REPORT ON LIBRARY OF SOTA REFURBISHMENT OPTIONS

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Executive Summary

The following report describes the overall data collection process and design concept for the database of renovation options which will be used as a backend of the DREEAM tool. The DREEAM tool will generate optimal renovation concepts for the three building sites participating in the DREEAM project.

The data collection for the database is divided into three phases: Phase 1: Library of SOTA renovation options, Phase 2: Techno-economic mapping of SOTA options and Phase 3: Market innovation scan. This document will give a short overview of these three phases. The focus of this document will however be on the first phase (the SOTA library).

The first stage of data collection for the library of SOTA renovation options ended at the end of January 2016 and is reported on in this deliverable. The SOTA library will however be updated throughout the project and especially after the Phase 2: "Techno-economic mapping of SOTA options". As a result, three versions of the library are expected:

Version 1: Description of the Methodology and Structure of the Database to be generated as well as initial library of SOTA-Technologies (until End of January 2016)

Version 2: Extension of the SOTA-Library with country-specific data from the building sites mainly based on data collected in phase 2 techno-economic mapping (until End March 2016)

Version 3: Extension of the SOTA-Library with data from other countries, not covered in the initial data collection, as a contribution to dissemination activities in WP 6 (second half of 2016 and in 2017).

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1 Introduction

The aim of this report is to describe the methodology of cost, labour and performance data gathered of different State of the Art (SOTA) renovation options to be considered within the DREEAM project. DREEAM develops optimised renovation recommendations for multi-building projects in social housing sector. The core of the project is based on an innovative calculation tool (referred to as DREEAM tool) that generates best-suited renovation options for multi-building sites, aiming to both maximise the energy efficiency gains and at the same time meet other co-benefits (NPV, ROI etc.) key to building owners. Through the transparent and accurate demonstration of multiple benefits resulting from energy efficiency measures, DREEAM aims to develop a replicable concept that can help to increase the rate of energy efficiency renovations in Europe.

The aim of the data collection is to have a common dataset for SOTA and innovative renovation options which can be used for the DREEAM calculation tool, including regionally tailored cost and performance data of the three building sites as well as other countries in the EU. This report lays out the overall data collection process, with the focus on the initial phase, the SOTA Library of renovation options.

2 Methodology Data Collection

The Data collection process within tasks 1.1, 1.2 and 1.3 of DREEAM will result in input data for the DREEAM tool. It focuses on collecting technological and cost data of SOTA renovation options for multi-family houses as well as innovative measures. All renovation measures should be adapted to country-specific characteristics and therefore supplemented with local specific solutions. The overall process is depicted in Figure 1.

