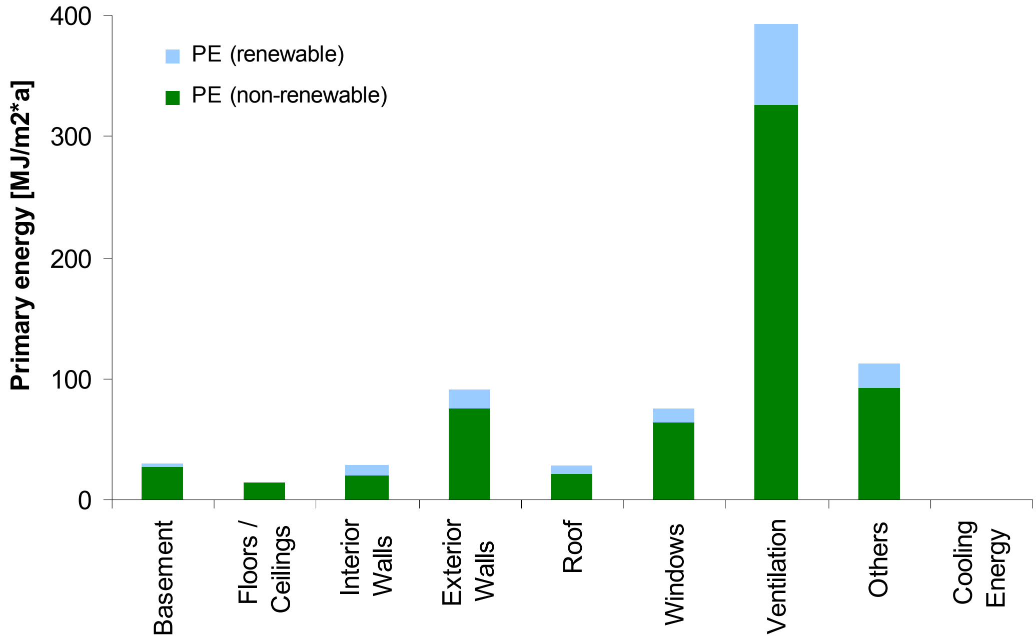


Z2_MF_005

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**98**	**7.5**	**-1.5**	**6.1**	**2.2E-02**	**2.5E-03**	**2.2E-03**	**2.6E-07**
Use Phase	**676**	**42.8**	**-10.7**	**32.1**	**1.2E-01**	**7.6E-03**	**4.0E-02**	**2.3E-06**
Refurbishment	17	1.0	-0.2	0.8	4.1E-03	3.8E-04	5.3E-04	4.9E-08
Heating & cooling	659	41.8	-10.4	31.3	1.1E-01	7.2E-03	3.9E-02	2.3E-06
End-of-Life	**-4**	**0.5**	**0.0**	**0.5**	**4.5E-04**	**7.0E-05**	**2.6E-05**	**-7.1E-09**
Construction	-2	0.4	0.0	0.4	5.0E-04	6.9E-05	3.7E-05	-4.1E-09
Refurbishment	-2	0.1	0.0	0.1	-5.0E-05	2.5E-07	-1.1E-05	-2.9E-09
Total*	**774**	**50.3**	**-12.1**	**38.2**	**1.4E-01**	**1.0E-02**	**4.2E-02**	**2.6E-06**
Heating & Cooling								
Basement	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Roof	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
Windows	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%	10.1%
Ventilation	59.5%	59.5%	59.6%	59.5%	59.5%	59.5%	59.6%	59.5%
Others	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%
Cooling Energy	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%
Construction Phase								
Basement	15.2%	22.4%	1.6%	27.4%	21.0%	24.7%	19.7%	21.7%
Floors/ceilings	13.7%	18.5%	1.8%	22.5%	17.0%	19.9%	16.1%	21.1%
Interior Walls	23.7%	20.4%	42.9%	15.0%	19.1%	18.0%	18.0%	21.0%
Exterior Walls	34.6%	29.4%	40.0%	26.9%	29.5%	26.8%	33.8%	23.8%
Roof	6.5%	4.2%	13.3%	2.1%	5.1%	4.2%	6.1%	6.6%
Windows	6.3%	5.1%	0.4%	6.2%	8.2%	6.4%	6.3%	5.8%

* Total = Construction Phase + Use Phase

Z2_MF_005



Annex C 43 Building type Z2_MF_006_ex

Multi-family house
Sandlime masonry, reinforced concrete flooring, pitched roof

Statistics

Proportion of Z2_MF_006_ex in the EU-25: 1.1%

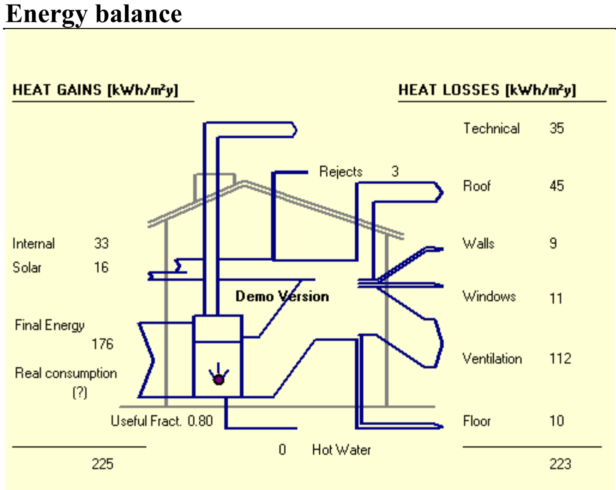
	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	96.0	1945.0	4.0	136.0				165.0					
Number of buildings [1 000]	6.0	121.6	0.3	8.5				10.3					
Stock in Mio. m^2	8	174	1	13				15					
Density in m^2/occupant	36.0	40.8	50.0	40.8				39.1					
Occupants per building	38.4	35.2	40.0	38.4				38.4					

Description of the building type

EXISTING

Zone	2
Building type	Multi-family house
Number	006_ex
Year of construction	Since 1980
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Concrete tile
Exterior wall	Sandlime brick masonry 20 cm (12 cm insulation)
Interior load-bearing wall	Sandlime brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

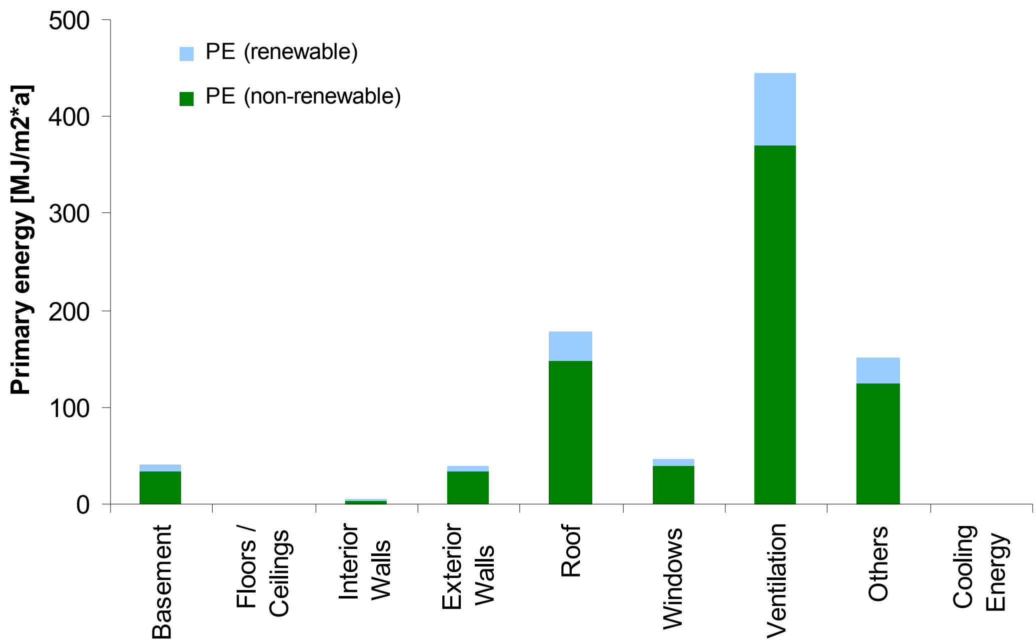


Z2_MF_006_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**909**	**57.6**	**-14.3**	**43.2**	**1.6E-01**	**1.0E-02**	**5.4E-02**	**3.1E-06**
Refurbishment	19	1.1	-0.2	0.9	4.8E-03	4.4E-04	5.6E-04	5.4E-08
Heating & cooling	890	56.4	-14.1	42.3	1.5E-01	9.7E-03	5.3E-02	3.1E-06
End-of-Life	**-4**	**0.5**	**0.0**	**0.5**	**4.3E-04**	**6.7E-05**	**1.9E-05**	**-5.8E-09**
Construction	-2	0.3	0.0	0.3	5.5E-04	7.3E-05	4.1E-05	-3.5E-09
Refurbishment	-2	0.1	0.0	0.1	-1.1E-04	-6.4E-06	-2.3E-05	-2.3E-09
Total*	**909**	**57.6**	**-14.3**	**43.2**	**1.6E-01**	**1.0E-02**	**5.4E-02**	**3.1E-06**
Heating & Cooling								
Basement	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Roof	20.1%	20.1%	20.1%	20.1%	20.1%	20.1%	20.1%	20.0%
Windows	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
Ventilation	49.9%	49.9%	49.9%	49.9%	49.9%	49.9%	49.9%	49.9%
Others	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_006_ex



Annex C 44 Building type Z2_MF_006

Multi-family house
Sandlime masonry,
reinforced concrete
flooring, pitched roof

Statistics

Proportion of Z2_MF_006 in the EU-25: 0.04%

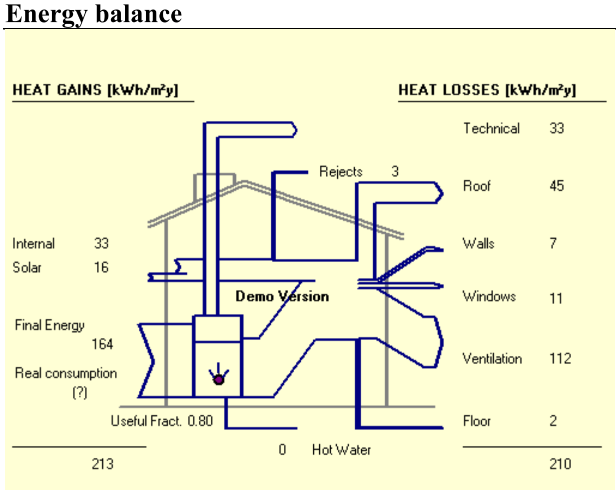
	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	5.7	77.6	0.3	11.7	3.9	0.8	25.3	9.3	28.4	3.4	1.2	8.5	5.0
Number of buildings [1 000]	0.4	4.8	0.02	0.7	0.2	0.05	1.6	0.6	1.8	0.2	0.07	0.5	0.3
Stock in Mio. m^2	0.5	7	0.04	1	0.4	0.1	2	1	2	0.2	0.1	1	0.4
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2	46.4	37.0	38.4	48.0	41.6	40.0	40.0	40.0

Description of the building type

NEW

Zone	2
Building type	Multi-family house
Number	006
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Concrete tile
Exterior wall	Sandlime brick masonry 20 cm (15 cm insulation)
Interior load-bearing wall	Sandlime brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

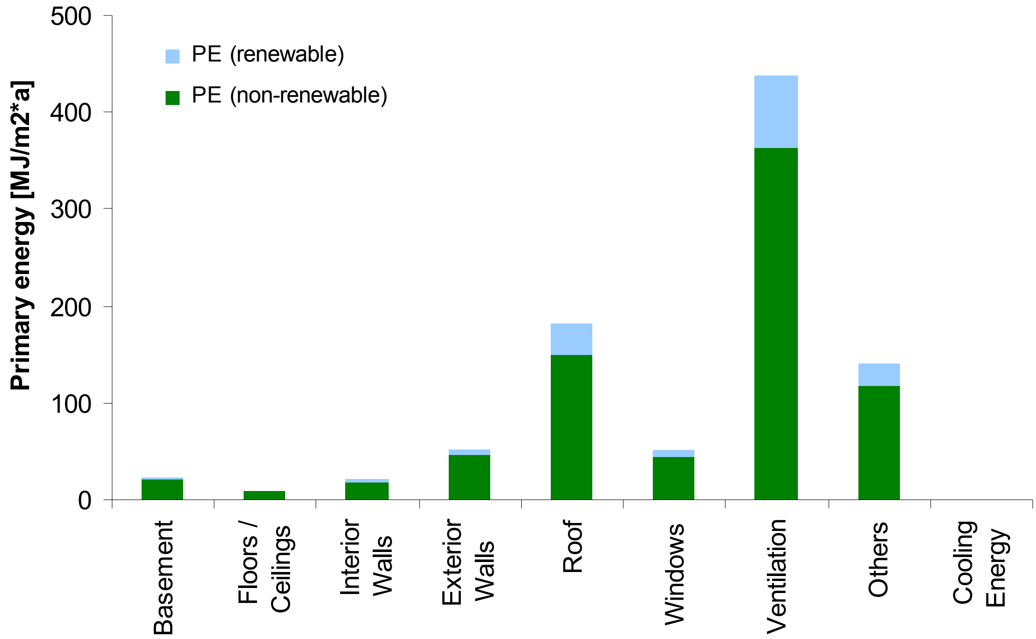


Z2_MF_006

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**72**	**6.3**	**-0.5**	**5.7**	**1.7E-02**	**2.1E-03**	**1.7E-03**	**2.0E-07**
Use Phase	**848**	**53.7**	**-13.4**	**40.3**	**1.5E-01**	**9.4E-03**	**5.0E-02**	**2.9E-06**
Refurbishment	17	1.0	-0.2	0.7	3.9E-03	3.6E-04	5.1E-04	4.7E-08
Heating & cooling	831	52.7	-13.2	39.5	1.4E-01	9.1E-03	5.0E-02	2.9E-06
End-of-Life	**-3**	**0.5**	**0.0**	**0.5**	**4.8E-04**	**7.3E-05**	**2.9E-05**	**-6.9E-09**
Construction	-2	0.4	0.0	0.4	5.4E-04	7.3E-05	4.0E-05	-3.9E-09
Refurbishment	-2	0.1	0.0	0.1	-5.6E-05	-4.8E-07	-1.1E-05	-2.9E-09
Total*	**920**	**59.9**	**-13.9**	**46.0**	**1.7E-01**	**1.1E-02**	**5.2E-02**	**3.1E-06**
Heating & Cooling								
Basement	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%	0.9%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Roof	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%	21.1%
Windows	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
Ventilation	52.6%	52.6%	52.6%	52.6%	52.5%	52.6%	52.6%	52.5%
Others	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%
Construction Phase								
Basement	20.4%	26.6%	4.2%	28.6%	27.3%	29.9%	25.7%	28.2%
Floors/ceilings	12.2%	14.6%	3.3%	15.7%	14.8%	16.0%	14.0%	18.2%
Interior Walls	23.2%	23.7%	46.7%	21.6%	17.9%	19.6%	15.9%	20.4%
Exterior Walls	26.4%	23.9%	8.8%	25.3%	22.5%	21.6%	28.1%	17.0%
Roof	8.9%	5.1%	35.9%	2.2%	6.8%	5.2%	8.0%	8.7%
Windows	8.5%	6.0%	1.0%	6.5%	10.7%	7.7%	8.3%	7.5%

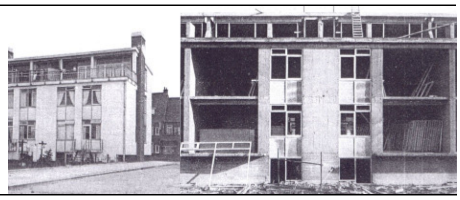
* Total = Construction Phase + Use Phase

Z2_MF_006



Annex C 45 Building type Z2_MF_007_ex

Multi-family house
Concrete wall, reinforced concrete flooring, pitched roof



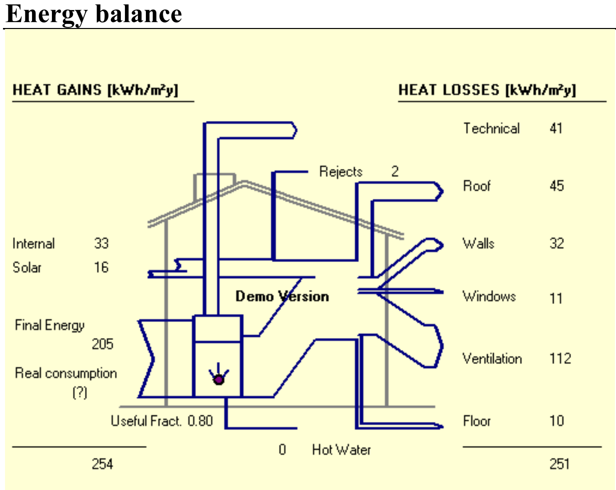
Statistics Proportion of Z2_MF_007_ex in the EU-25: 1.7%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]		778.0					768.0	66.0	1180.0	95.0	40.0	352.0	205.0
Number of buildings [1 000]		48.6					48.0	4.1	73.8	5.9	2.5	22.0	12.8
Stock in Mio. m^2		70					67	6	80	5	3	27	15
Density in m^2/occupant		40.8					38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building		35.2					37.0	38.4	48.0	41.6	40.0	40.0	40.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	007_ex
Year of construction	1950-1965
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 10°
Roof cladding	Concrete tile
Exterior wall	Reinforced concrete 20 cm
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

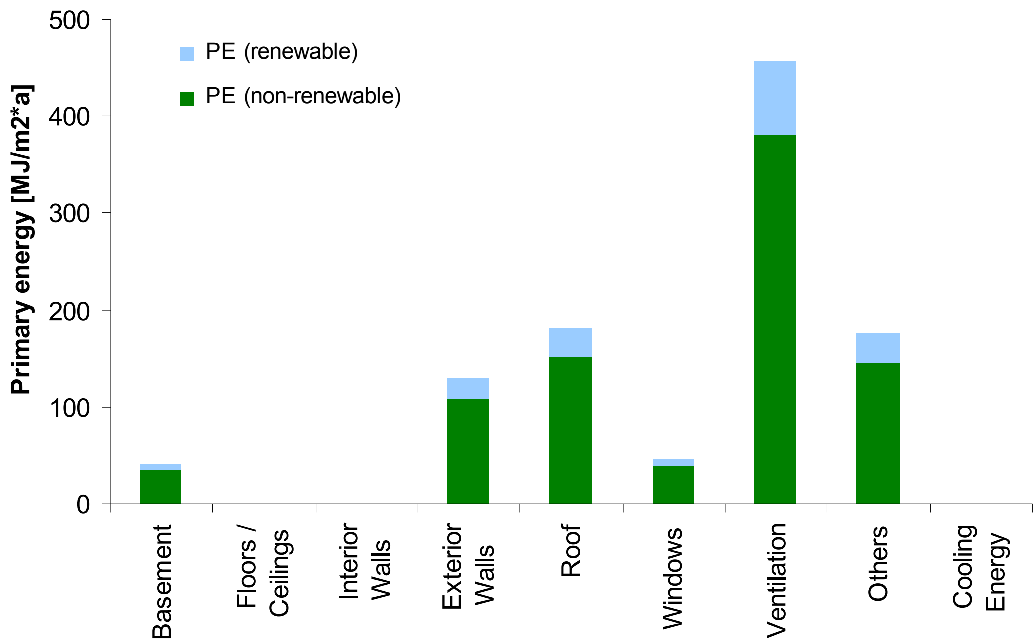


Z2_MF_007_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 038**	**65.8**	**-16.4**	**49.5**	**1.8E-01**	**1.1E-02**	**6.2E-02**	**3.6E-06**
Refurbishment	6	0.3	0.0	0.3	1.7E-03	1.5E-04	1.3E-04	1.4E-08
Heating & cooling	1 033	65.5	-16.3	49.1	1.8E-01	1.1E-02	6.2E-02	3.6E-06
End-of-Life	**-3**	**0.4**	**0.0**	**0.4**	**2.8E-04**	**4.3E-05**	**-5.9E-06**	**-9.9E-10**
Construction	-3	0.3	0.0	0.3	3.7E-04	5.2E-05	1.1E-05	-1.9E-09
Refurbishment	-1	0.0	0.0	0.0	-9.0E-05	-9.0E-06	-1.7E-05	8.8E-10
Total*	**1 038**	**65.8**	**-16.4**	**49.5**	**1.8E-01**	**1.1E-02**	**6.2E-02**	**3.6E-06**
Heating & Cooling								
Basement	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%	12.7%
Roof	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%
Windows	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%	4.2%
Ventilation	44.3%	44.3%	44.4%	44.3%	44.3%	44.3%	44.3%	44.3%
Others	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_007_ex



Annex C 46 Building type Z2_MF_007

Multi-family house
Concrete wall, reinforced concrete flooring, pitched roof

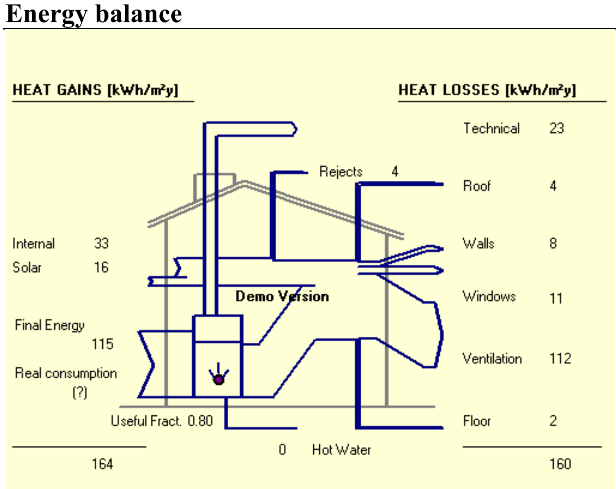
Statistics Proportion of Z2_MF_007 in the EU-25: 0.04%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	5.7	77.6	0.3	11.7	3.9	0.8	25.3	9.3	28.4	3.4	1.2	8.5	5.0
Number of buildings [1 000]	0.4	4.8	0.02	0.7	0.2	0.05	1.6	0.6	1.8	0.2	0.07	0.5	0.3
Stock in Mio. m^2	0.5	7	0.04	1	0.4	0.1	2	1	2	0.2	0.1	1	0.4
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6	36.0	38.0	39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	38.4	35.2	40.0	38.4	35.2	46.4	37.0	38.4	48.0	41.6	40.0	40.0	40.0

Description of the building type **NEW**

Zone	2
Building type	Multi-family house
Number	007
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 10° (14 cm insulation)
Roof cladding	Concrete tile
Exterior wall	Reinforced concrete 20 cm (12 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

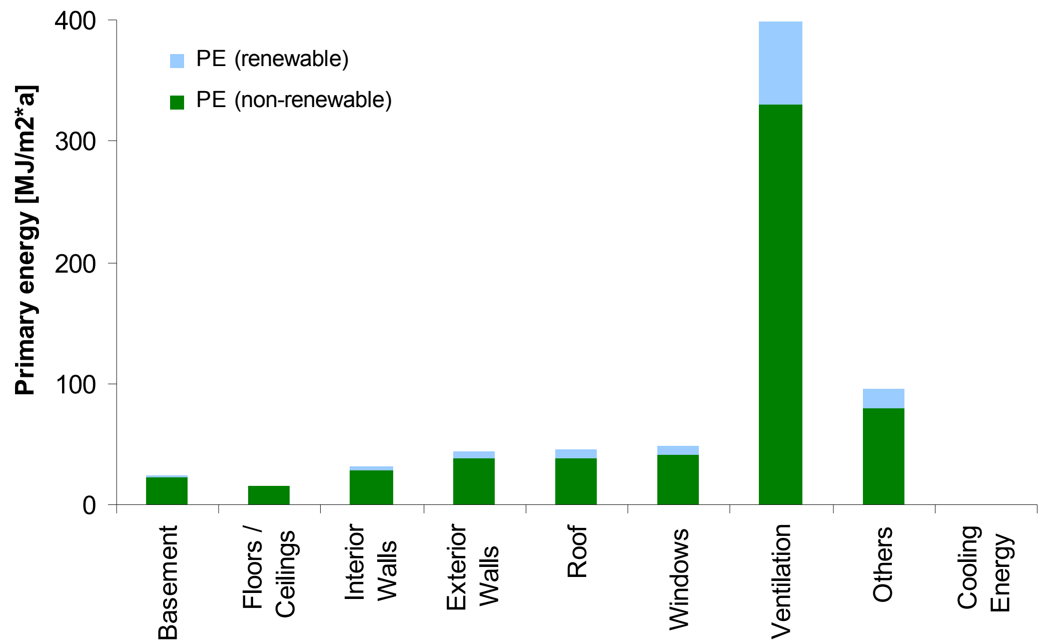


Z2_MF_007

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**106**	**9.6**	**-0.5**	**9.1**	**2.6E-02**	**3.4E-03**	**2.6E-03**	**4.1E-07**
Use Phase	**598**	**37.9**	**-9.5**	**28.5**	**1.1E-01**	**6.7E-03**	**3.5E-02**	**2.1E-06**
Refurbishment	15	1.0	-0.2	0.7	3.9E-03	3.8E-04	4.9E-04	4.9E-08
Heating & cooling	583	37.0	-9.2	27.7	1.0E-01	6.4E-03	3.5E-02	2.0E-06
End-of-Life	**1**	**0.5**	**0.0**	**0.5**	**1.5E-03**	**2.0E-04**	**2.1E-04**	**1.4E-09**
Construction	2	0.4	0.0	0.4	1.5E-03	1.9E-04	2.2E-04	4.1E-09
Refurbishment	-2	0.1	0.0	0.1	-4.2E-05	6.6E-07	-1.1E-05	-2.7E-09
Total*	**704**	**47.5**	**-9.9**	**37.6**	**1.3E-01**	**1.0E-02**	**3.8E-02**	**2.5E-06**
Heating & Cooling								
Basement	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%	1.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
Roof	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%	2.4%
Windows	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%	6.7%
Ventilation	68.4%	68.3%	68.3%	68.2%	68.2%	68.2%	68.3%	68.1%
Others	16.5%	16.5%	16.5%	16.5%	16.4%	16.5%	16.5%	16.4%
Cooling Energy	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%
Construction Phase								
Basement	15.7%	20.0%	5.6%	20.7%	20.3%	20.9%	19.3%	15.7%
Floors/ceilings	14.2%	16.5%	6.6%	17.0%	16.5%	16.7%	15.7%	15.2%
Interior Walls	22.7%	28.7%	28.8%	28.7%	28.5%	29.2%	26.1%	28.3%
Exterior Walls	12.8%	15.4%	6.7%	15.8%	15.9%	15.3%	18.0%	13.9%
Roof	26.8%	14.9%	51.0%	13.1%	10.9%	12.6%	14.7%	22.7%
Windows	6.6%	4.5%	1.3%	4.7%	8.0%	5.4%	6.2%	4.2%

* Total = Construction Phase + Use Phase

Z2_MF_007



Annex C 47 Building type Z2_MF_008

Multi-family house
Concrete wall, reinforced concrete flooring, flat roof

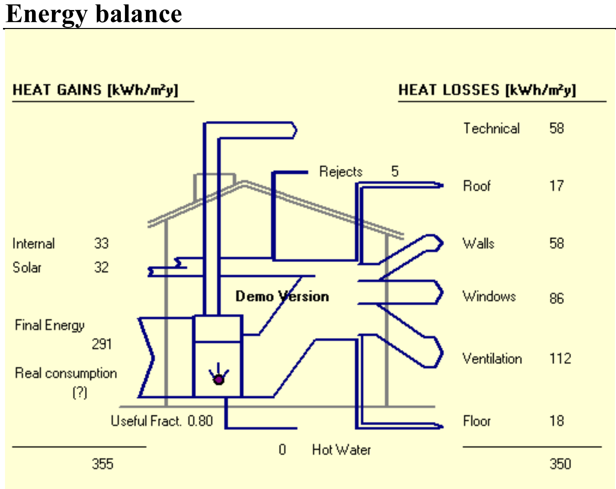
Statistics Proportion of Z2_MF_008 in the EU-25: 1.4%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]		778.0					512.0		1180.0	95.0	24.0	220.0	82.0
Number of buildings [1 000]		27.8					18.3		42.1	3.4	0.9	7.9	2.9
Stock in Mio. m^2		70					44		80	5	2	17	6
Density in m^2/occupant		40.8					38.0		22.7	21.6	30.0	30.5	30.0
Occupants per building		61.6					64.0		84.0	72.8	70.0	70.0	70.0

Description of the building type **EXISTING**

Zone	2
Building type	Multi-family house
Number	008
Year of construction	1970-1990
Residual service life	30 a
Dimension	32 m * 12 m
Storey	7
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Reinforced concrete 25 cm (5 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and double-glazing

Energy balance

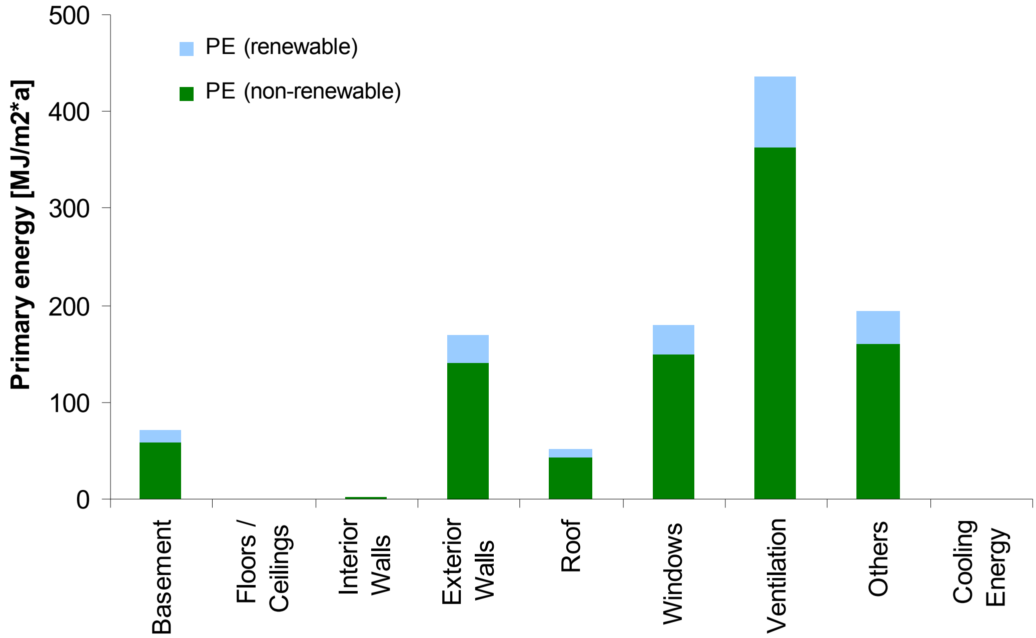


Z2_MF_008

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 104**	**69.9**	**-17.4**	**52.6**	**1.9E-01**	**1.2E-02**	**6.6E-02**	**3.8E-06**
Refurbishment	11	0.7	-0.1	0.6	3.1E-03	2.7E-04	3.7E-04	3.1E-08
Heating & cooling	1 093	69.3	-17.3	52.0	1.9E-01	1.2E-02	6.5E-02	3.8E-06
End-of-Life	**-1**	**0.2**	**0.0**	**0.2**	**2.8E-04**	**2.6E-05**	**-1.2E-06**	**3.3E-09**
Construction	0	0.1	0.0	0.1	3.3E-04	3.4E-05	1.6E-05	2.4E-09
Refurbishment	-1	0.1	0.0	0.1	-5.2E-05	-7.5E-06	-1.7E-05	9.1E-10
Total*	**1 104**	**69.9**	**-17.4**	**52.6**	**1.9E-01**	**1.2E-02**	**6.6E-02**	**3.8E-06**
Heating & Cooling								
Basement	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%	6.4%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	15.4%	15.4%	15.4%	15.4%	15.4%	15.4%	15.4%	15.4%
Roof	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%	4.6%
Windows	15.9%	15.9%	15.9%	15.9%	15.9%	15.9%	15.9%	15.9%
Ventilation	39.9%	39.9%	39.9%	39.9%	39.9%	39.9%	39.9%	39.9%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_MF_008



Annex C 48 Building type Z2_HR_001

High-rise building
Concrete wall, reinforced concrete flooring, flat roof

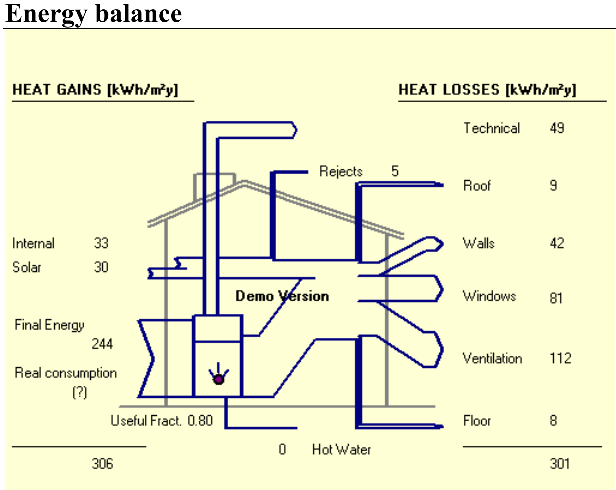
Statistics Proportion of Z2_HR_001 in the EU-25: 2.0%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]		1167.0	8.0	136.0	78.0		256.0		1416.0	190.0	24.0	528.0	246.0
Number of buildings [1 000]		23.3	0.2	2.7	1.6		5.1		28.3	3.8	0.5	10.6	4.9
Stock in Mio. m^2		105	1	13	9		22		97	11	2	40	18
Density in m^2/occupant		40.8	50.0	40.8	49.6		38.0		22.7	21.6	30.0	30.5	30.0
Occupants per building		110.0	125.0	120.0	110.0		115.0		150.0	130.0	125.0	125.0	125.0

Description of the building type **EXISTING**

Zone	2
Building type	High-rise building
Number	001
Year of construction	1960-1990
Residual service life	30 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Reinforced concrete 25 cm (5 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and double-glazing

Energy balance



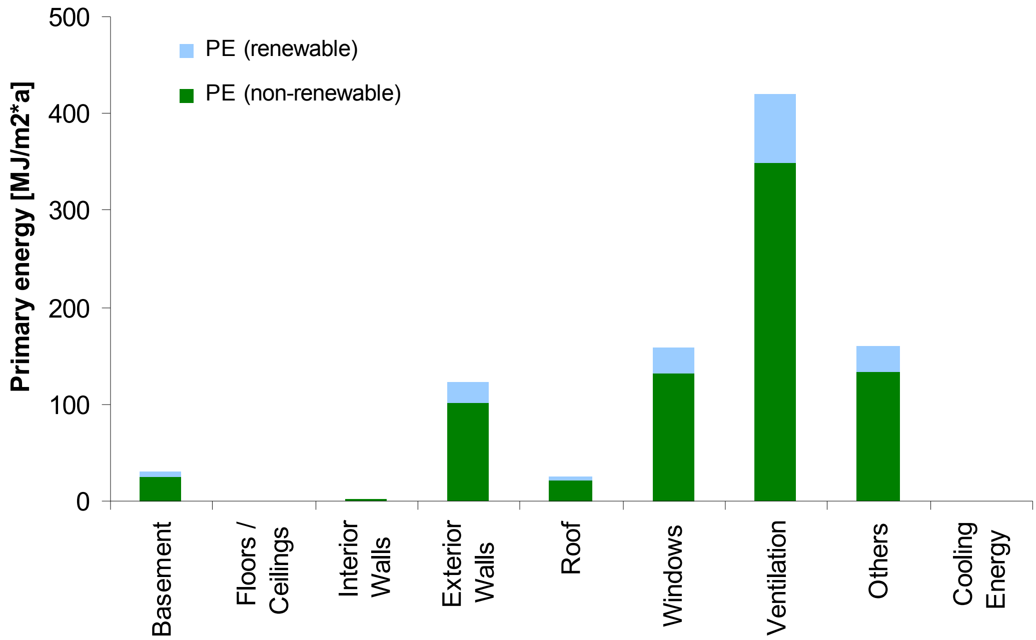
Z2_HR_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**920**	**58.3**	**-14.5**	**43.8**	**1.6E-01**	**1.0E-02**	**5.5E-02**	**3.2E-06**
Refurbishment	6	0.4	0.0	0.4	1.8E-03	1.6E-04	2.4E-04	1.9E-08
Heating & cooling	913	57.9	-14.5	43.4	1.6E-01	9.9E-03	5.5E-02	3.1E-06
End-of-Life	**-1**	**0.1**	**0.0**	**0.1**	**2.3E-04**	**2.1E-05**	**5.1E-06**	**1.9E-09**
Construction	0	0.1	0.0	0.1	2.5E-04	2.5E-05	1.4E-05	1.5E-09
Refurbishment	-1	0.0	0.0	0.0	-2.0E-05	-3.7E-06	-8.8E-06	4.6E-10
Total*	**920**	**58.3**	**-14.5**	**43.8**	**1.6E-01**	**1.0E-02**	**5.5E-02**	**3.2E-06**

Heating & Cooling								
Basement	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	13.3%	13.3%	13.3%	13.3%	13.3%	13.3%	13.3%	13.3%
Roof	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%	2.7%
Windows	17.1%	17.1%	17.1%	17.1%	17.1%	17.1%	17.1%	17.1%
Ventilation	46.0%	46.0%	46.1%	46.0%	46.0%	46.0%	46.0%	46.0%
Others	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%

* Total = Use Phase

Z2_HR_001



Annex C 49 Building type Z2_HR_002_ex

High-rise building
Brick masonry, reinforced concrete flooring, flat roof

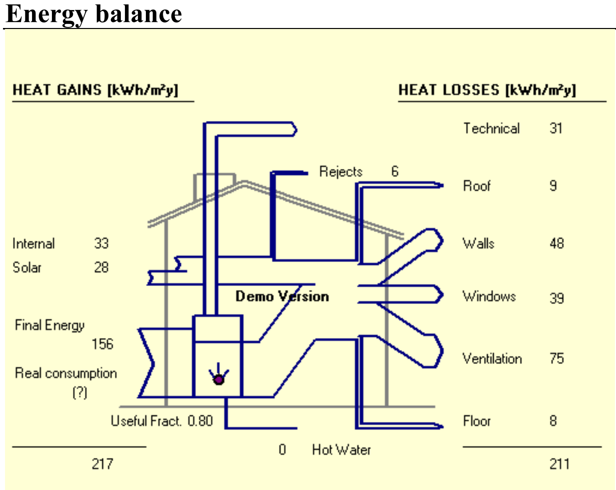
Statistics Proportion of Z2_HR_002_ex in the EU-25: 1.1%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	96.0	389.0	8.0	204.0	78.0			33.0	708.0	114.0	40.0	264.0	328.0
Number of buildings [1 000]	1.9	7.8	0.2	4.1	1.6			0.7	14.2	2.3	0.8	5.30	6.6
Stock in Mio. m^2	8	35	1	20	9			3	48	6	3	20	25
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6			39.1	22.7	21.6	30.0	30.5	30.0
Occupants per building	120.0	110.0	125.0	120.0	110.0			120.0	150.0	130.0	125.0	125.0	125.0

Description of the building type **EXISTING**

Zone	2
Building type	High-rise building
Number	002_ex
Year of construction	Since 1970
Residual service life	30 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 25 cm (5 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster: lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

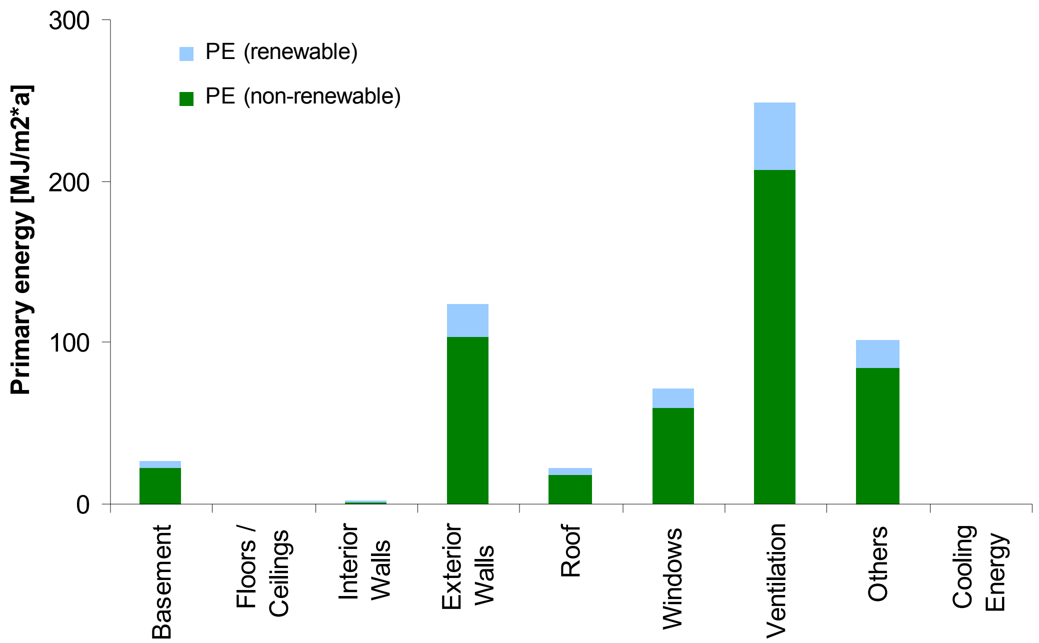


Z2_HR_002_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**599**	**37.9**	**-9.4**	**28.5**	**1.0E-01**	**6.7E-03**	**3.6E-02**	**2.1E-06**
Refurbishment	10	0.6	-0.1	0.5	2.8E-03	2.4E-04	3.2E-04	2.9E-08
Heating & cooling	589	37.3	-9.3	28.0	1.0E-01	6.4E-03	3.5E-02	2.0E-06
End-of-Life	**-2**	**0.3**	**0.0**	**0.3**	**5.4E-04**	**6.3E-05**	**2.5E-05**	**8.2E-10**
Construction	0	0.2	0.0	0.2	6.5E-04	7.3E-05	4.6E-05	1.3E-09
Refurbishment	-1	0.1	0.0	0.1	-1.1E-04	-9.9E-06	-2.1E-05	-4.6E-10
Total*	**599**	**37.9**	**-9.4**	**28.5**	**1.0E-01**	**6.7E-03**	**3.6E-02**	**2.1E-06**
Heating & Cooling								
Basement	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	20.8%	20.9%	20.9%	20.8%	20.8%	20.8%	20.9%	20.8%
Roof	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%	3.8%
Windows	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%	11.3%
Ventilation	42.3%	42.3%	42.3%	42.3%	42.3%	42.3%	42.3%	42.2%
Others	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%
Cooling Energy	0.1%	0.0%	0.0%	0.1%	0.1%	0.1%	0.0%	0.2%