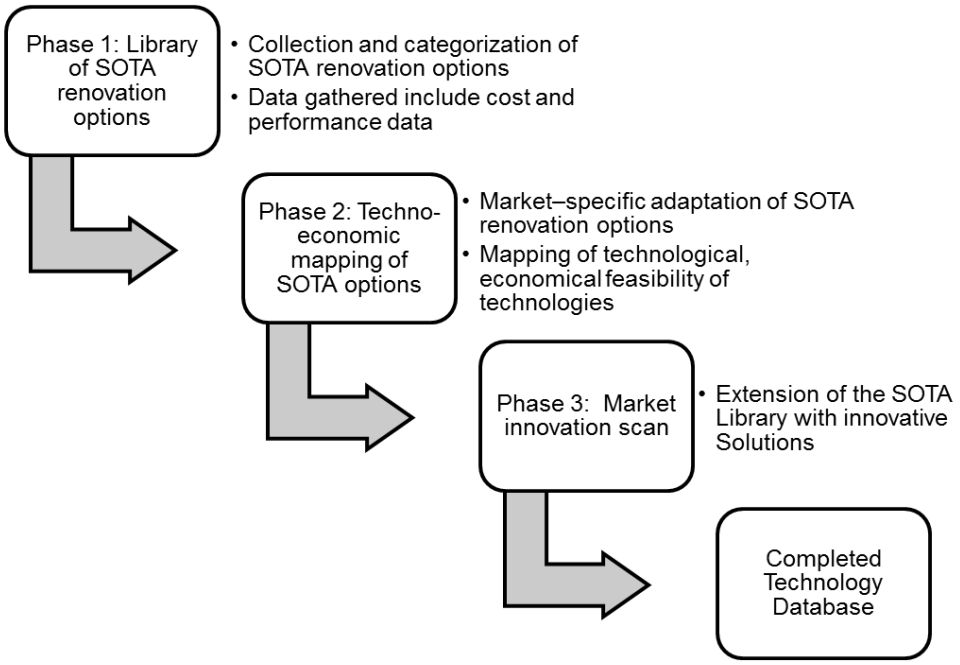


Figure 1 Data collection for the development of the DREEAM tool

2.1 Phase 1 Library of SOTA renovation options

In the first phase information on State of the Art renovation options SOTA) is collected from existing data sources. This phase focuses on generating technological and cost data for different refurbishment measures. Refurbishment options are collected for different building components and their functions in the building. The structure of the library is roughly divided into passive components (i.e. measures on the building envelope) and active components (i.e. measures on the HVAC as well as energy generation systems). The data collection focuses on established measures and therefore is collected from refurbishment and tender cost catalogues which mainly include common practice measures.

2.2 Phase 2: Techno-economic mapping of SOTA options

Based on the SOTA library generated in the first phase, a more in-depth techno-economic mapping of SOTA technologies and renovation options will be done for each market of the three building sites within this project (Italy, UK and Sweden). This means adapting the library for each country and collecting further, country-specific data. It may include additional indicators such as specific expectations of building owners and local tenants (e.g. establishment of socially acceptable options, financial feasibility, technical and management possibilities, regulations constraints, etc.), which would help to give tailored recommendations for the building sites participating in DREEAM.

2.3 Phase 3: Market innovation scan

In the third phase, the SOTA technology database is further complemented with innovative solutions which are not yet broadly applied on the market and are therefore not included in the cost catalogues the initial SOTA-library is based on. Therefore, a wider innovation scan is conducted which targets different innovation suppliers, which are then included into technology database.

3 DREEAM Technology Database

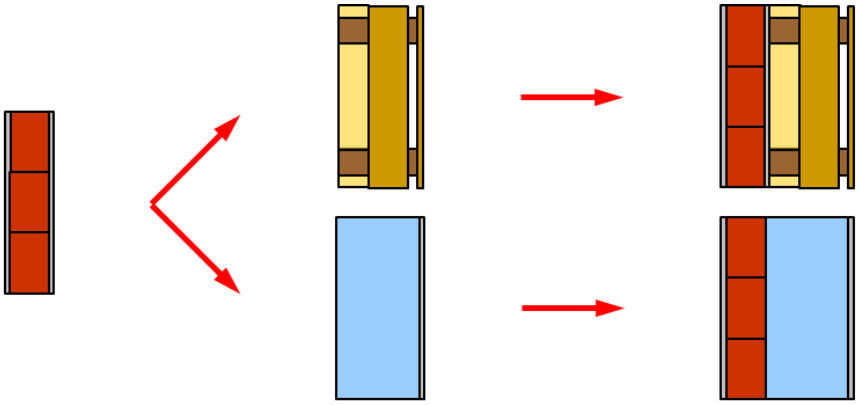
3.1 Database Structure

The Technology database is structured according to different building components and building main energetic building functions (see Table 1).

Table 1 Building Components and Technology categories included in the database

Passive Technologies		**Active Technologies**	
1	Outer walls against air	1	Heating System
2	Outer walls against earth	2	Heat Distribution
3	Basement (floor against earth)	3	Ventilation
4	Floors against unheated	4	Cooling
5	Ceiling against unheated	5	Lighting
6	Flat roof	6	Shading
7	Tilted roof	7	Solarthermal Systems
8	Windows in Wall	8	Storage Tank
9	Windows in Tilted Roof	9	PV
10	Windows in Flat Roof	10	Control Systems/Building Automation
		11	Battery Systems

The data gathered for the database is structured in a way that both data on the standard renovation solutions and the initial state of the building can be considered. The data gathered is divided into two parts: (1) an evaluation of the current state and what it takes to be refurbished (i.e. what needs to be done in order to apply a certain renovation option) and (2) data of different renovation option (new materials/installation, new performance). Together the database can deliver detailed information on performance, costs (both demolition and installation), waste and added materials and the labour intensity for each renovation option for each component (see Figure 2).