* Total = Use Phase

Z2_HR_002_ex



Annex C 50 Building type Z2_HR_002

High-rise building
Brick masonry, reinforced concrete flooring, flat roof

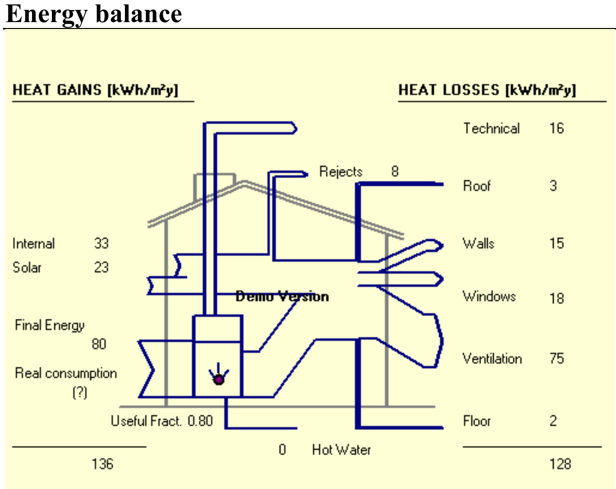
Statistics Proportion of Z2_HR_002 in the EU-25: 0.03%

	Belgium	Germany	Luxembourg	The Netherlands	Denmark	Ireland	United Kingdom	Austria	Poland	Slovakia	Slovenia	Czech Republic	Hungary
Number of dwellings [1 000]	3.3	23.7	0.5	7.9	3.0		8.0		53.5	7.5	1.6	15.7	10.5
Number of buildings [1 000]	0.1	0.5	0.01	0.2	0.1		0.2		1.1	0.2	0.03	0.3	0.2
Stock in Mio. m^2	0.3	2.1	0.1	0.8	0.3		0.7		3.7	0.4	0.1	1.2	0.8
Density in m^2/occupant	36.0	40.8	50.0	40.8	49.6		37.8		22.7	21.6	30.0	30.5	30.0
Occupants per building	120.0	110.0	125.0	120.0	110.0		115.0		150.0	130.0	125.0	125.0	125.0

Description of the building type **NEW**

Zone	2
Building type	High-rise building
Number	002
Year of construction	Since 2006
Residual service life	40 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof (12 cm insulation)
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 25 cm (12 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance



Z2_HR_002

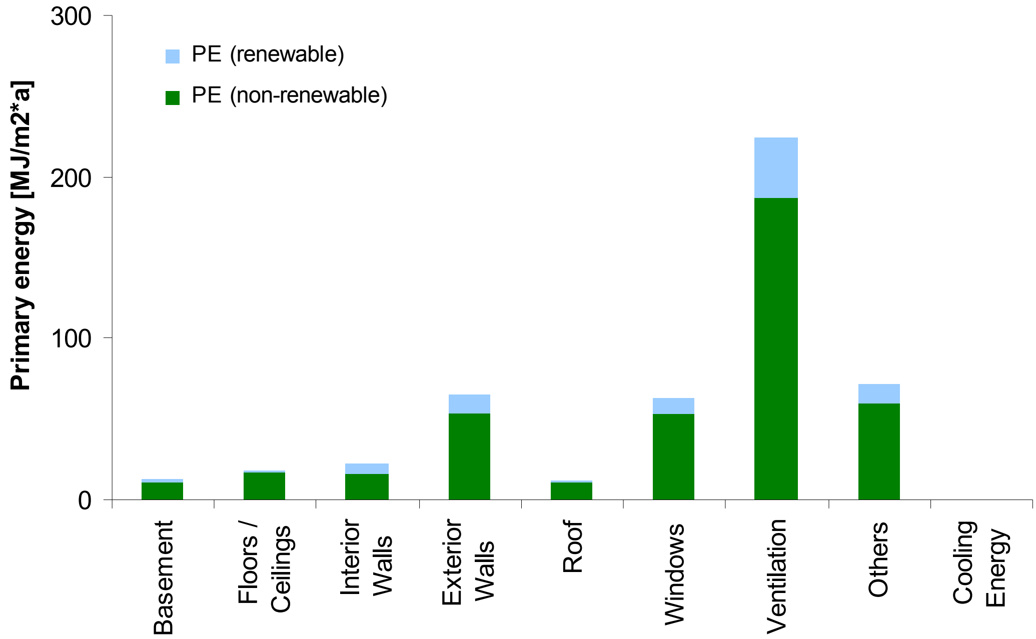
	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**69**	**5.7**	**-1.0**	**4.7**	**1.7E-02**	**1.9E-03**	**1.6E-03**	**1.9E-07**
Use Phase	**422**	**26.7**	**-6.7**	**20.0**	**7.4E-02**	**4.7E-03**	**2.5E-02**	**1.4E-06**
Refurbishment	11	0.7	-0.2	0.5	2.9E-03	2.6E-04	3.5E-04	3.3E-08
Heating & cooling	411	26.0	-6.5	19.5	7.1E-02	4.5E-03	2.5E-02	1.4E-06
End-of-Life	**-2**	**0.3**	**0.0**	**0.3**	**4.6E-04**	**5.5E-05**	**2.5E-05**	**-7.2E-10**
Construction	0	0.2	0.0	0.2	4.8E-04	5.5E-05	3.4E-05	7.9E-10
Refurbishment	-1	0.1	0.0	0.1	-2.3E-05	-3.9E-07	-8.9E-06	-1.5E-09
Total*	**491**	**32.4**	**-7.6**	**24.8**	**9.1E-02**	**6.6E-03**	**2.7E-02**	**1.6E-06**

Heating & Cooling								
Basement	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%	1.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%	10.9%
Roof	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Windows	13.1%	13.1%	13.1%	13.1%	13.1%	13.1%	13.1%	13.1%
Ventilation	54.7%	54.7%	54.7%	54.7%	54.7%	54.7%	54.7%	54.6%
Others	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%
Cooling Energy	0.1%	0.1%	0.0%	0.1%	0.1%	0.1%	0.0%	0.3%

Construction Phase								
Basement	8.7%	12.6%	0.9%	15.0%	12.1%	14.1%	11.5%	11.5%
Floors/ceilings	24.9%	31.5%	3.5%	37.4%	29.6%	33.8%	29.0%	36.4%
Interior Walls	27.8%	22.5%	52.3%	16.2%	21.3%	19.7%	21.0%	22.4%
Exterior Walls	26.0%	23.0%	42.4%	18.9%	22.2%	20.0%	25.8%	17.6%
Roof	3.6%	3.8%	0.4%	4.5%	3.6%	4.0%	3.7%	4.3%
Windows	9.0%	6.7%	0.5%	8.0%	11.1%	8.4%	8.9%	7.8%

* Total = Construction Phase + Use Phase

Z2_HR_002



Annex C 51 Building type Z3_SI_001

Single-family house
Brick masonry, wooden flooring, pitched roof

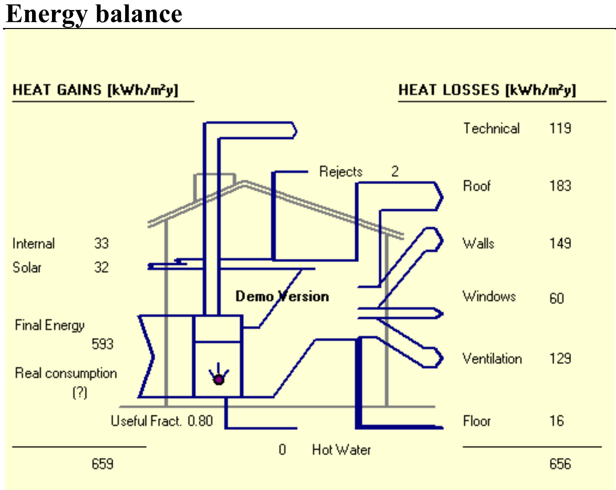
Statistics Proportion of Z3_SI_001 in the EU-25: 0.2%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	52.0	220.0	12.0	20.0	39.0
Number of buildings [1 000]	34.7	146.7	8.0	13.3	26.0
Stock in Mio. m^2	4	20	1	1	2
Density in m^2/occupant	35	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	001
Year of construction	Until 1945
Residual service life	40 a
Dimension	10 m * 9 m
Storey	2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Brick
Window	Wooden frame and single-glazing

Energy balance

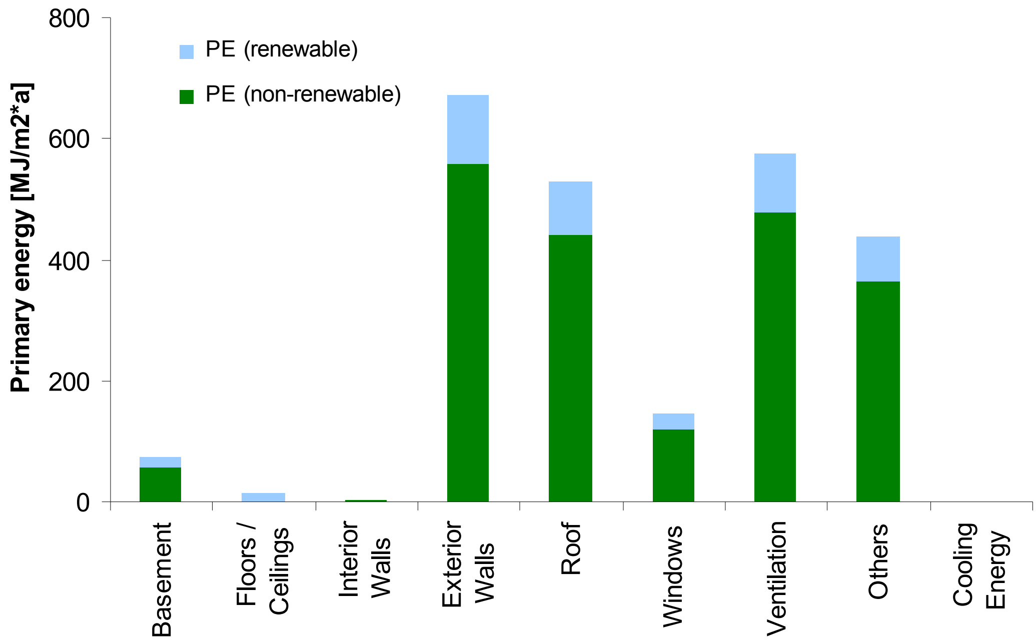


Z3_SI_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 472**	**155.8**	**-40.5**	**115.3**	**4.3E-01**	**2.7E-02**	**1.5E-01**	**8.5E-06**
Refurbishment	57	2.7	-2.3	0.4	9.8E-03	8.8E-04	1.7E-03	1.7E-07
Heating & cooling	2 416	153.2	-38.3	114.9	4.2E-01	2.6E-02	1.4E-01	8.3E-06
End-of-Life	**-36**	**4.1**	**0.0**	**4.1**	**3.7E-04**	**2.9E-04**	**5.0E-05**	**-1.1E-07**
Construction	-20	2.7	0.0	2.7	1.5E-03	3.2E-04	1.5E-04	-6.4E-08
Refurbishment	-17	1.4	0.0	1.4	-1.2E-03	-3.1E-05	-1.0E-04	-4.7E-08
Total*	**2 472**	**155.8**	**-40.5**	**115.3**	**4.3E-01**	**2.7E-02**	**1.5E-01**	**8.5E-06**
Heating & Cooling								
Basement	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	27.5%	27.5%	27.5%	27.5%	27.5%	27.5%	27.5%	27.5%
Roof	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%	21.9%
Windows	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%	5.7%
Ventilation	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%	23.8%
Others	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

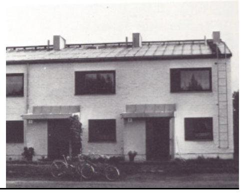
* Total = Use Phase

Z3_SI_001



Annex C 52 Building type Z3_SI_002

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof



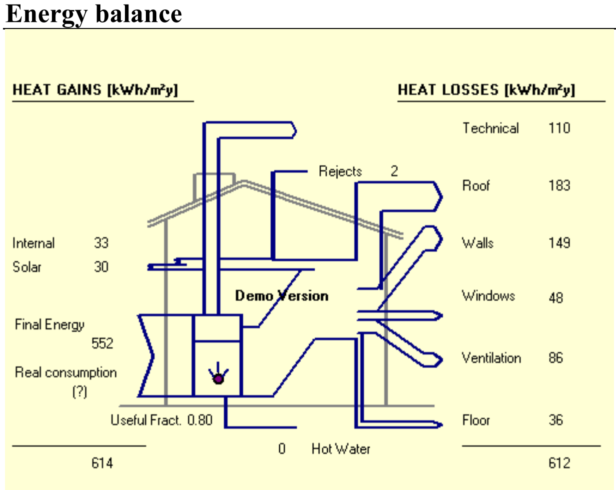
Statistics Proportion of Z3_SI_002 in the EU-25: 0.3%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	286.0	88.0	66.0	110.0	143.0
Number of buildings [1 000]	190.7	58.7	44.0	73.3	95.3
Stock in Mio. m^2	22	8	4	6	9
Density in m^2/occupant	35	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	002
Year of construction	1945-1980
Residual service life	30 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Brick masonry 40 cm
Interior load-bearing wall	Reinforced concrete
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Wooden frame and double-glazing

Energy balance

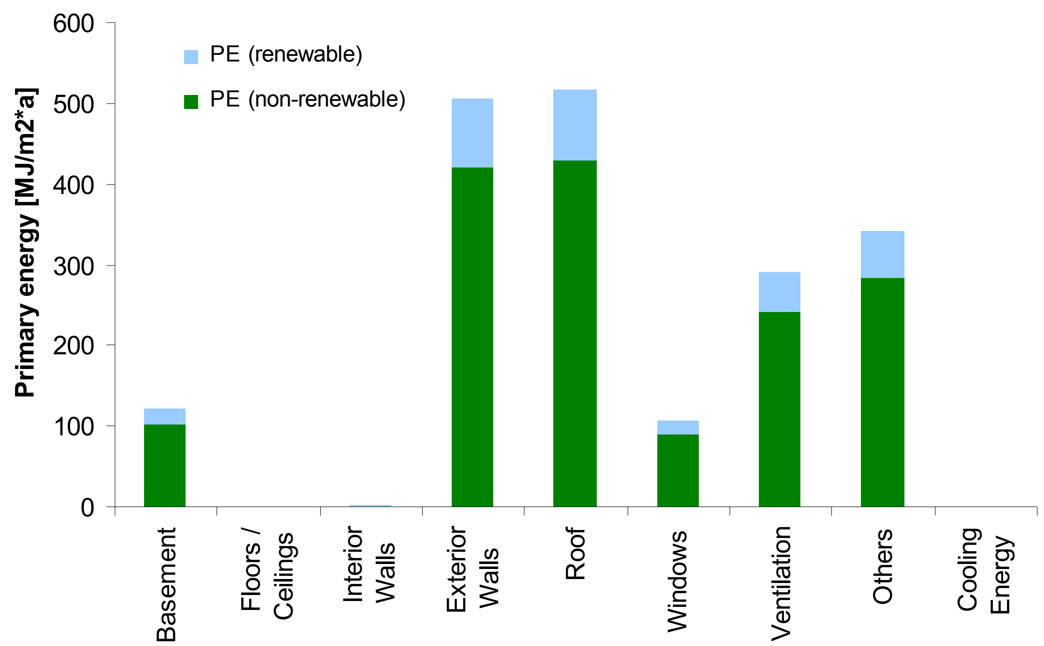


Z3_SI_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 892**	**119.9**	**-29.8**	**90.1**	**3.3E-01**	**2.1E-02**	**1.1E-01**	**6.5E-06**
Refurbishment	16	1.0	-0.1	0.9	4.7E-03	3.9E-04	6.8E-04	4.4E-08
Heating & cooling	1 876	118.9	-29.7	89.2	3.3E-01	2.0E-02	1.1E-01	6.5E-06
End-of-Life	**-6**	**1.0**	**0.0**	**1.0**	**1.2E-03**	**1.7E-04**	**8.1E-05**	**-1.1E-08**
Construction	-4	0.8	0.0	0.8	1.3E-03	1.8E-04	1.1E-04	-1.0E-08
Refurbishment	-2	0.1	0.0	0.1	-1.1E-04	-1.2E-05	-2.6E-05	-1.1E-09
Total*	**1 892**	**119.9**	**-29.8**	**90.1**	**3.3E-01**	**2.1E-02**	**1.1E-01**	**6.5E-06**
Heating & Cooling								
Basement	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%	26.8%
Roof	27.7%	27.7%	27.7%	27.7%	27.7%	27.7%	27.7%	27.7%
Windows	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Ventilation	15.5%	15.5%	15.5%	15.5%	15.5%	15.5%	15.5%	15.5%
Others	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%	18.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_SI_002



Annex C 53 Building type Z3_SI_003

Single-family house
Wooden wall, wooden flooring, pitched roof

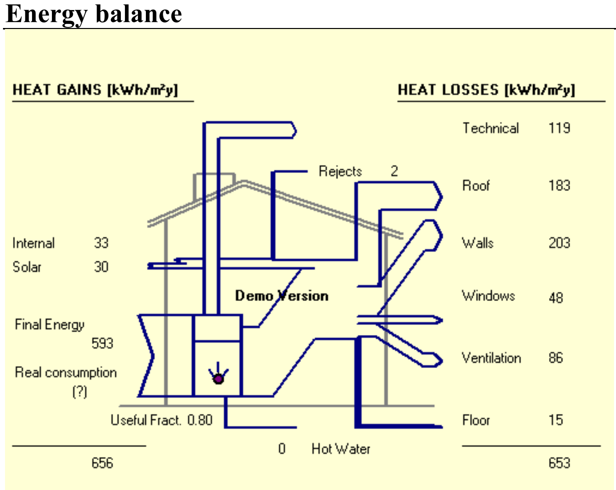
Statistics Proportion of Z3_SI_003 in the EU-25: 0.2%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	52.0	220.0	6.0	10.0	26.0
Number of buildings [1 000]	34.7	146.7	4.0	6.7	17.3
Stock in Mio. m^2	4	20	0	1	2
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	003
Year of construction	Until 1945
Residual service life	30 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Solid wooden construction 16 cm
Interior load-bearing wall	Solid wooden construction 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Wooden façade/plasterboard
Floor	Wooden flooring
Basement wall	Brick 80 cm
Basement ceiling	Wooden construction and stoneboard
Foundation	Concrete
Window	Wooden frame and double-glazing

Energy balance

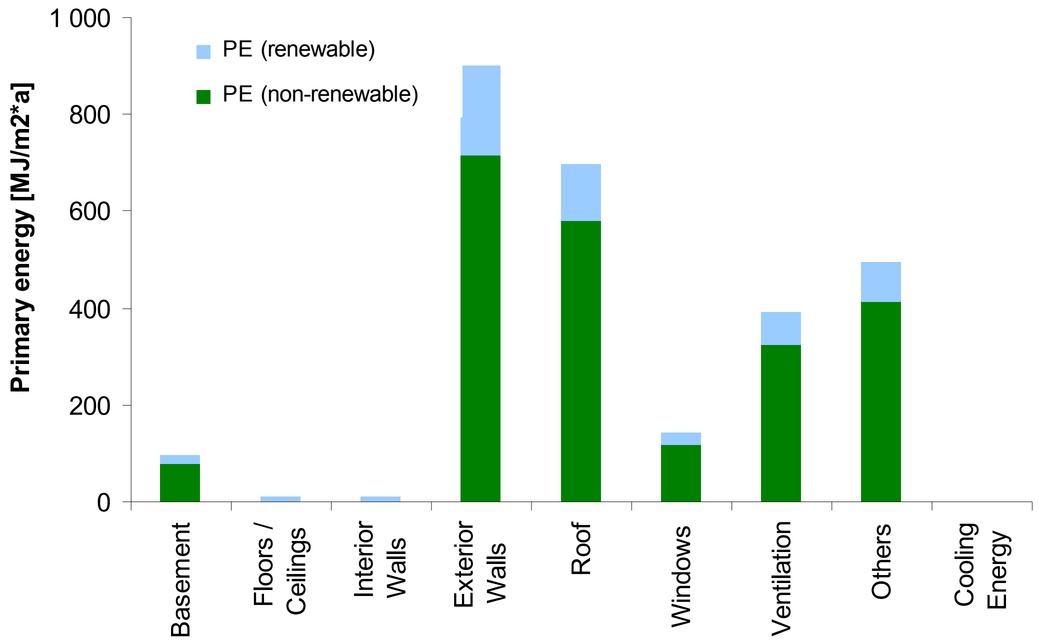


Z3_SI_003

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 836**	**178.1**	**-48.6**	**129.5**	**4.9E-01**	**3.2E-02**	**1.6E-01**	**9.7E-06**
Refurbishment	127	6.3	-5.7	0.6	2.2E-02	2.3E-03	2.5E-03	3.7E-07
Heating & cooling	2 709	171.8	-42.9	128.8	4.7E-01	3.0E-02	1.6E-01	9.3E-06
End-of-Life	**-132**	**11.5**	**0.0**	**11.5**	**-8.5E-03**	**-1.1E-04**	**-7.3E-04**	**-3.8E-07**
Construction	-93	8.1	0.0	8.1	-6.1E-03	-9.1E-05	-5.2E-04	-2.6E-07
Refurbishment	-39	3.4	0.0	3.4	-2.4E-03	-2.3E-05	-2.1E-04	-1.1E-07
Total*	**2 836**	**178.1**	**-48.6**	**129.5**	**4.9E-01**	**3.2E-02**	**1.6E-01**	**9.7E-06**
Heating & Cooling								
Basement	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%	2.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	34.0%	34.0%	34.0%	33.8%	34.0%	34.0%	34.0%	34.0%
Roof	25.9%	25.8%	25.8%	25.7%	25.8%	25.8%	25.8%	25.8%
Windows	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Ventilation	14.4%	14.4%	14.4%	14.3%	14.4%	14.4%	14.4%	14.4%
Others	18.3%	18.3%	18.3%	18.2%	18.3%	18.3%	18.3%	18.3%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_SI_003



Annex C 54 Building type Z3_SI_004

Single-family house
Wooden wall with brick façade, reinforced concrete flooring, pitched roof

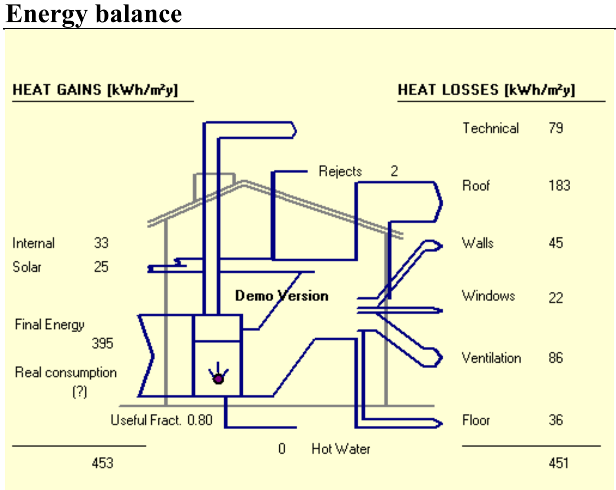
Statistics Proportion of Z3_SI_004 in the EU-25: 0.2%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	130.0	220.0	12.0	20.0	26.0
Number of buildings [1 000]	86.7	146.7	8.0	13.3	17.3
Stock in Mio. m^2	10	20	1	1	2
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	004
Year of construction	1940-1970
Residual service life	20 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Wooden panel structure (10 cm insulation), brick façade 10 cm
Interior load-bearing wall	Reinforced concrete
Interior wall	Wooden construction
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance



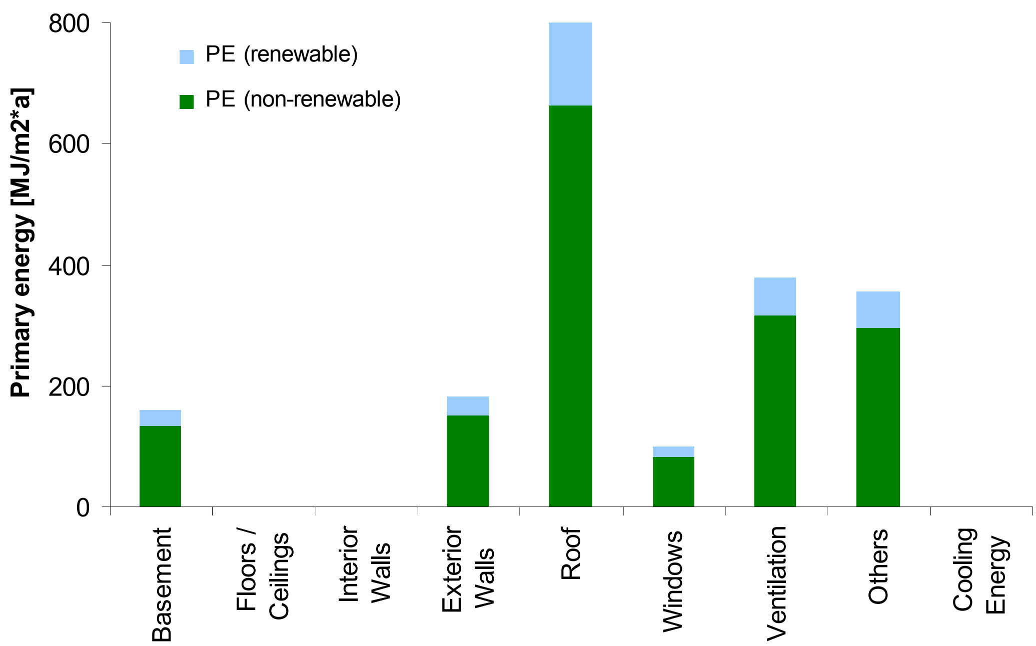
Z3_SI_004

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 005**	**127.1**	**-31.6**	**95.4**	**3.5E-01**	**2.2E-02**	**1.2E-01**	**6.9E-06**
Refurbishment	8	0.5	0.0	0.5	2.6E-03	2.0E-04	3.7E-04	2.0E-08
Heating & cooling	1 997	126.6	-31.6	95.0	3.5E-01	2.2E-02	1.2E-01	6.9E-06
End-of-Life	**-28**	**2.6**	**0.0**	**2.6**	**-6.9E-04**	**7.9E-05**	**-9.8E-05**	**-6.9E-08**
Construction	-26	2.6	0.0	2.6	-5.9E-04	9.2E-05	-7.5E-05	-7.0E-08
Refurbishment	-1	0.0	0.0	0.0	-1.0E-04	-1.3E-05	-2.2E-05	6.8E-10
Total*	**2 005**	**127.1**	**-31.6**	**95.4**	**3.5E-01**	**2.2E-02**	**1.2E-01**	**6.9E-06**

Heating & Cooling								
Basement	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%	8.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Roof	40.5%	40.5%	40.5%	40.5%	40.5%	40.5%	40.5%	40.5%
Windows	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%	4.7%
Ventilation	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%	19.0%
Others	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_SI_004



Annex C 55 Building type Z3_SI_005

Single-family house
Breeze concrete, breeze concrete block flooring, pitched roof

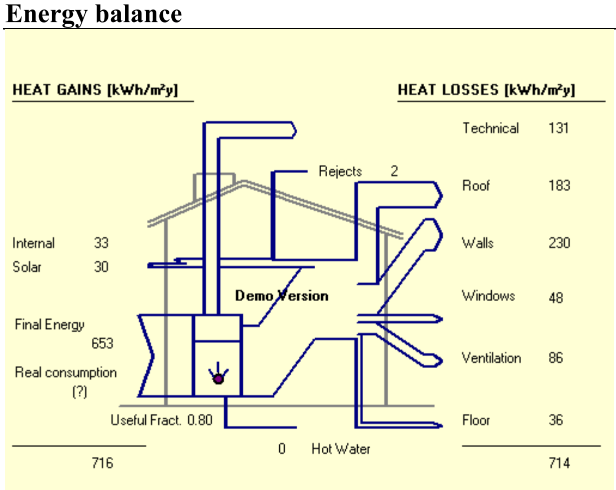
Statistics Proportion of Z3_SI_005 in the EU-25: 0.4%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	286.0	440.0	30.0	30.0	78.0
Number of buildings [1 000]	190.7	293.3	20.0	20.0	52.0
Stock in Mio. m^2	22	40	2	2	5
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	005
Year of construction	1945-1970
Residual service life	20 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Concrete tile
Exterior wall	Breeze concrete 30 cm
Interior load-bearing wall	Breeze concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Breeze concrete block
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

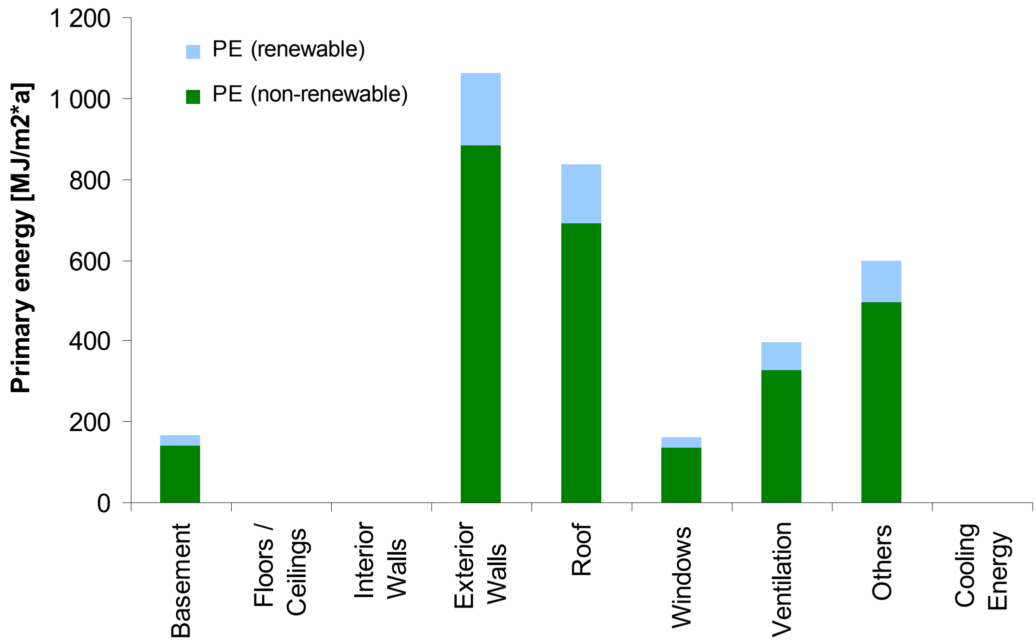


Z3_SI_005

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**3 232**	**204.9**	**-51.1**	**153.8**	**5.6E-01**	**3.5E-02**	**1.9E-01**	**1.1E-05**
Refurbishment	8	0.5	0.0	0.5	2.7E-03	2.0E-04	3.7E-04	2.0E-08
Heating & cooling	3 224	204.4	-51.1	153.3	5.6E-01	3.5E-02	1.9E-01	1.1E-05
End-of-Life	**-8**	**1.4**	**0.0**	**1.4**	**1.8E-03**	**2.5E-04**	**1.2E-04**	**-1.8E-08**
Construction	-7	1.4	0.0	1.4	1.9E-03	2.6E-04	1.5E-04	-1.9E-08
Refurbishment	-1	0.0	0.0	0.0	-1.1E-04	-1.3E-05	-2.3E-05	6.8E-10
Total*	**3 232**	**204.9**	**-51.1**	**153.8**	**5.6E-01**	**3.5E-02**	**1.9E-01**	**1.1E-05**
Heating & Cooling								
Basement	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	32.9%	32.9%	32.9%	32.9%	32.9%	32.9%	32.9%	32.9%
Roof	26.2%	26.2%	26.2%	26.2%	26.2%	26.2%	26.2%	26.2%
Windows	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
Ventilation	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%	12.3%
Others	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%	18.6%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_SI_005



Annex C 56 Building type Z3_SI_006_ex

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof

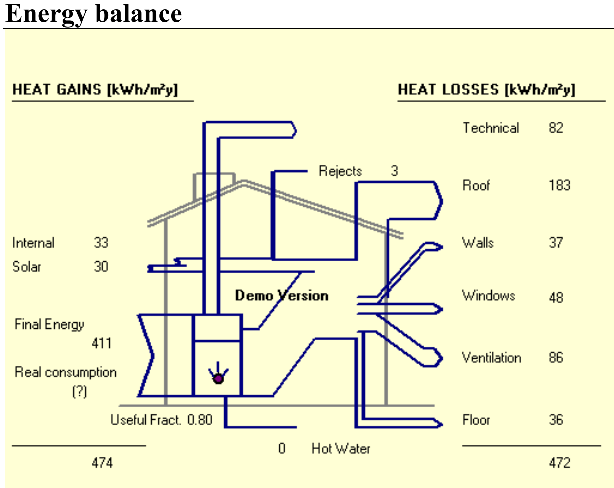

Statistics Proportion of Z3_SI_006_ex in the EU-25: 0.2%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	52.0	220.0	18.0	20.0	39.0
Number of buildings [1 000]	34.7	146.7	12.0	13.3	26.0
Stock in Mio. m^2	4	20	1	1	2
Density in m^2/occupant	35	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	006_ex
Year of construction	Since 1980
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick masonry 25 cm (12 cm insulation)
Interior load-bearing wall	Reinforced concrete 10 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and triple-glazing

Energy balance

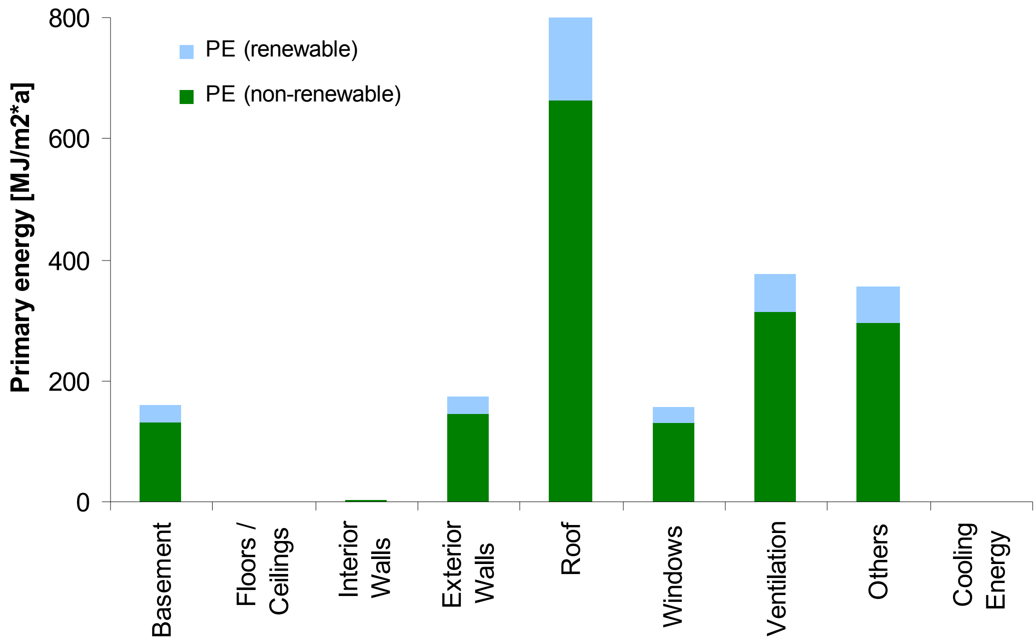


Z3_SI_006_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**2 031**	**128.7**	**-31.9**	**96.8**	**3.5E-01**	**2.2E-02**	**1.2E-01**	**7.0E-06**
Refurbishment	30	1.9	-0.2	1.7	7.8E-03	6.9E-04	1.2E-03	7.7E-08
Heating & cooling	2 001	126.8	-31.7	95.2	3.5E-01	2.2E-02	1.2E-01	6.9E-06
End-of-Life	**-6**	**0.8**	**0.0**	**0.8**	**7.9E-04**	**1.1E-04**	**4.5E-05**	**-1.2E-08**
Construction	-4	0.6	0.0	0.6	8.0E-04	1.1E-04	6.0E-05	-8.9E-09
Refurbishment	-2	0.2	0.0	0.2	-1.7E-05	5.9E-07	-1.5E-05	-3.0E-09
Total*	**2 031**	**128.7**	**-31.9**	**96.8**	**3.5E-01**	**2.2E-02**	**1.2E-01**	**7.0E-06**
Heating & Cooling								
Basement	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%	7.9%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%	8.1%
Roof	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%	40.0%
Windows	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%
Ventilation	18.8%	18.8%	18.8%	18.8%	18.8%	18.8%	18.8%	18.8%
Others	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_SI_006_ex



Annex C 57 Building type Z3_SI_006

Single-family house
Brick masonry, reinforced concrete flooring, pitched roof

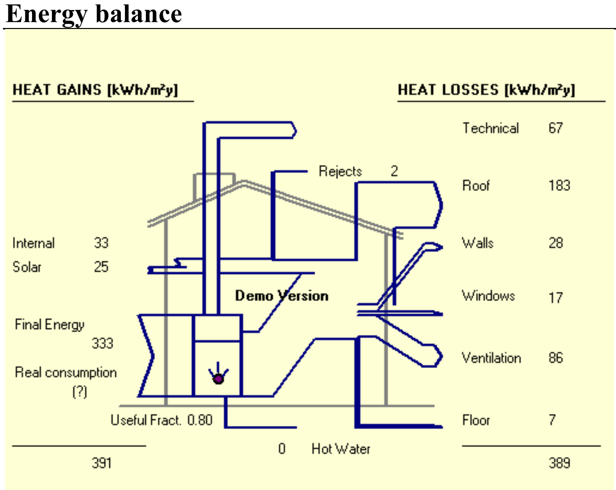
Statistics Proportion of Z3_SI_006 in the EU-25: 0.01%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	8.5	16.8	1.3	2.0	4.1
Number of buildings [1 000]	5.7	11.2	0.9	1.3	2.7
Stock in Mio. m^2	0.7	1.5	0.1	0.1	0.2
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **NEW**

Zone	3
Building type	Single-family house
Number	006
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick masonry 25 cm (15 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and triple-glazing

Energy balance



Z3_SI_006

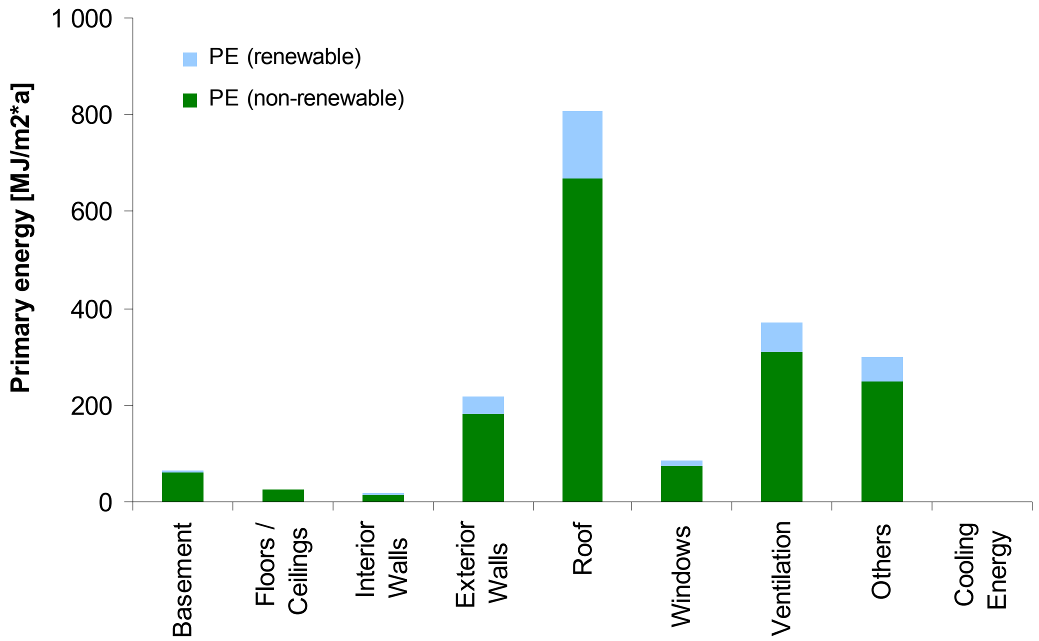
	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**180**	**14.3**	**-2.1**	**12.3**	**4.3E-02**	**4.9E-03**	**4.5E-03**	**5.0E-07**
Use Phase	**1 713**	**108.5**	**-26.9**	**81.7**	**3.0E-01**	**1.9E-02**	**1.0E-01**	**5.9E-06**
Refurbishment	31	1.9	-0.2	1.7	7.6E-03	6.9E-04	1.2E-03	7.7E-08
Heating & cooling	1 682	106.6	-26.6	80.0	2.9E-01	1.8E-02	1.0E-01	5.8E-06
End-of-Life	**-6**	**0.9**	**0.0**	**0.9**	**7.8E-04**	**1.2E-04**	**4.8E-05**	**-1.4E-08**
Construction	-4	0.7	0.0	0.7	7.7E-04	1.1E-04	5.8E-05	-1.0E-08
Refurbishment	-2	0.2	0.0	0.2	7.9E-06	3.5E-06	-9.9E-06	-3.5E-09
Total*	**1 893**	**122.9**	**-29.0**	**93.9**	**3.4E-01**	**2.4E-02**	**1.1E-01**	**6.4E-06**