Initial make-up/state:	Renovation solutions:	New make-up/state:
• Performance	• Performance	• Performance
• Demolition costs	• Installation costs	• Total Installation costs
• Removed materials	• Added materials	• Waste and added materials
• Labour Intensity	• Labour Intensity	• Total Labour Intensity
• Etc.	• Etc.	• Etc.

Figure 2 DREEAM Technology Database Structure

3.2 Cost Data Structure

The main data collected is that referring to cost of different measures. The data is structured structured based on [1] and in line with the standard EN 15459, in order to enable a total cost calculation within the Tool (see Figure 3). The data collection for the technology database is mainly focused on installation and maintenance cost, however also additional factors such local profit margins, professional fees (i.e. planning costs) and taxes will be collected during phase 2 of the data collection. Operational cost can be included if the renovation strategies are likely to have a significant impact on operational costs (e.g. through lowering turnover significantly), in this case data has to be provided by the building owners. The resulting database, therefore, allows for a full cost accounting approach taking into account initial investment, running and replacement costs of different solutions.

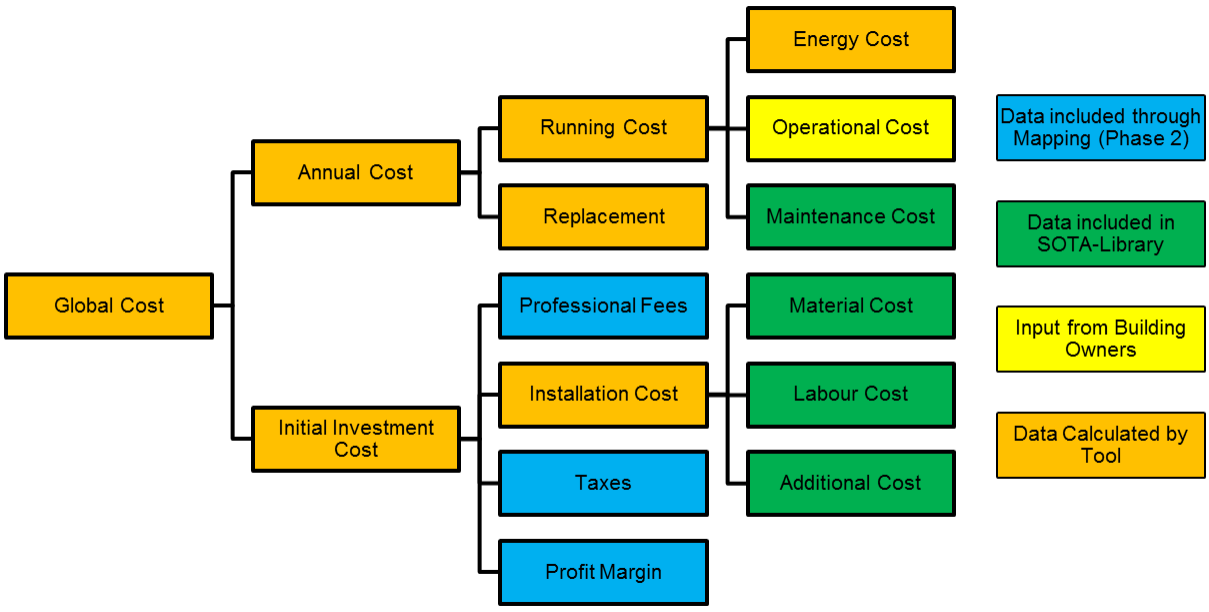


Figure 3 Cost Structure applied in DREEAM (adapted from [1]).