Heating & Cooling								
Basement	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%	7.2%
Roof	46.9%	46.9%	46.9%	46.9%	46.9%	46.9%	46.9%	46.9%
Windows	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
Ventilation	22.1%	22.1%	22.1%	22.1%	22.1%	22.1%	22.1%	22.1%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Construction Phase								
Basement	18.9%	27.4%	2.3%	31.7%	25.6%	29.7%	23.1%	24.9%
Floors/ceilings	13.4%	17.6%	2.4%	20.2%	15.9%	18.2%	14.5%	19.8%
Interior Walls	7.8%	8.7%	9.1%	8.6%	8.0%	8.8%	7.2%	11.6%
Exterior Walls	44.8%	36.1%	59.8%	32.1%	36.6%	32.4%	42.0%	29.6%
Roof	9.9%	6.2%	26.1%	2.9%	7.4%	6.0%	8.5%	9.6%
Windows	5.1%	3.9%	0.4%	4.5%	6.3%	4.8%	4.7%	4.5%

* Total = Construction Phase + Use Phase

Z3_SI_006



Annex C 58 Building type Z3_SI_007_ex

Single-family house
Wooden frame wall,
wooden flooring, pitched
roof

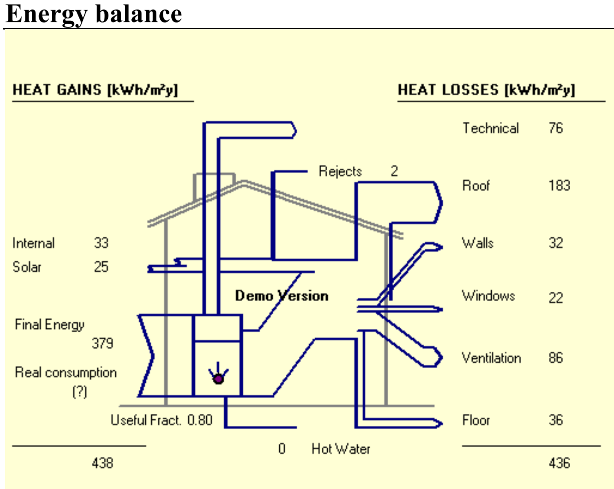

Statistics Proportion of Z3_SI_007_ex in the EU-25: 0.3%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	130.0	352.0	18.0	30.0	52.0
Number of buildings [1 000]	86.7	234.7	12.0	20.0	34.7
Stock in Mio. m^2	10	32	1	2	3
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type **EXISTING**

Zone	3
Building type	Single-family house
Number	007_ex
Year of construction	Since 1960
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Wooden frame structure 16 cm (16 cm insulation)
Interior load-bearing wall	Wooden frame 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Wooden façade, plasterboard
Floor	Wooden flooring
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

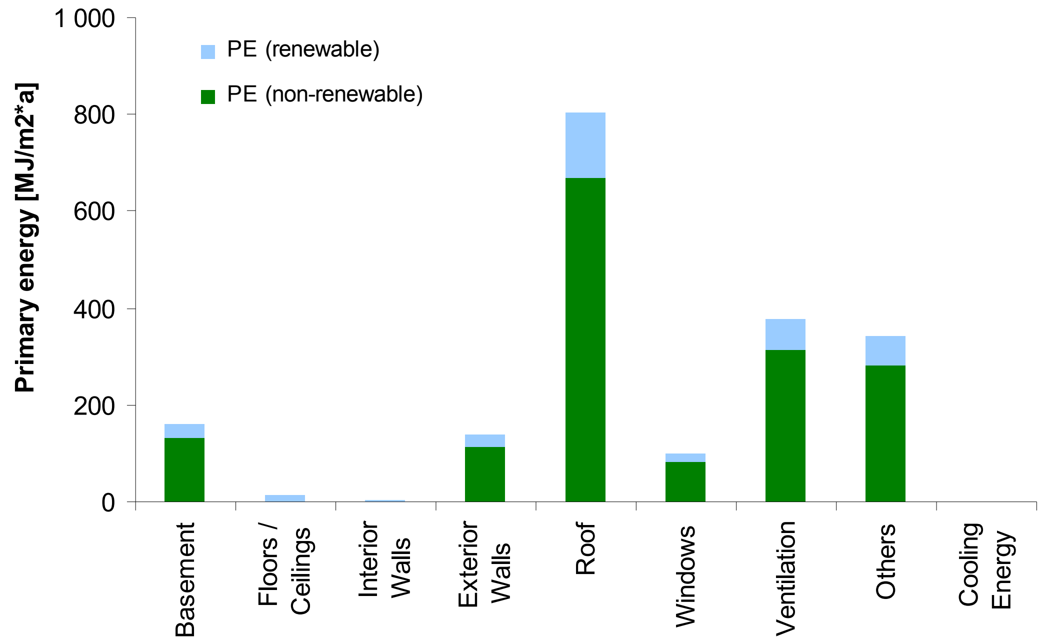


Z3_SI_007_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 965**	**123.6**	**-32.5**	**91.1**	**3.4E-01**	**2.2E-02**	**1.2E-01**	**6.7E-06**
Refurbishment	52	2.3	-2.2	0.1	9.0E-03	7.8E-04	1.5E-03	1.6E-07
Heating & cooling	1 913	121.3	-30.3	91.0	3.3E-01	2.1E-02	1.1E-01	6.6E-06
End-of-Life	**-45**	**3.8**	**0.0**	**3.8**	**-3.1E-03**	**-6.8E-05**	**-2.7E-04**	**-1.3E-07**
Construction	-28	2.5	0.0	2.5	-1.8E-03	-2.9E-05	-1.6E-04	-8.1E-08
Refurbishment	-16	1.4	0.0	1.4	-1.2E-03	-3.9E-05	-1.1E-04	-4.6E-08
Total*	**1 965**	**123.6**	**-32.5**	**91.1**	**3.4E-01**	**2.2E-02**	**1.2E-01**	**6.7E-06**
Heating & Cooling								
Basement	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%	8.3%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%	7.3%
Roof	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%	42.0%
Windows	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%
Ventilation	19.8%	19.7%	19.7%	19.7%	19.7%	19.7%	19.7%	19.7%
Others	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%	17.8%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_SI_007_ex



Annex C 59 Building type Z3_SI_007

Single-family house
Wooden frame wall, wooden flooring, pitched roof

Statistics

Proportion of Z3_SI_007 in the EU-25: 0.01%

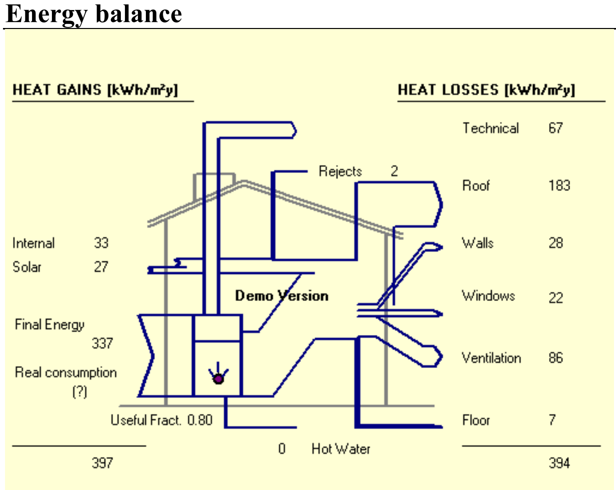
	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	8.5	16.8	1.3	2.0	4.1
Number of buildings [1 000]	5.7	11.2	0.9	1.3	2.7
Stock in Mio. m^2	0.7	1.5	0.1	0.1	0.2
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	3.3	3.2	3.6	4.1	3.9

Description of the building type

NEW

Zone	3
Building type	Single-family house
Number	007
Year of construction	Since 2006
Residual service life	40 a
Dimension	10 m * 9 m
Storey	1 to 2
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Wooden frame structure 16 cm (21 cm insulation)
Interior load-bearing wall	Wooden frame 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Wooden façade, plasterboard
Floor	Wooden flooring
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance



Z3_SI_007

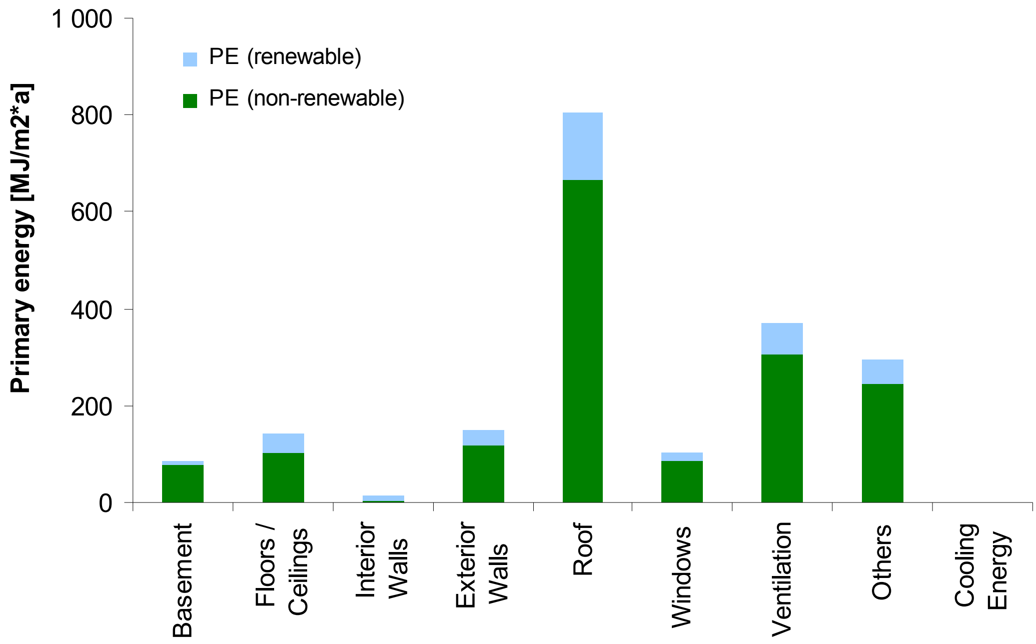
	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**226**	**12.3**	**-4.4**	**7.9**	**3.3E-02**	**4.0E-03**	**4.1E-03**	**7.3E-07**
Use Phase	**1 776**	**112.8**	**-29.2**	**83.7**	**3.1E-01**	**2.0E-02**	**1.0E-01**	**6.1E-06**
Refurbishment	79	5.2	-2.3	2.9	1.7E-02	1.8E-03	2.2E-03	2.6E-07
Heating & cooling	1 697	107.6	-26.9	80.7	2.9E-01	1.8E-02	1.0E-01	5.8E-06
End-of-Life	**-41**	**3.5**	**0.0**	**3.5**	**-2.6E-03**	**-3.7E-05**	**-2.2E-04**	**-1.2E-07**
Construction	-24	2.1	0.0	2.1	-1.5E-03	-1.6E-05	-1.3E-04	-6.9E-08
Refurbishment	-16	1.4	0.0	1.4	-1.1E-03	-2.1E-05	-9.4E-05	-4.7E-08
Total*	**2 003**	**125.1**	**-33.6**	**91.6**	**3.4E-01**	**2.4E-02**	**1.1E-01**	**6.8E-06**

Heating & Cooling								
Basement	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%	7.1%
Roof	46.4%	46.3%	46.3%	46.3%	46.3%	46.3%	46.3%	46.3%
Windows	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%
Ventilation	21.8%	21.8%	21.8%	21.8%	21.8%	21.8%	21.8%	21.8%
Others	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%	17.5%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Construction Phase								
Basement	13.1%	26.3%	1.1%	40.3%	28.1%	30.7%	21.2%	14.9%
Floors/ceilings	60.0%	49.4%	52.3%	47.9%	37.7%	43.7%	41.5%	60.3%
Interior Walls	5.3%	4.0%	13.1%	-1.0%	5.6%	4.3%	4.5%	6.0%
Exterior Walls	11.6%	10.7%	18.4%	6.4%	14.5%	10.6%	18.0%	9.5%
Roof	7.0%	6.6%	11.2%	4.1%	8.9%	6.8%	8.4%	6.0%
Windows	2.7%	2.9%	3.9%	2.4%	5.2%	3.9%	6.4%	3.2%

* Total = Construction Phase + Use Phase

Z3_SI_007



Annex C 60 Building type Z3_MF_001

Multi-family house
Brick masonry, wooden flooring, pitched roof

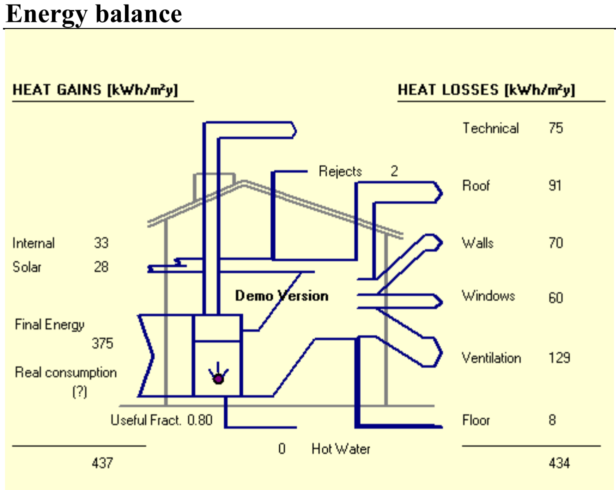
Statistics Proportion of Z3_MF_001 in the EU-25: 0.3%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	78.0	440.0	12.0	80.0	78.0
Number of buildings [1 000]	4.9	27.5	0.8	5.0	4.9
Stock in Mio. m^2	6	40	1	4	5
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	001
Year of construction	Until 1940
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Brick 50 cm
Interior load-bearing wall	Brick 30 cm
Interior wall	Wooden construction 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Wooden joist ceiling
Basement wall	Solid brick 80 cm
Basement ceiling	Vaulted ceiling
Foundation	Brick
Window	Wooden frame and double-glazing

Energy balance

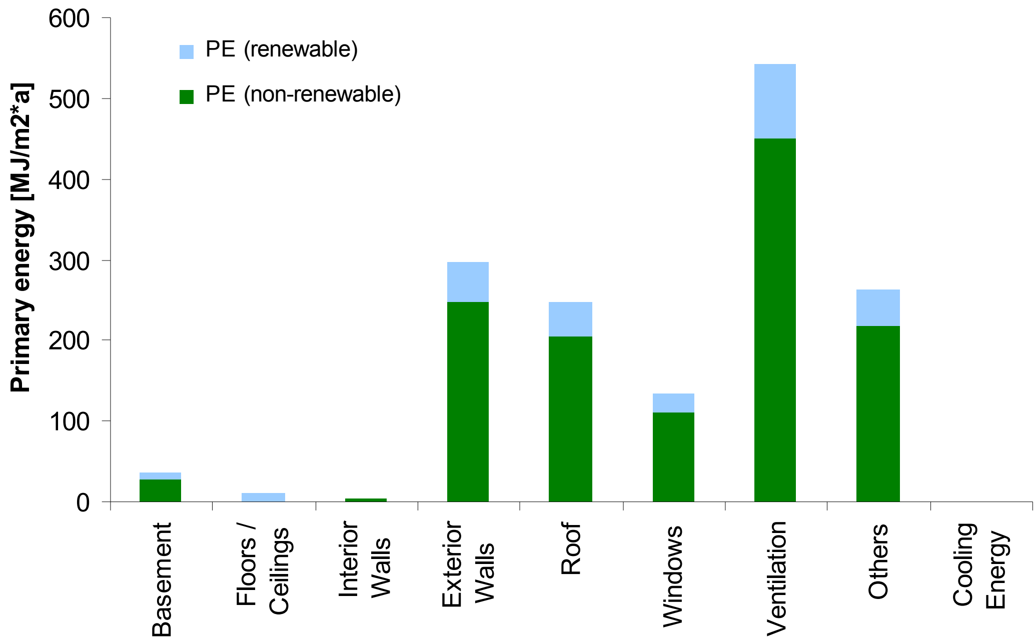


Z3_MF_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 548**	**97.5**	**-25.5**	**72.0**	**2.7E-01**	**1.7E-02**	**9.1E-02**	**5.3E-06**
Refurbishment	39	1.8	-1.6	0.2	6.4E-03	6.0E-04	1.0E-03	1.2E-07
Heating & cooling	1 509	95.7	-23.9	71.8	2.6E-01	1.6E-02	9.0E-02	5.2E-06
End-of-Life	**-24**	**2.7**	**0.0**	**2.7**	**1.3E-04**	**1.8E-04**	**2.3E-05**	**-7.3E-08**
Construction	-12	1.7	0.0	1.7	9.7E-04	2.1E-04	9.6E-05	-4.0E-08
Refurbishment	-12	1.0	0.0	1.0	-8.4E-04	-2.1E-05	-7.3E-05	-3.3E-08
Total*	**1 548**	**97.5**	**-25.5**	**72.0**	**2.7E-01**	**1.7E-02**	**9.1E-02**	**5.3E-06**
Heating & Cooling								
Basement	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%	2.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%
Roof	16.3%	16.3%	16.3%	16.3%	16.3%	16.3%	16.3%	16.3%
Windows	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%	8.6%
Ventilation	35.9%	35.9%	35.9%	35.9%	35.9%	35.9%	35.9%	35.9%
Others	17.4%	17.4%	17.4%	17.4%	17.4%	17.4%	17.4%	17.4%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_001



Annex C 61 Building type Z3_MF_002

Multi-family house
Breeze concrete wall, reinforced concrete flooring, pitched roof

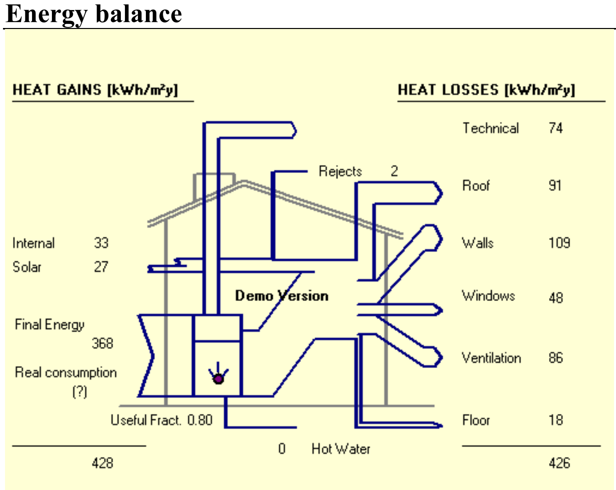
Statistics Proportion of Z3_MF_002 in the EU-25: 0.5%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	260.0	440.0	30.0	100.0	143.0
Number of buildings [1 000]	16.3	27.5	1.9	6.3	8.9
Stock in Mio. m^2	20	40	2	6	9
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	002
Year of construction	1940-1980
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof
Roof cladding	Brick
Exterior wall	Breeze concrete 30 cm
Interior load-bearing wall	Breeze concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

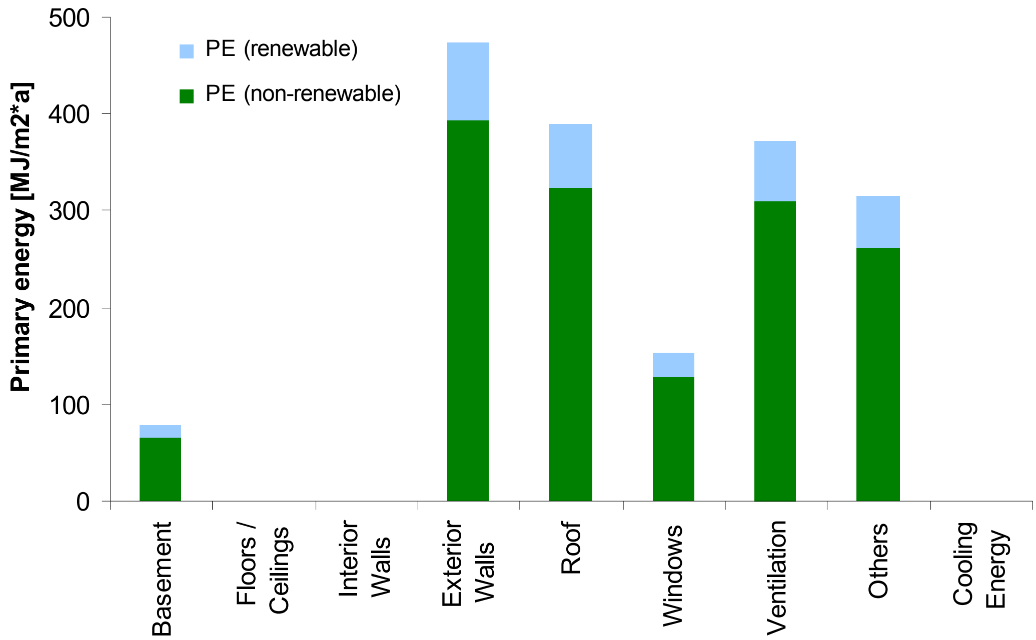


Z3_MF_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 786**	**113.2**	**-28.2**	**85.0**	**3.1E-01**	**2.0E-02**	**1.1E-01**	**6.1E-06**
Refurbishment	6	0.4	0.0	0.4	1.9E-03	1.5E-04	2.1E-04	1.4E-08
Heating & cooling	1 780	112.8	-28.2	84.6	3.1E-01	1.9E-02	1.1E-01	6.1E-06
End-of-Life	**-7**	**0.7**	**0.0**	**0.7**	**2.3E-04**	**5.9E-05**	**-9.1E-06**	**-1.1E-08**
Construction	-6	0.7	0.0	0.7	3.2E-04	6.9E-05	8.3E-06	-1.2E-08
Refurbishment	-1	0.0	0.0	0.0	-8.5E-05	-9.4E-06	-1.7E-05	7.0E-10
Total*	**1 786**	**113.2**	**-28.2**	**85.0**	**3.1E-01**	**2.0E-02**	**1.1E-01**	**6.1E-06**
Heating & Cooling								
Basement	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	26.5%	26.5%	26.5%	26.5%	26.5%	26.5%	26.5%	26.5%
Roof	22.1%	22.1%	22.1%	22.1%	22.1%	22.1%	22.1%	22.1%
Windows	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%	8.4%
Ventilation	20.9%	20.9%	20.9%	20.9%	20.9%	20.9%	20.9%	20.9%
Others	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%	17.7%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