3.3 Data Sources

The initial library of SOTA renovation options was collected based on available refurbishment catalogues and tendering cost catalogues. During the second phase, the SOTA Library is adapted based on local catalogues and/or based on catalogues used by the building owners themselves. Table 2 shows the data sources considered during Phase 1 and 2 of the renovation option database generation. The necessary data for the innovative technologies gathered during the innovation scan is provided by the Innovation suppliers directly.

Table 2 Data Sources considered for the SOTA database in Phase 1 and 2

Country	**Data Source**
Italy	DEI TIPOGRAFIA DEL GENIO CIVILE [2]
Sweden	WIKELLS [3]
UK	BCIS [4]
Spain	CYPE INGENIEROS [5]
Germany	SIRADOS [6]

4 Conclusion

The aim of this deliverable was to describe the process of data collected for the DREEAM tool but with the focus on the first phase: the SOTA Library. As the data collection is divided into three phases (Phase 1: Library of SOTA renovation options, Phase 2: Techno-economic mapping of SOTA options and Phase 3: Market innovation scan) also this deliverable will be continuously updated throughout this process, with focus on the remaining phases.

The aim of the data collection process is to have a common dataset for SOTA and innovative Renovation options, including regionally tailored cost and performance data of the three building sites as well as other building sites, which can serve as the backend of the DREEAM tool.

5 Annex

The Results of the SOTA Library of Phase 1 of the data collection are gathered in the "DREEAM_SOTA-Library_v1.xlsx" document.

An overview of different components covered in the database, as well as screenshots of the relevant database sections are provided below.

5.1 SOTA database – overview of included technologies

1	**Outer walls against air**
1,1	External insulation (ventilated façade)
1,2	External insulation (EIFS System)
1,3	Internal filling of air cavity with thermal insulation
1,4	Internal insulation
2	**Outer walls against earth**
2,1	Perimeter insulation
2,2	Internal Insulation of the Basement wall
3	**Basement (floor against earth)**
3,1	Insulation on the inside (heated side) of the floor slab
4	**Floors against unheated**
4,1	Insulation on the inside (heated side) of the floor slab
4,2	Insulation on the outside (unheated heated side) of the floor slab
5	**Ceiling against unheated**
5,1	Insulation below the ceiling slab
5,2	Insulation above the ceiling slab
6	**Flat roof**
6,1	External Insulation above the roof slab
6,2	Internal Insulation below the roof slab
7	**Tilted roof**
7,1	External Insulation on roof
7,2	Core Insulation between roof beams
7,3	Internal Insulation below the roof construction
8	**Windows in Wall**
8,1	Double glass with air cavity
8,2	Double glass with air cavity and low-e glazing
8,3	Double glass with argon cavity and low-e glazing
9	**Windows in Tilted Roof**
9,1	Double glass with air cavity
9,2	Double glass with air cavity and low-e glazing
9,3	Double glass with argon cavity and low-e glazing
10	**Windows in Flat Roof**
10,1	Simple glass dome

11	Heating System
11,1	Oil boiler (conventional)
11,2	Gas boiler (conventional)
11,3	Oil boiler (condensing)
11,4	Gas boiler (condensing)
11,5	Heat pump air
11,6	Heat pump ground
11,7	Heat pump groundwater
11,8	District heating station
11,9	Pellet stove
11,1	CHP oil
11,11	CHP gas
11,12	CHP wood
12	**Heat Distribution**
12,1	Radiator heating
12,2	Floor heating
13	**Ventilation**
13,1	Automatic Natural Ventilation
13,2	Mechanical Ventilation systems (exhaust air)
13,3	Mechanical Ventilation systems (heat recovery)
13,4	Decentral Mechanical Ventilation systems
14	**Cooling**
14,1	Decentral air conditioning units
14,2	Chillers
14,3	Use of free-cooling
15	**Lighting**
15,1	Conventional Lighting
15,2	LED Lighting
16	**Shading**
16,1	Drop-arm awnings installation
16,2	External window blinds
16,3	Automation of solar shading devices
16,4	Solar control vinyl film
17	**Solarthermal Collectors**
17,1	Flat solar collector
17,2	Vacuum tube solar collector
18	**Storage Tank**
18,1	Hotwater tank
18,2	Hotwater tank with electrical boiler
18,3	Hotwater tank from thermosolar
19	**PV**
19,1	Amorph-Silica Modules
19,2	CIS Modules
19,3	monocrystalin-Silica Modules
19,4	polycrystalin-Silica Modules

20	Control Systems
20,1	Climatic control system for heating/cooling
20,2	Indoor thermostatic control system
20,3	Climatic-indoor thermostatic system
20,4	Occupancy sensors for lighting
20,5	Automatic daylight dimming systems
20,6	Solar thermal control systems
21	**Battery**
21,1	Lead battery
21,2	LI-Ion Battery

5.2 SOTA database – screenshots of different sections

5.2.1 Section 1-7 (outer walls against air/earth, basement, floor/ceiling against unheated, flat/tilted roof)

Reference				Component/Technology	Insulation Thickness	Labour Intensity	Labour Cost [EUR/m2]	Material Cost	Additional Cost [EUR/m2]	Total Cost [EUR/m2]
	1			**Outer walls against air**						
1.1.	1	1		External insulation (ventilated façade)						
1.1.1	1	1	1	Ventilated Fassade - 40 mm insulation	40 mm	1,79	30,42	62,70	4,66	97,78
1.1.1	1	1	1	Ventilated Fassade - 60 mm insulation	60 mm	1,79	30,42	65,46	4,79	100,68
1.1.1	1	1	1	Ventilated Fassade - 80 mm insulation	80 mm	1,79	30,42	65,46	4,79	100,68
1.1.2	1	1	2	Ventilated Fassade - 50 mm insulation	50 mm	1,43	24,27	82,60	5,34	112,22
1.1.2	1	1	2	Ventilated Fassade - 80 mm insulation	80 mm	1,43	24,27	87,16	5,57	117,00
1.1.2	1	1	2	Ventilated Fassade - 100 mm insulation	100 mm	1,43	24,27	90,81	5,75	120,84
1.2.	1	2		External insulation (EIFS System)						
1.2.1	1	2	1	External insulation (EIFS System) - 40 mm insulation	40 mm	1,53	25,59	28,39	2,70	56,68
1.2.1	1	2	1	External insulation (EIFS System) - 60 mm insulation	60 mm	1,53	25,59	31,96	2,88	60,43
1.2.1	1	2	1	External insulation (EIFS System) - 80 mm insulation	80 mm	1,53	25,59	33,59	2,96	62,14
1.2.2	1	2	2	External insulation (EIFS System) - 40 mm insulation	40 mm	1,53	25,59	43,72	3,47	72,78
1.2.2	1	2	2	External insulation (EIFS System) - 60 mm insulation	60 mm	1,53	25,59	62,62	4,41	92,62
1.2.2	1	2	2	External insulation (EIFS System) - 80 mm insulation	80 mm	1,53	25,59	81,52	5,36	112,47
1.3.	1	3		Filling air cavity with thermal insulation						
1.3.1	1	3	1	Filling air cavity with thermal insulation - 60 mm insulation	60 mm	1,44	23,55	9,79	1,67	35,01
1.3.1	1	3	1	Filling air cavity with thermal insulation - 80 mm insulation	80 mm	1,44	23,55	13,01	1,83	38,39
1.3.1	1	3	1	Filling air cavity with thermal insulation - 100 mm insulation	100 mm	1,44	23,55	16,23	1,99	41,77
1.4.	1	4		Internal insulation						
1.4.1	1	4	1	Internal insulation - 10 + 30 mm insulation	10 + 30 mm	0,60	10,33	20,63	1,55	32,50
1.4.1	1	4	1	Internal insulation - 10 + 50 mm insulation	10 + 50 mm	0,60	10,33	28,00	1,92	40,24
1.4.1	1	4	1	Internal insulation - 10 + 80 mm insulation	10 + 80 mm	0,60	10,33	34,87	2,26	47,46
1.4.2	1	4	2	Internal insulation - 10 + 100 mm insulation	10 + 100 mm	0,60	10,33	38,22	2,43	50,98
	2			**Outer walls against earth**						
2.1.	2	1		Perimeter insulation						