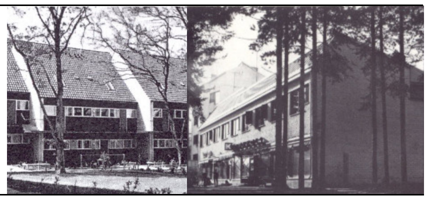
* Total = Use Phase

Z3_MF_002



Annex C 62 Building type Z3_MF_003

Multi-family house
Wooden wall and brick façade, reinforced concrete flooring, pitched roof



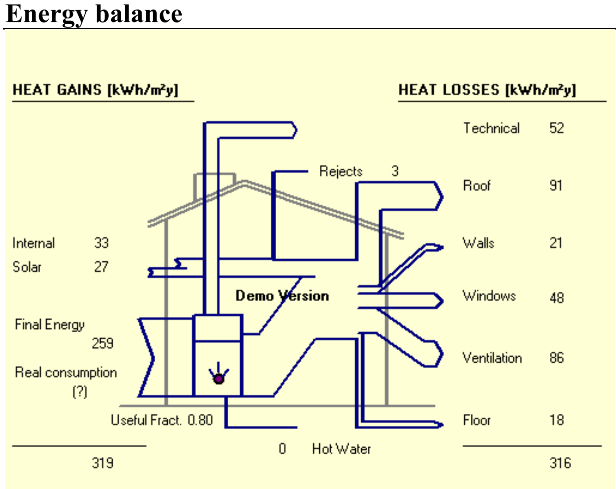
Statistics Proportion of Z3_MF_003 in the EU-25: 0.3%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	130.0	220.0	18.0	80.0	65.0
Number of buildings [1 000]	8.1	13.8	1.1	5.0	4.1
Stock in Mio. m^2	10	20	1	4	4
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	003
Year of construction	1940-1970
Residual service life	30 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Wooden panel structure (10 cm insulation), brick façade 10 cm
Interior load-bearing wall	Reinforced concrete
Interior wall	Wooden construction 10 cm
Plaster	Plasterboard
Floor	Reinforced concrete
Basement wall	
Basement ceiling	
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

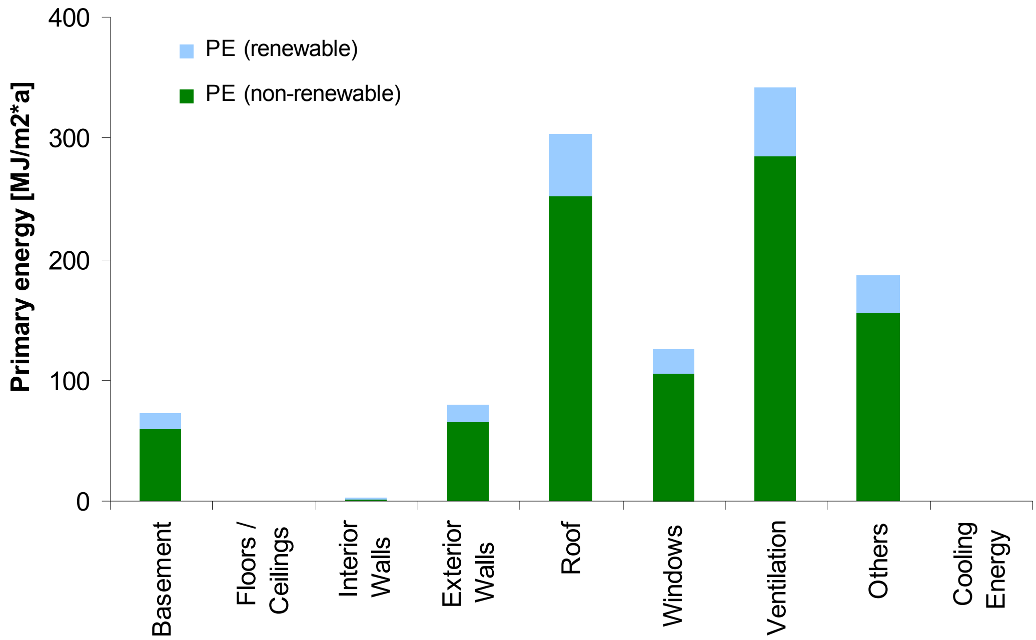


Z3_MF_003

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 121**	**71.0**	**-17.7**	**53.2**	**2.0E-01**	**1.2E-02**	**6.7E-02**	**3.9E-06**
Refurbishment	13	0.7	-0.2	0.5	3.2E-03	2.9E-04	2.6E-04	3.8E-08
Heating & cooling	1 108	70.2	-17.5	52.7	1.9E-01	1.2E-02	6.6E-02	3.8E-06
End-of-Life	**-10**	**0.9**	**0.0**	**0.9**	**-4.4E-04**	**9.0E-06**	**-6.4E-05**	**-2.2E-08**
Construction	-9	0.8	0.0	0.8	-2.7E-04	2.1E-05	-3.7E-05	-2.0E-08
Refurbishment	-2	0.1	0.0	0.1	-1.6E-04	-1.2E-05	-2.7E-05	-1.1E-09
Total*	**1 121**	**71.0**	**-17.7**	**53.2**	**2.0E-01**	**1.2E-02**	**6.7E-02**	**3.9E-06**
Heating & Cooling								
Basement	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%
Roof	27.5%	27.5%	27.5%	27.5%	27.5%	27.5%	27.5%	27.5%
Windows	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%	10.8%
Ventilation	30.9%	30.9%	30.9%	30.9%	30.9%	30.9%	30.9%	30.9%
Others	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_003



Annex C 63 Building type Z3_MF_004

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

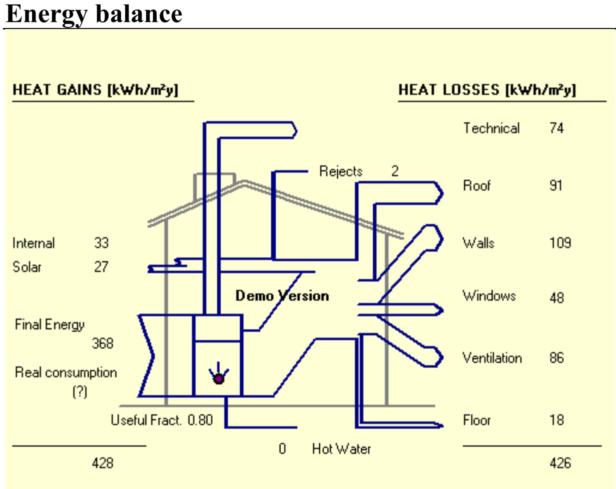
Statistics Proportion of Z3_MF_004 in the EU-25: 0.4%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	208.0	220.0	60.0	150.0	195.0
Number of buildings [1 000]	13.0	13.8	3.8	9.4	12.2
Stock in Mio. m^2	16	20	4	8	12
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	004
Year of construction	1945-1980
Residual service life	30 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 45°
Roof cladding	Brick
Exterior wall	Brick masonry 40 cm
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Breeze concrete block
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

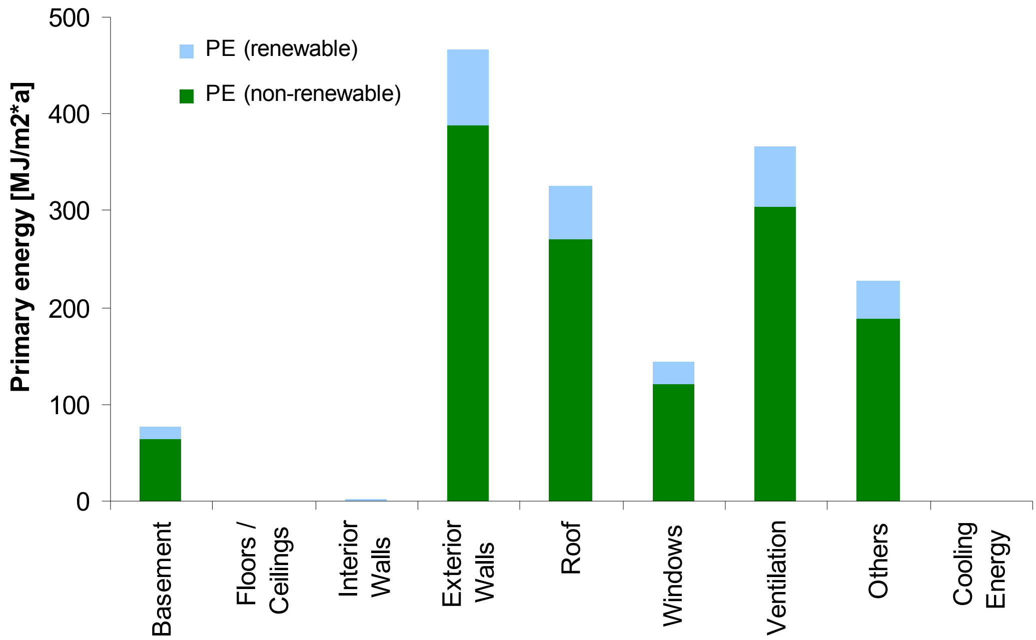


Z3_MF_004

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 615**	**102.3**	**-25.5**	**76.8**	**2.8E-01**	**1.8E-02**	**9.6E-02**	**5.6E-06**
Refurbishment	15	0.9	-0.2	0.7	4.1E-03	3.5E-04	4.7E-04	4.5E-08
Heating & cooling	1 600	101.4	-25.3	76.1	2.8E-01	1.7E-02	9.6E-02	5.5E-06
End-of-Life	**-6**	**0.7**	**0.0**	**0.7**	**4.2E-04**	**7.4E-05**	**9.4E-06**	**-9.1E-09**
Construction	-4	0.5	0.0	0.5	5.7E-04	8.6E-05	3.7E-05	-7.5E-09
Refurbishment	-2	0.1	0.0	0.1	-1.5E-04	-1.2E-05	-2.8E-05	-1.6E-09
Total*	**1 615**	**102.3**	**-25.5**	**76.8**	**2.8E-01**	**1.8E-02**	**9.6E-02**	**5.6E-06**
Heating & Cooling								
Basement	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%	4.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	29.0%	29.0%	29.0%	29.0%	29.0%	29.0%	29.0%	29.0%
Roof	20.4%	20.4%	20.4%	20.4%	20.4%	20.4%	20.4%	20.4%
Windows	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%	8.7%
Ventilation	22.9%	22.9%	22.9%	22.9%	22.9%	22.9%	22.9%	22.9%
Others	14.2%	14.2%	14.2%	14.2%	14.2%	14.2%	14.2%	14.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_004



Annex C 64 Building type Z3_MF_005

Multi-family house
Breeze and reinforced concrete wall, reinforced concrete flooring, flat roof

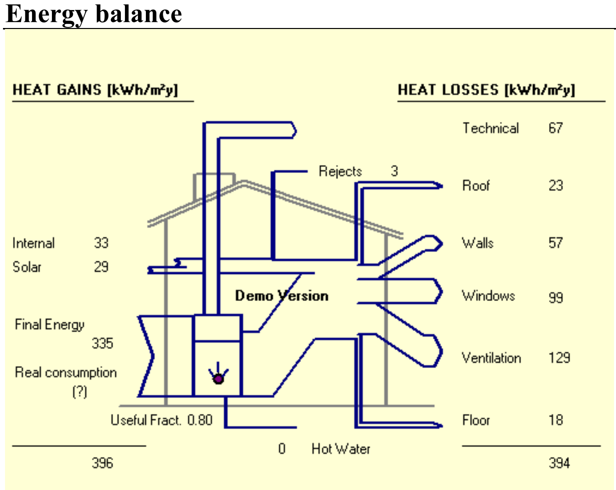
Statistics Proportion of Z3_MF_005 in the EU-25: 0.5%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	260.0	440.0	30.0	120.0	104.0
Number of buildings [1 000]	16.3	27.5	1.9	7.5	6.5
Stock in Mio. m^2	20	40	2	7	6
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	005
Year of construction	1960-1990
Residual service life	20 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Reinforced concrete 15 cm, breeze concrete 15 cm
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and double-glazing

Energy balance

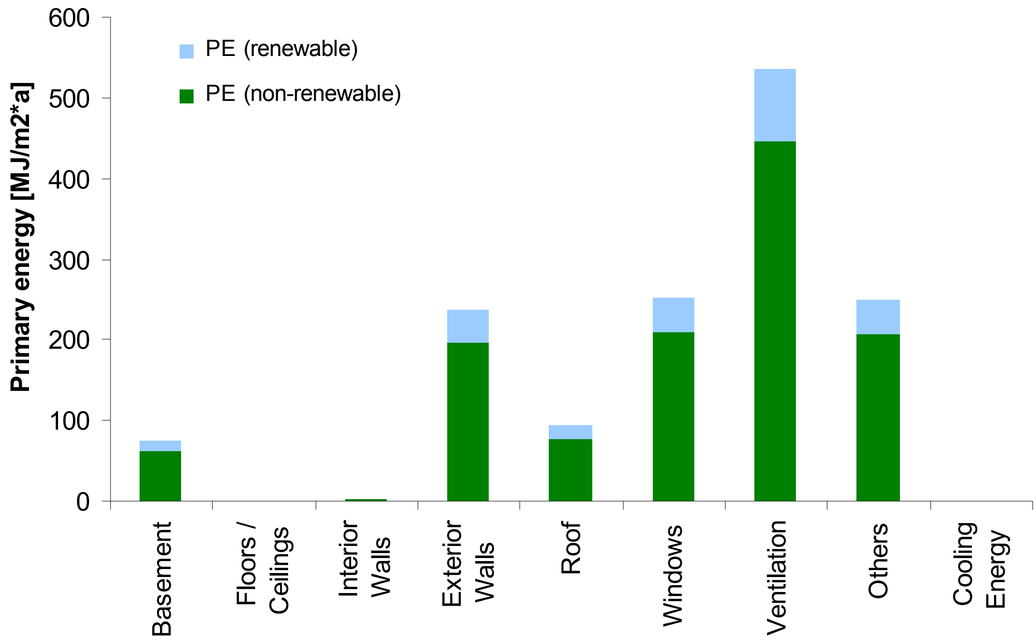


Z3_MF_005

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 449**	**91.8**	**-22.9**	**69.0**	**2.5E-01**	**1.6E-02**	**8.7E-02**	**5.0E-06**
Refurbishment	6	0.3	0.0	0.3	1.7E-03	1.5E-04	1.3E-04	1.4E-08
Heating & cooling	1 443	91.5	-22.9	68.6	2.5E-01	1.6E-02	8.6E-02	5.0E-06
End-of-Life	**-1**	**0.5**	**0.0**	**0.5**	**1.3E-03**	**1.5E-04**	**8.6E-05**	**2.4E-09**
Construction	0	0.5	0.0	0.5	1.4E-03	1.6E-04	1.0E-04	1.5E-09
Refurbishment	-1	0.0	0.0	0.0	-9.0E-05	-9.0E-06	-1.7E-05	8.9E-10
Total*	**1 449**	**91.8**	**-22.9**	**69.0**	**2.5E-01**	**1.6E-02**	**8.7E-02**	**5.0E-06**
Heating & Cooling								
Basement	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%	5.2%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	16.4%	16.4%	16.4%	16.4%	16.4%	16.4%	16.4%	16.4%
Roof	6.6%	6.6%	6.6%	6.6%	6.6%	6.6%	6.6%	6.6%
Windows	17.3%	17.3%	17.3%	17.3%	17.3%	17.3%	17.3%	17.3%
Ventilation	37.2%	37.2%	37.2%	37.2%	37.2%	37.2%	37.2%	37.2%
Others	17.3%	17.3%	17.3%	17.3%	17.3%	17.3%	17.3%	17.3%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_005



Annex C 65 Building type Z3_MF_006_ex

Multi-family house
Wooden wall, wooden flooring, pitched roof

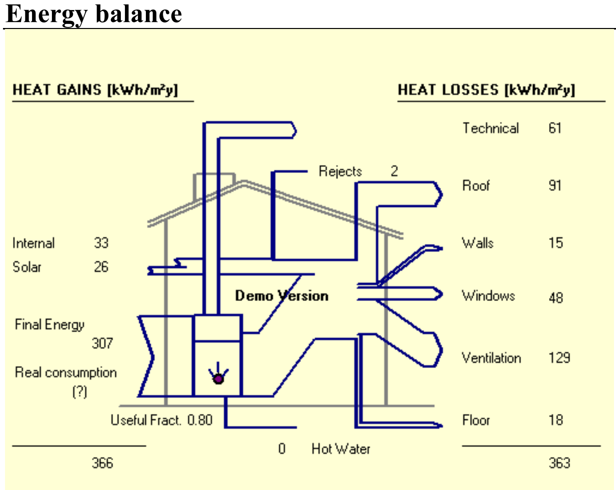
Statistics Proportion of Z3_MF_006_ex in the EU-25: 0.1%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	78.0	88.0	6.0	30.0	26.0
Number of buildings [1 000]	4.9	5.5	0.4	1.9	1.6
Stock in Mio. m^2	6	8	0	2	2
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	006_ex
Year of construction	Since 1970
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Brick
Exterior wall	Wooden construction 16 cm (16 cm insulation), wooden façade
Interior load-bearing wall	Wooden construction 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Plasterboard
Floor	Wooden flooring
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

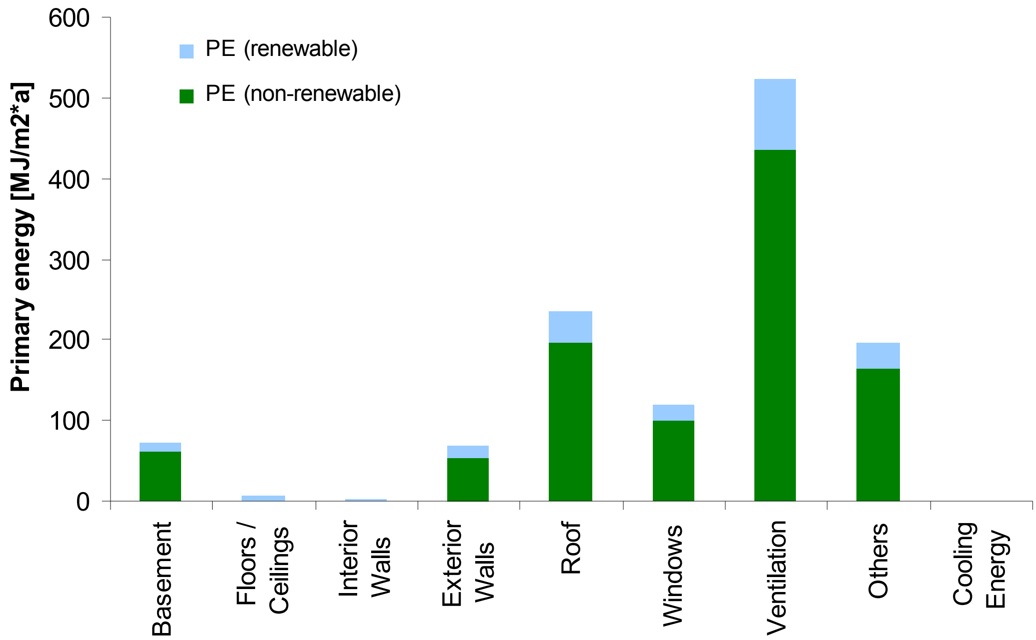


Z3_MF_006_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 241**	**78.0**	**-20.3**	**57.7**	**2.2E-01**	**1.4E-02**	**7.3E-02**	**4.2E-06**
Refurbishment	39	1.7	-1.3	0.5	6.9E-03	6.2E-04	7.3E-04	1.1E-07
Heating & cooling	1 202	76.2	-19.0	57.2	2.1E-01	1.3E-02	7.2E-02	4.1E-06
End-of-Life	**-28**	**2.2**	**0.0**	**2.2**	**-2.2E-03**	**-8.0E-05**	**-2.2E-04**	**-7.1E-08**
Construction	-18	1.4	0.0	1.4	-1.3E-03	-3.8E-05	-1.2E-04	-4.6E-08
Refurbishment	-11	0.8	0.0	0.8	-9.0E-04	-4.2E-05	-9.4E-05	-2.5E-08
Total*	**1 241**	**78.0**	**-20.3**	**57.7**	**2.2E-01**	**1.4E-02**	**7.3E-02**	**4.2E-06**
Heating & Cooling								
Basement	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%	6.1%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%	5.1%
Roof	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%	19.5%
Windows	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%	9.4%
Ventilation	43.5%	43.5%	43.5%	43.5%	43.5%	43.5%	43.5%	43.5%
Others	16.4%	16.4%	16.4%	16.4%	16.4%	16.4%	16.4%	16.4%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_006_ex



Annex C 66 Building type Z3_MF_006

Multi-family house
Wooden wall, wooden flooring, pitched roof

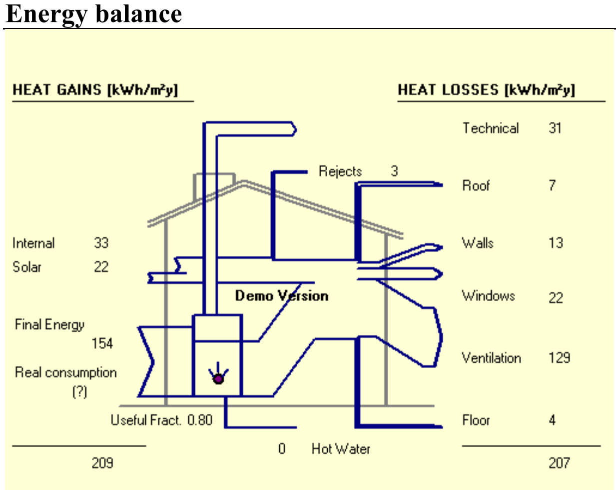
Statistics Proportion of Z3_MF_006 in the EU-25: 0.01%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	11.7	18.2	1.8	5.7	6.6
Number of buildings [1 000]	0.7	1.1	0.1	0.4	0.4
Stock in Mio. m^2	0.9	1.7	0.1	0.3	0.4
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **NEW**

Zone	3
Building type	Multi-family house
Number	006
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30° (16 cm insulation)
Roof cladding	Brick
Exterior wall	Wooden construction 16 cm (21 cm insulation)
Interior load-bearing wall	Wooden construction 16 cm
Interior wall	Wooden construction 10 cm
Plaster	Plasterboard
Floor	Wooden flooring
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Wooden frame and double-glazing

Energy balance

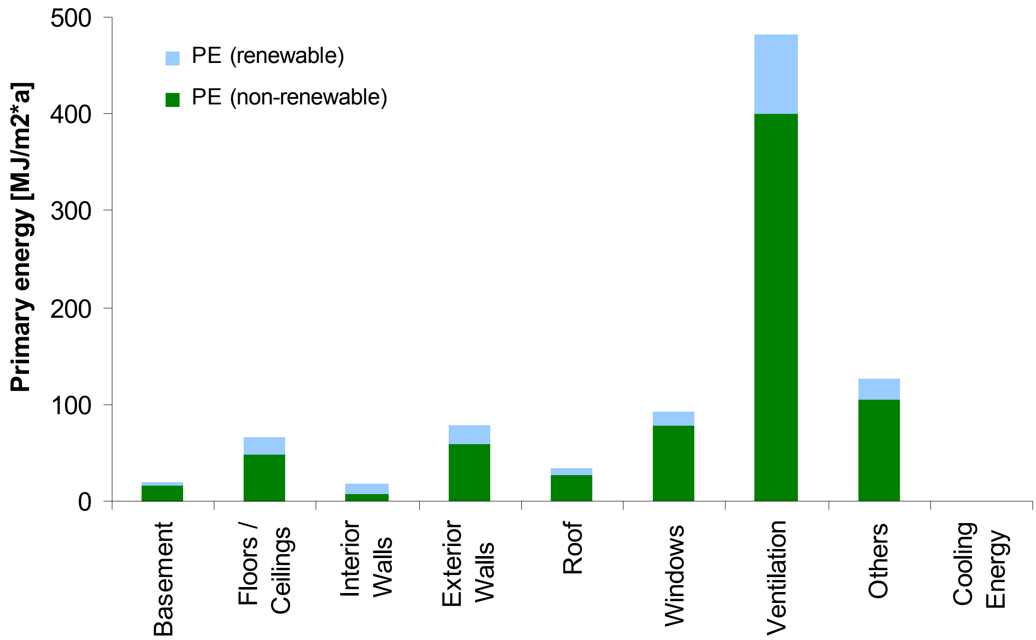


Z3_MF_006

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**121**	**5.9**	**-2.6**	**3.3**	**1.7E-02**	**1.9E-03**	**1.9E-03**	**3.7E-07**
Use Phase	**822**	**51.2**	**-13.9**	**37.3**	**1.4E-01**	**9.1E-03**	**4.7E-02**	**2.8E-06**
Refurbishment	41	1.8	-1.6	0.2	6.7E-03	6.2E-04	7.5E-04	1.3E-07
Heating & cooling	780	49.5	-12.4	37.1	1.4E-01	8.5E-03	4.7E-02	2.7E-06
End-of-Life	**-27**	**2.2**	**0.0**	**2.2**	**-2.0E-03**	**-6.6E-05**	**-2.0E-04**	**-7.2E-08**
Construction	-16	1.3	0.0	1.3	-1.1E-03	-3.0E-05	-1.1E-04	-4.1E-08
Refurbishment	-12	0.9	0.0	0.9	-9.4E-04	-3.6E-05	-8.9E-05	-3.0E-08
Total*	**942**	**57.2**	**-16.5**	**40.7**	**1.6E-01**	**1.1E-02**	**4.9E-02**	**3.2E-06**
Heating & Cooling								
Basement	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%	1.9%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%	6.2%
Roof	3.4%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%	3.3%
Windows	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%
Ventilation	61.9%	61.7%	61.7%	61.7%	61.7%	61.7%	61.7%	61.7%
Others	16.3%	16.3%	16.3%	16.3%	16.3%	16.3%	16.3%	16.3%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Construction Phase								
Basement	3.0%	9.2%	0.0%	16.2%	9.4%	11.7%	6.6%	2.5%
Floors/ceilings	52.9%	48.2%	42.0%	53.0%	33.9%	41.9%	41.3%	56.6%
Interior Walls	13.0%	12.2%	27.8%	0.1%	14.2%	12.0%	12.6%	15.0%
Exterior Walls	18.6%	16.6%	21.1%	13.1%	22.2%	18.5%	22.8%	15.6%
Roof	6.0%	6.3%	8.7%	4.5%	7.9%	6.4%	8.2%	5.5%
Windows	6.0%	7.5%	0.2%	13.1%	12.4%	9.5%	8.5%	4.7%

* Total = Construction Phase + Use Phase

Z3_MF_006



Annex C 67 Building type Z3_MF_007_ex

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

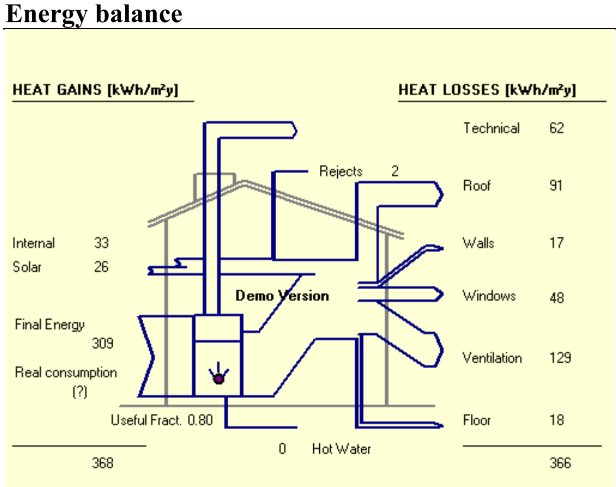
Statistics Proportion of Z3_MF_007_ex in the EU-25: 0.2%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	104.0	132.0	18.0	50.0	65.0
Number of buildings [1 000]	6.5	8.3	1.1	3.1	4.1
Stock in Mio. m^2	8	12	1	3	4
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	007_ex
Year of construction	Since 1980
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30°
Roof cladding	Concrete tile
Exterior wall	Brick masonry 25 cm (12 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

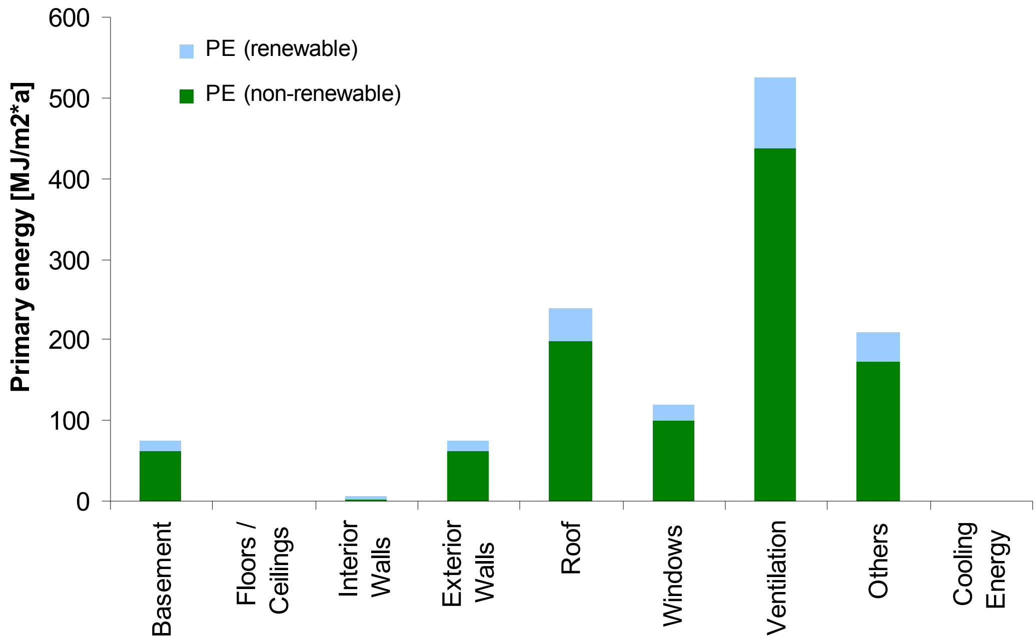


Z3_MF_007_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 254**	**79.4**	**-19.8**	**59.6**	**2.2E-01**	**1.4E-02**	**7.4E-02**	**4.3E-06**
Refurbishment	24	1.4	-0.3	1.2	6.0E-03	5.5E-04	7.0E-04	6.7E-08
Heating & cooling	1 230	78.0	-19.5	58.5	2.1E-01	1.3E-02	7.4E-02	4.2E-06
End-of-Life	**-5**	**0.6**	**0.0**	**0.6**	**3.9E-04**	**6.5E-05**	**1.0E-05**	**-7.4E-09**
Construction	-2	0.4	0.0	0.4	5.1E-04	7.2E-05	3.6E-05	-4.6E-09
Refurbishment	-2	0.2	0.0	0.2	-1.3E-04	-6.8E-06	-2.6E-05	-2.7E-09
Total*	**1 254**	**79.4**	**-19.8**	**59.6**	**2.2E-01**	**1.4E-02**	**7.4E-02**	**4.3E-06**
Heating & Cooling								
Basement	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%	5.6%
Roof	19.4%	19.4%	19.4%	19.4%	19.4%	19.4%	19.4%	19.4%
Windows	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%	9.2%
Ventilation	42.8%	42.8%	42.8%	42.8%	42.8%	42.8%	42.8%	42.8%
Others	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_007_ex



Annex C 68 Building type Z3_MF_007

Multi-family house
Brick masonry, reinforced concrete flooring, pitched roof

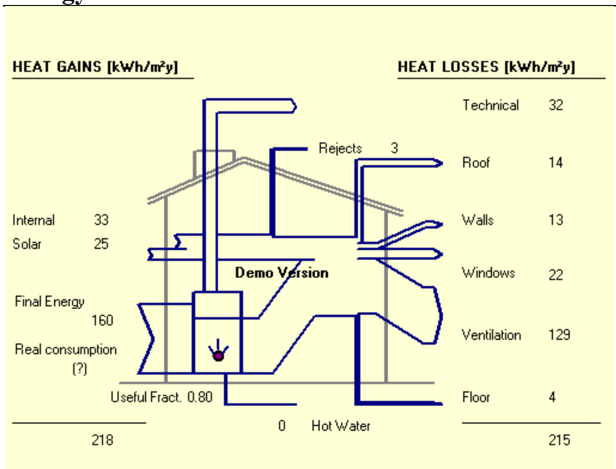
Statistics Proportion of Z3_MF_007 in the EU-25: 0.01%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	11.7	18.2	1.8	5.7	6.6
Number of buildings [1 000]	0.4	0.6	0.1	0.2	0.2
Stock in Mio. m^2	0.5	1	0.1	0.2	0.2
Density in m^2/occupant	35.0	43.6	25.1	20.5	23.3
Occupants per building	35.2	33.6	38.4	43.2	41.6

Description of the building type **NEW**

Zone	3
Building type	Multi-family house
Number	007
Year of construction	Since 2006
Residual service life	40 a
Dimension	32 m * 12 m
Storey	4
Floor to floor height	3 m
Roof	Pitched roof 30° (16 cm insulation)
Roof cladding	Concrete tile
Exterior wall	Brick masonry 25 cm (15 cm insulation)
Interior load-bearing wall	Brick masonry 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Concrete
Window	Plastic frame and double-glazing

Energy balance

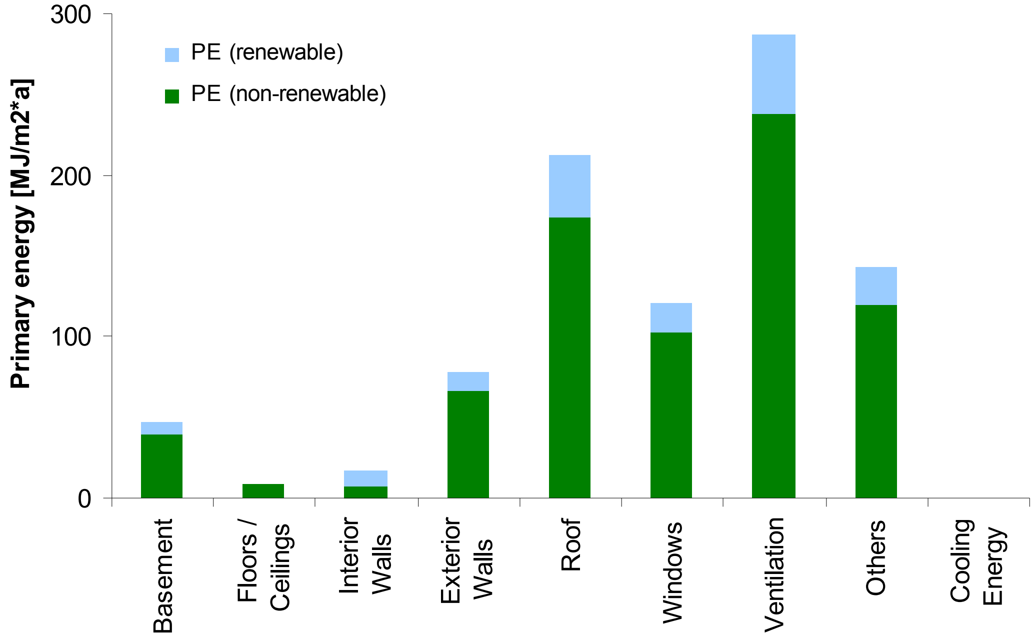


Z3_MF_007

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**108**	**8.4**	**-1.5**	**6.8**	**2.5E-02**	**2.8E-03**	**2.5E-03**	**2.9E-07**
Use Phase	**845**	**53.5**	**-13.4**	**40.2**	**1.5E-01**	**9.0E-03**	**5.0E-02**	**2.9E-06**
Refurbishment	20	1.2	-0.3	0.9	4.6E-03	4.3E-04	6.0E-04	5.6E-08
Heating & cooling	208	52.4	-13.1	39.3	1.4E-01	9.0E-03	4.9E-02	2.8E-06
End-of-Life	**-52**	**0.8**	**0.0**	**0.8**	**-6.1E-03**	**3.2E-05**	**-1.0E-03**	**-5.7E-08**
Construction	-38	-0.3	0.0	-0.3	-5.0E-03	7.2E-05	-1.0E-03	-2.0E-08
Refurbishment	-14	1.1	0.0	1.1	-1.1E-03	-4.0E-05	-1.0E-07	-3.7E-08
Total*	**954**	**61.9**	**-14.9**	**47.0**	**1.7E-01**	**1.2E-02**	**5.3E-02**	**3.2E-06**
Heating & Cooling								
Basement	18.3%	5.3%	4.6%	5.5%	5.4%	5.4%	5.1%	4.6%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	19.7%	5.0%	4.9%	5.0%	5.1%	3.9%	4.8%	5.0%
Roof	99.4%	24.8%	25.1%	24.7%	25.4%	23.7%	24.6%	25.1%
Windows	50.5%	13.0%	12.5%	13.2%	13.3%	13.1%	12.9%	14.0%
Ventilation	140.7%	35.5%	35.3%	35.5%	35.1%	34.2%	35.4%	35.4%
Others	68.8%	17.7%	17.1%	17.9%	16.9%	17.1%	17.1%	18.3%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Construction Phase								
Basement	7.2%	22.2%	1.0%	26.9%	20.7%	25.1%	11.1%	21.7%
Floors/ceilings	7.2%	22.2%	1.1%	26.9%	20.7%	20.9%	20.9%	21.7%
Interior Walls	38.2%	22.2%	48.4%	16.3%	20.7%	16.7%	20.9%	21.7%
Exterior Walls	26.4%	22.2%	29.1%	20.6%	27.6%	20.9%	16.2%	21.7%
Roof	14.7%	7.4%	19.4%	4.7%	6.9%	4.2%	3.5%	10.8%
Windows	3.5%	7.4%	0.2%	9.0%	6.9%	8.4%	3.6%	10.8%

* Total = Construction Phase + Use Phase

Z3_MF_007



Annex C 69 Building type Z3_MF_008

Multi-family house
Concrete wall, reinforced concrete flooring, flat roof

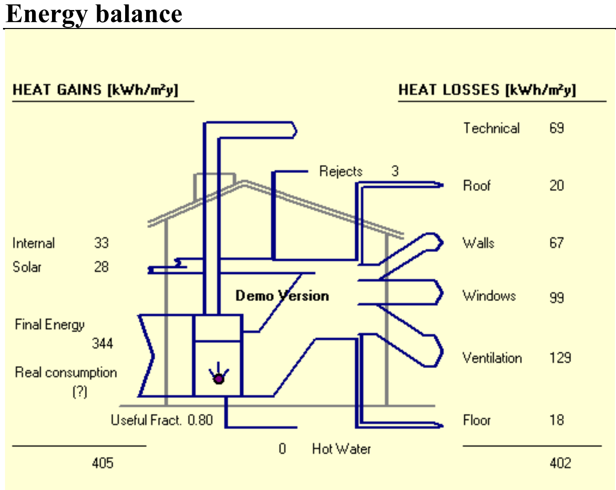
Statistics Proportion of Z3_MF_008 in the EU-25: 0.1%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]	104.0		18.0	40.0	52.0
Number of buildings [1 000]	3.7		0.6	1.4	1.9
Stock in Mio. m^2	8		1	2	3
Density in m^2/occupant	35.0		25.1	20.5	23.3
Occupants per building	61.6		67.2	75.6	72.8

Description of the building type **EXISTING**

Zone	3
Building type	Multi-family house
Number	008
Year of construction	1960-1990
Residual service life	30 a
Dimension	32 m * 12 m
Storey	7
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Reinforced concrete 15 cm (12 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and double-glazing

Energy balance

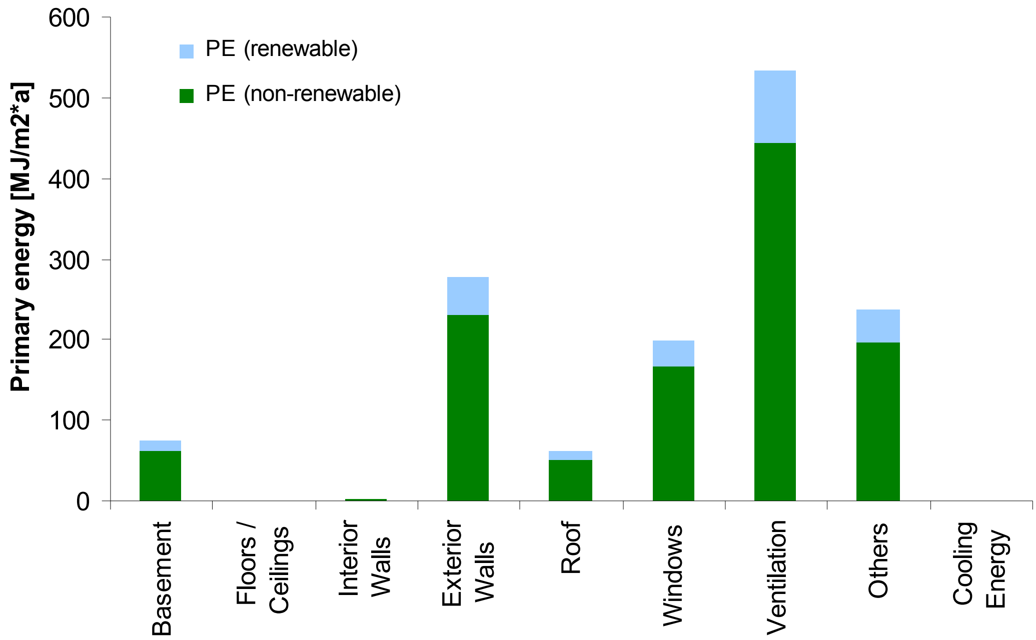


Z3_MF_008

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 389**	**88.0**	**-21.9**	**66.1**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.8E-06**
Refurbishment	12	0.7	-0.1	0.7	3.3E-03	2.9E-04	4.0E-04	3.3E-08
Heating & cooling	1 377	87.3	-21.8	65.5	2.4E-01	1.5E-02	8.2E-02	4.7E-06
End-of-Life	**-1**	**0.2**	**0.0**	**0.2**	**3.2E-04**	**3.0E-05**	**-1.4E-06**	**3.7E-09**
Construction	0	0.1	0.0	0.1	3.8E-04	3.8E-05	1.8E-05	2.7E-09
Refurbishment	-1	0.1	0.0	0.1	-5.9E-05	-8.5E-06	-1.9E-05	1.0E-09
Total*	**1 389**	**88.0**	**-21.9**	**66.1**	**2.4E-01**	**1.5E-02**	**8.3E-02**	**4.8E-06**
Heating & Cooling								
Basement	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%	5.4%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	20.1%	20.1%	20.1%	20.1%	20.1%	20.1%	20.1%	20.1%
Roof	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%	4.4%
Windows	14.1%	14.1%	14.1%	14.1%	14.1%	14.1%	14.1%	14.1%
Ventilation	38.8%	38.8%	38.8%	38.8%	38.8%	38.8%	38.8%	38.8%
Others	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%	17.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_MF_008