2.1.1	2	1	1	Perimeter insulation - 40 mm insulation	40 mm	0,37	6,31	6,12	0,62	13,05
2.1.1	2	1	1	Perimeter insulation - 60 mm insulation	60 mm	0,37	6,31	8,90	0,76	15,97
2.1.1	2	1	1	Perimeter insulation - 80 mm insulation	80 mm	0,37	6,31	11,69	0,90	18,91
2.2.	2	2		Internal Insulation of the Basement wall			same as 1.4.			
	3			**Basement (floor against earth)**						
3.1.	3	1		Insulation on the inside (heated side) of the floor slab						
3.1.1	3	1	1	Insulation on the inside (heated side) of the floor slab - 40 mm insulation	40 mm	1,22	20,32	19,93	2,01	42,27
3.1.1	3	1	1	Insulation on the inside (heated side) of the floor slab - 40 mm insulation	60 mm	1,22	20,32	23,10	2,17	45,60
3.1.1	3	1	1	Insulation on the inside (heated side) of the floor slab - 40 mm insulation	80 mm	1,22	20,32	26,27	2,33	48,92
	4			**Floors against unheated**						
4.1.	4	1		Insulation on the inside (heated side) of the floor slab			same as 3.1.			
4.2.	4	2		Insulation on the outside (unheated heated side) of the floor slab			same as 5.1.			
	5			**Ceiling against unheated**						
5.1.	5	1		Insulation below the ceiling slab						
5.1.1	5	1	1	Insulation below the ceiling slab - 40 mm insulation	40 mm	0,79	13,54	18,47	1,60	33,61
5.1.1	5	1	1	Insulation below the ceiling slab - 60 mm insulation	60 mm	0,79	13,54	21,40	1,75	36,69
5.2.	5	2		Insulation above the ceiling slab			same as 3.1.			
	6			**Flat roof**						
6.1.	6	1		External Insulation above the roof slab						
6.1.1	6	1	1	External Insulation above the roof slab - 40 mm insulation	40 mm	0,48	8,14	11,68	0,99	20,81
6.1.1	6	1	1	External Insulation above the roof slab - 60 mm insulation	60 mm	0,48	8,14	14,45	1,13	23,72
6.1.1	6	1	1	External Insulation above the roof slab - 80 mm insulation	80 mm	0,48	8,14	17,22	1,27	26,63
6.1.2	6	1	2	External Insulation above the roof slab - 40 mm insulation	40 mm	0,55	9,24	26,42	1,78	37,45
6.1.2	6	1	2	External Insulation above the roof slab - 60 mm insulation	60 mm	0,55	9,24	29,19	1,92	40,36
6.1.2	6	1	2	External Insulation above the roof slab - 80 mm insulation	80 mm	0,55	9,24	31,97	2,06	43,27
6.2.	6	2		Internal Insulation below the roof slab			same as 5.1.			
	7			**Tilted roof**						
7.1.	7	1		External Insulation on roof						
7.1.1	7	1	1	External Insulation on roof - 50 mm insulation	50 mm	3,19	52,74	26,63	3,97	83,34
7.1.1	7	1	1	External Insulation on roof - 60 mm insulation	60 mm	3,19	52,74	27,80	4,03	84,57
7.2.	7	2		Core Insulation between roof beams						
7.2.1	7	2	1	Core Insulation between roof beams - 80 mm insulation	80 mm	0,17	2,82	3,46	0,31	6,59
7.2.1	7	2	1	Core Insulation between roof beams - 120 mm insulation	120 mm	0,17	2,82	5,26	0,40	8,48
7.2.1	7	2	1	Core Insulation between roof beams - 200 mm insulation	200 mm	0,17	2,82	8,46	0,56	11,84
7.3.	7	3		Internal Insulation below the roof construction			same as 5.1.			