Annex C 70 Building type Z3_HR_001

High-rise building
Concrete wall, reinforced
concrete flooring, flat roof

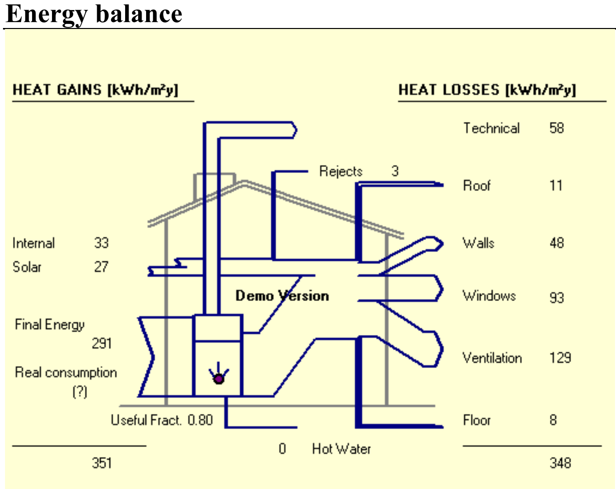
Statistics Proportion of Z3_HR_001 in the EU-25: 0.03%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]			60.0		
Number of buildings [1 000]			1.2		
Stock in Mio. m^2			4		
Density in m^2/occupant			25.1		
Occupants per building			120		

Description of the building type **EXISTING**

Zone	3
Building type	High-rise building
Number	001
Year of construction	1950-1990
Residual service life	30 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Reinforced concrete 25 cm (10 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Reinforced concrete 6 cm
Plaster	Exterior plaster lime-cement; interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Aluminium/plastic frame and double-glazing

Energy balance

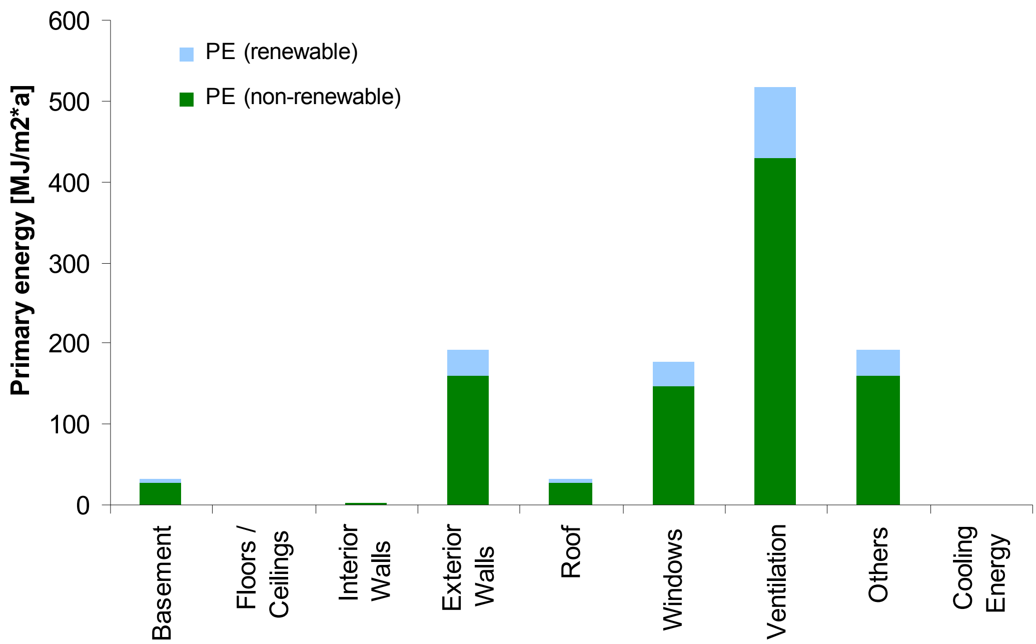


Z3_HR_001

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**1 146**	**72.7**	**-18.1**	**54.6**	**2.0E-01**	**1.3E-02**	**6.8E-02**	**3.9E-06**
Refurbishment	8	0.5	-0.1	0.5	2.4E-03	2.0E-04	3.1E-04	2.4E-08
Heating & cooling	1 138	72.2	-18.0	54.1	2.0E-01	1.2E-02	6.8E-02	3.9E-06
End-of-Life	**-1**	**0.2**	**0.0**	**0.2**	**2.9E-04**	**2.8E-05**	**6.8E-06**	**2.5E-09**
Construction	0	0.1	0.0	0.1	3.2E-04	3.2E-05	1.8E-05	1.9E-09
Refurbishment	-1	0.0	0.0	0.0	-2.6E-05	-4.8E-06	-1.2E-05	6.0E-10
Total*	**1 146**	**72.7**	**-18.1**	**54.6**	**2.0E-01**	**1.3E-02**	**6.8E-02**	**3.9E-06**
Heating & Cooling								
Basement	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%	16.9%
Roof	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%	2.8%
Windows	15.3%	15.3%	15.3%	15.3%	15.3%	15.3%	15.3%	15.3%
Ventilation	45.3%	45.3%	45.3%	45.3%	45.3%	45.3%	45.3%	45.3%
Others	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%	17.0%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_HR_001



Annex C 71 Building type Z3_HR_002_ex

High-rise building
Brick cavity wall, reinforced concrete flooring, flat roof

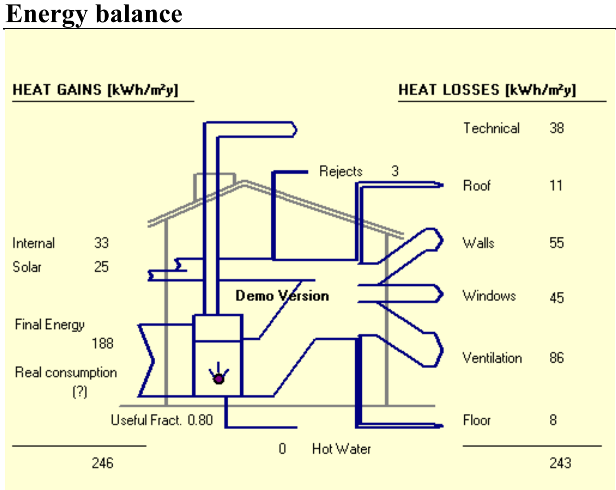
Statistics Proportion of Z3_HR_002_ex in the EU-25: 0.04%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]			90.0		
Number of buildings [1 000]			1.8		
Stock in Mio. m^2			5		
Density in m^2/occupant			25.1		
Occupants per building			120		

Description of the building type **EXISTING**

Zone	3
Building type	High-rise building
Number	002_ex
Year of construction	Since 1960
Residual service life	30 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 30 cm (10 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

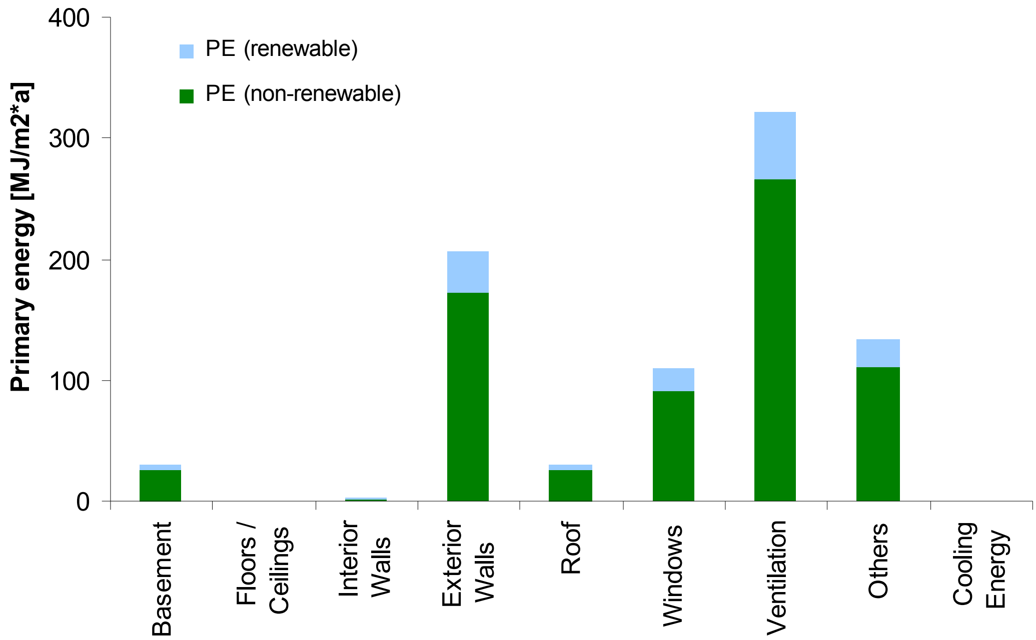


Z3_HR_002_ex

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Use Phase	**836**	**52.9**	**-13.2**	**39.7**	**1.5E-01**	**9.3E-03**	**5.0E-02**	**2.9E-06**
Refurbishment	14	0.8	-0.2	0.6	3.7E-03	3.2E-04	4.2E-04	3.9E-08
Heating & cooling	822	52.1	-13.0	39.1	1.4E-01	9.0E-03	4.9E-02	2.8E-06
End-of-Life	**-3**	**0.5**	**0.0**	**0.5**	**6.6E-04**	**8.2E-05**	**2.8E-05**	**-4.4E-10**
Construction	-1	0.3	0.0	0.3	8.1E-04	9.5E-05	5.7E-05	6.1E-10
Refurbishment	-2	0.1	0.0	0.1	-1.5E-04	-1.4E-05	-2.9E-05	-1.0E-09
Total*	**836**	**52.9**	**-13.2**	**39.7**	**1.5E-01**	**9.3E-03**	**5.0E-02**	**2.9E-06**
Heating & Cooling								
Basement	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%
Roof	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%	3.6%
Windows	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
Ventilation	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%	39.0%
Others	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%	16.2%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

* Total = Use Phase

Z3_HR_002_ex



Annex C 72 Building type Z3_HR_002

High-rise building
Brick cavity wall,
reinforced concrete
flooring, flat roof

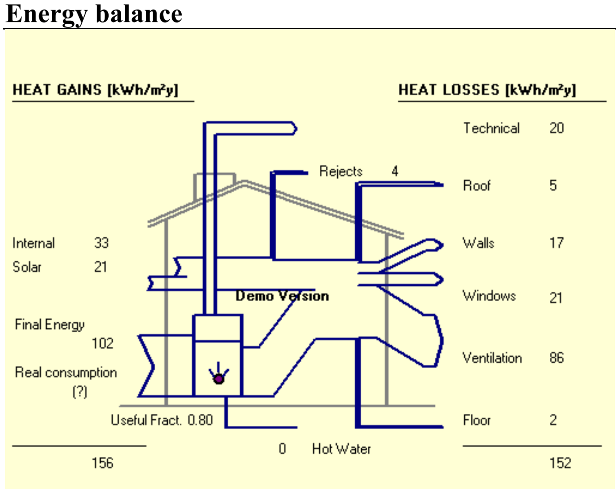
Statistics Proportion of Z3_HR_002 in the EU-25: 0.001%

	Finland	Sweden	Estonia	Latvia	Lithuania
Number of dwellings [1 000]			3.1		
Number of buildings [1 000]			0.1		
Stock in Mio. m^2			0.2		
Density in m^2/occupant			25.1		
Occupants per building			120		

Description of the building type **NEW**

Zone	3
Building type	High-rise building
Number	002
Year of construction	Since 2006
Residual service life	40 a
Dimension	30 m * 15 m
Storey	10
Floor to floor height	3 m
Roof	Flat roof (10 cm insulation)
Roof cladding	Bitumen layer
Exterior wall	Brick masonry 30 cm (12 cm insulation)
Interior load-bearing wall	Reinforced concrete 20 cm
Interior wall	Plasterboard 10 cm
Plaster	Interior plaster: lime-gypsum
Floor	Reinforced concrete
Basement wall	Reinforced concrete
Basement ceiling	Reinforced concrete (5 cm insulation)
Foundation	Reinforced concrete
Window	Plastic frame and double-glazing

Energy balance

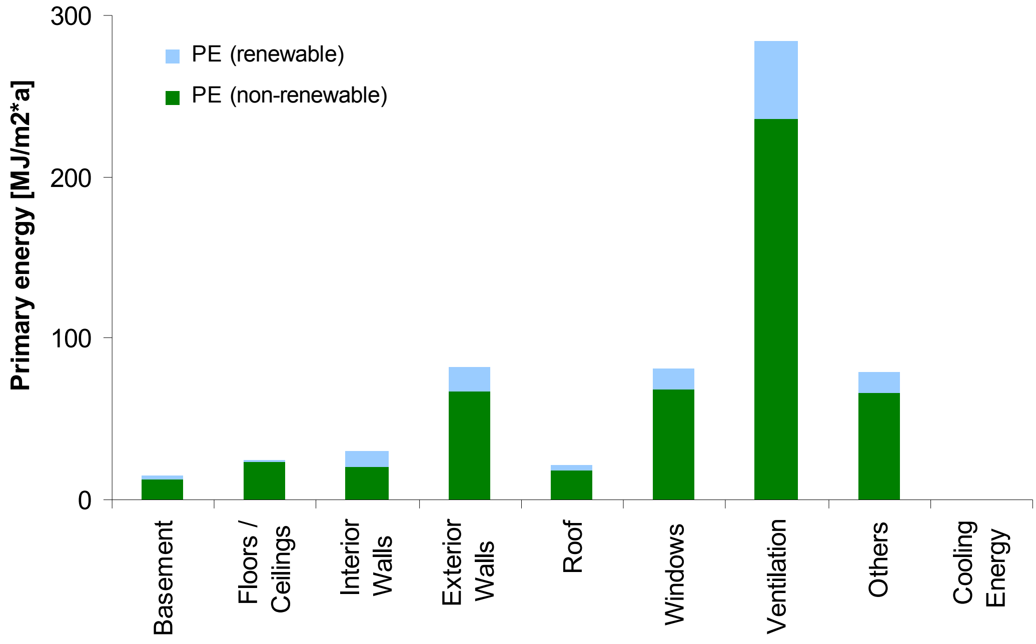


Z3_HR_002

	PE (total) MJ/m2*a	GWP (out) kg/m2*a	GWP (incorp.) kg/m2*a	GWP (net) kg/m2*a	AP kg/m2*a	EP kg/m2*a	POCP kg/m2*a	ODP kg/m2*a
Construction Phase	**93**	**7.6**	**-1.3**	**6.2**	**2.2E-02**	**2.5E-03**	**2.1E-03**	**2.6E-07**
Use Phase	**526**	**33.3**	**-8.3**	**25.0**	**9.2E-02**	**5.9E-03**	**3.1E-02**	**1.8E-06**
Refurbishment	14	0.9	-0.2	0.6	3.8E-03	3.4E-04	4.6E-04	4.4E-08
Heating & cooling	512	32.4	-8.1	24.3	8.9E-02	5.6E-03	3.1E-02	1.8E-06
End-of-Life	**-2**	**0.4**	**0.0**	**0.4**	**5.5E-04**	**6.9E-05**	**2.8E-05**	**-2.2E-09**
Construction	-1	0.3	0.0	0.3	6.1E-04	7.1E-05	4.3E-05	4.6E-10
Refurbishment	-2	0.2	0.0	0.2	-6.1E-05	-2.6E-06	-1.4E-05	-2.7E-09
Total*	**619**	**40.9**	**-9.7**	**31.2**	**1.1E-01**	**8.4E-03**	**3.3E-02**	**2.1E-06**
Heating & Cooling								
Basement	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
Floors/ceilings	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Interior Walls	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Exterior Walls	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%	11.0%
Roof	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%	3.2%
Windows	13.5%	13.5%	13.5%	13.5%	13.5%	13.5%	13.5%	13.5%
Ventilation	55.5%	55.5%	55.5%	55.5%	55.5%	55.5%	55.5%	55.5%
Others	15.5%	15.5%	15.5%	15.5%	15.5%	15.5%	15.5%	15.5%
Cooling Energy	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Construction Phase								
Basement	8.3%	12.3%	0.8%	14.7%	11.8%	13.8%	11.0%	11.2%
Floors/ceilings	25.0%	31.5%	3.5%	37.5%	29.7%	33.8%	29.2%	36.2%
Interior Walls	27.7%	22.4%	53.3%	15.8%	21.2%	19.6%	20.9%	22.6%
Exterior Walls	25.4%	22.7%	41.4%	18.7%	21.8%	19.7%	25.2%	17.3%
Roof	4.8%	4.5%	0.5%	5.4%	4.6%	4.8%	5.0%	5.0%
Windows	8.7%	6.6%	0.5%	7.9%	10.9%	8.3%	8.7%	7.6%

* Total = Construction Phase + Use Phase

Z3_HR_002



Annex D Cost indicators

Annex D 1 Net present value (NPV)

The net present value (NPV) calculation is the most common dynamical cost calculation method. It takes into account the income and cost for each following period multiplied by a discount factor. The discount factor contains the adequate target or discount rate. An easy explanation of the net present value and the adequate target rate is as follows: If one has the choice to invest money or to bring the money to the bank and get an interest rate of 4%, then the adequate target rate is assumed to be 4%. Calculating the net present value with this adequate target rate the following results might occur:

Net present value = 0	The investment is as good as taking the money to the bank
Net present value > 0	The investment is better then the alternative (money to the bank)
Net present value < 0	The investment should not be done, as it is better to bring the money to the bank

The formula to calculate the net present value *NPV* is as follows:

$$NPV = -C_0 + \sum_{t=1}^{n} \frac{C_t}{(1+r)^t} \qquad 2)$$

C_0	Initial investment (i.e. the refurbishment action)
t	Time of the cash flow (year)
n	Total time of the project (here: residual service life of the building)
C_t	Expected net cash flow (expected income in time t minus expected expense in time t)
r	Discount rate (4%)

When calculating this cost indicator for the improvement options, the initial investment C_0 was calculated as the additional cost for the improvement measure compared to the alternative. The net cash flow C_t was assumed to be the cost of the energy saved for each respective year t.

The energy costs might increase in the next years. This was reflected by assuming a moderate increase of the energy cost by 2% per year.

Annex D 2 Internal rate of return

The internal rate of return (*IRR*) is the reverse calculation of the NPV. That means, to calculate the adequate target rate (see previous section) that would be necessary to yield a net-present value equal to zero. Therefore, it can be understood as yield for the investment:

$$0 = -C_0 + \sum_{t=1}^{n} \frac{C_t}{(1+IRR)^t} \qquad 3)$$

C_0	Initial investment (i.e. the refurbishment action)
t	Time of the cash flow (year)
n	Total time of the project (here: residual service life of the building)
C_t	Expected net cash flow (expected income in time t minus expected expense in time t)

Annex E Reference list for the definition of building types in the EU-25

This annex provides the list of the literature that has been used to characterize the European residential building stock. This literature is the basis for the definition of the building types used in this study.

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Abstract

This report on "Environmental improvement potential of residential buildings" is a JRC's scientific contribution to the European Commission's Integrated Product Policy framework which seeks to minimise the environmental degradation caused the life cycle of products. A previous study coordinated by the JRC (EIPRO study) had shown that building occupancy and structure all together make up 20 to 35% of the impacts of all products for most impact categories.
This report presents a systematic overview of the environmental life cycle impacts of residential buildings in EU-25. It also provides an analysis of the technical improvement options that could be help reducing these environmental impacts, with a special focus to their main source, namely energy use for space heating. The report assesses the environmental benefits and the costs associated with these improvement options.

The mission of the JRC is to provide customer-driven scientific and technical support for the conception, development, implementation and monitoring of EU policies. As a service of the European Commission, the JRC functions as a reference centre of science and technology for the Union. Close to the policy-making process, it serves the common interest of the Member States, while being independent of special interests, whether private or national.

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