5.2.2 Section 8-10 (windows in wall, in tilted roof, in flat roof)

Reference				Component/Technology	U-Value[W/Km2]	g-Value [%]	Light transmission [%]	Labour Intensity [h/m2]	Labour Cost [EUR/m2]	Material Cost [EUR/m2]	Additional Cost [EUR/m2]	Total Cost [EUR/m2]	Maintenance Cost [EUR/m2 year]
	8			**Windows in Wall**									
8.1.	8	1		Double glass with air cavity									
8.1.1	8	1	1	4 mm / 6 mm / 4 mm - alu. (U-Value = 3.28)	3,28	77	81	0,77	13,84	226,26	12,01	252,11	0,77
8.1.1	8	1	1	4 mm / 6 mm / 4 mm - PVC (U-Value = 3.08)	3,08	77	81	0,77	13,84	202,87	10,84	227,54	0,77
8.1.1	8	1	1	4 mm / 6 mm / 4 mm - wood (U-Value = 3.04)	3,04	77	81	0,77	13,84	534,21	27,40	575,45	0,77
8.1.2	8	1	2	6 mm / 10 mm / 6 mm - alu. (U-Value = 2.96)	2,96	76	81	0,77	13,84	249,10	13,15	276,08	0,77
8.1.2	8	1	2	6 mm / 10 mm / 6 mm - PVC (U-Value = 2.76)	2,76	76	81	0,77	13,84	226,97	12,04	252,85	0,77
8.1.2	8	1	2	6 mm / 10 mm / 6 mm - wood (U-Value = 2.72)	2,72	76	81	0,77	13,84	557,05	28,54	599,43	0,77
8.1.3	8	1	3	10 mm / 14 mm / 10 mm - alu. (U-Value = 2.8)	2,8	69	77	0,77	13,84	293,31	15,36	322,51	0,77
8.1.3	8	1	3	10 mm / 14 mm / 10 mm - PVC (U-Value = 2.6)	2,6	69	77	0,77	13,84	269,92	14,19	297,95	0,77
8.1.3	8	1	3	10 mm / 14 mm / 10 mm - wood (U-Value = 2.56)	2,56	69	77	0,77	13,84	601,26	18,45	633,55	0,77
8.2.	8	2		Double glass with air cavity and low e-glazing									
8.2.1	8	2	1	4 mm / 6 mm / 4 mm - alu. (U-Value = 2.64)	2,64	41	48	0,77	13,84	296,31	15,51	325,66	2,32
8.2.1	8	2	1	4 mm / 6 mm / 4 mm - PVC (U-Value = 2.44)	2,44	41	48	0,77	13,84	272,92	14,34	301,09	2,32
8.2.1	8	2	1	4 mm / 6 mm / 4 mm - wood (U-Value = 2.4)	2,4	41	48	0,77	13,84	604,26	30,90	649,00	2,32
8.2.2	8	2	2	6 mm / 10 mm / 6 mm - alu. (U-Value = 2.08)	2,08	41	48	0,77	13,84	301,92	15,79	331,55	2,32
8.2.2	8	2	2	6 mm / 10 mm / 6 mm - PVC (U-Value = 1.88)	1,88	41	48	0,77	13,84	278,53	14,62	306,99	2,32
8.2.2	8	2	2	6 mm / 10 mm / 6 mm - wood (U-Value = 1.84)	1,84	41	48	0,77	13,84	609,87	31,19	654,90	2,32
8.2.3	8	2	3	8 mm / 14 mm / 6 mm - alu. (U-Value = 1.84)	1,84	41	48	0,77	13,84	293,31	15,36	322,51	2,32
8.2.3	8	2	3	8 mm / 14 mm / 6 mm - PVC (U-Value = 1.64)	1,64	41	48	0,77	13,84	269,92	14,19	297,95	2,32
8.2.3	8	2	3	8 mm / 14 mm / 6 mm - wood (U-Value = 1.6)	1,6	41	48	0,77	13,84	601,26	30,75	645,85	2,32
8.3.	8	3		Double glass with argon cavity and low e-glazing									
8.3.1	8	3	1	4 mm / 10 mm / 6 mm - alu. (U-Value = 1.76)	1,76	39	48	0,77	13,84	302,95	15,84	332,63	2,47
8.3.1	8	3	1	4 mm / 10 mm / 6 mm - PVC (U-Value = 1.56)	1,56	39	48	0,77	13,84	279,56	14,67	308,07	2,47
8.3.1	8	3	1	4 mm / 10 mm / 6 mm - wood (U-Value = 1.52)	1,52	39	48	0,77	13,84	610,90	31,24	655,97	2,47
8.3.2	8	3	2	6 mm / 12 mm / 6 mm - alu. (U-Value = 1.68)	1,68	39	48	0,77	13,84	308,26	16,10	338,20	2,47
8.3.2	8	3	2	6 mm / 12 mm / 6 mm - PVC (U-Value = 1.48)	1,48	39	48	0,77	13,84	284,87	14,94	313,64	2,47
8.3.2	8	3	2	6 mm / 12 mm / 6 mm - wood (U-Value = 1.44)	1,44	39	48	0,77	13,84	616,21	31,50	661,55	2,47
8.3.3	8	3	3	8 mm / 14 mm / 6 mm - alu. (U-Value = 1.52)	1,52	39	48	0,77	13,84	341,83	17,78	373,45	2,47
8.3.3	8	3	3	8 mm / 14 mm / 6 mm - PVC (U-Value = 1.32)	1,32	39	48	0,77	13,84	318,44	16,61	348,89	2,47
8.3.3	8	3	3	8 mm / 14 mm / 6 mm - wood (U-Value = 1.28)	1,28	39	48	0,77	13,84	649,78	33,18	696,80	2,47
	9			**Windows in Tilted Roof**									
9.1.	9	1		Double glass with air cavity									
9.1.1	9	1	1	4 mm / 6 mm / 4 mm - alu. (U-Value = 3.28)	3,28	77	81	0,77	13,84	294,40	15,41	323,65	0,84
9.1.1	9	1	1	4 mm / 6 mm / 4 mm - PVC (U-Value = 3.08)	3,08	77	81	0,77	13,84	271,01	14,24	299,09	0,84
9.1.1	9	1	1	4 mm / 6 mm / 4 mm - wood (U-Value = 3.04)	3,04	77	81	0,77	13,84	602,35	30,81	647,00	0,84
9.1.2	9	1	2	6 mm / 10 mm / 6 mm - alu. (U-Value = 2.96)	2,96	76	81	0,77	13,84	317,24	16,55	347,63	0,84
9.1.2	9	1	2	6 mm / 10 mm / 6 mm - PVC (U-Value = 2.76)	2,76	76	81	0,77	13,84	295,11	15,45	324,39	0,84
9.1.2	9	1	2	6 mm / 10 mm / 6 mm - wood (U-Value = 2.72)	2,72	76	81	0,77	13,84	625,19	31,95	670,98	0,84
9.1.3	9	1	3	10 mm / 14 mm / 10 mm - alu. (U-Value = 2.8)	2,8	69	77	0,77	13,84	361,45	18,76	394,05	0,84
9.1.3	9	1	3	10 mm / 14 mm / 10 mm - PVC (U-Value = 2.6)	2,6	69	77	0,77	13,84	338,06	17,59	369,49	0,84
9.1.3	9	1	3	10 mm / 14 mm / 10 mm - wood (U-Value = 2.56)	2,56	69	77	0,77	13,84	669,40	13,66	696,90	0,84
9.2.	9	2		Double glass with air cavity and low e-glazing									
9.2.1	9	2	1	4 mm / 6 mm / 4 mm - alu. (U-Value = 2.64)	2,64	41	48	0,77	13,84	364,45	18,91	397,20	2,34
9.2.1	9	2	1	4 mm / 6 mm / 4 mm - PVC (U-Value = 2.44)	2,44	41	48	0,77	13,84	341,06	17,74	372,64	2,34
9.2.1	9	2	1	4 mm / 6 mm / 4 mm - wood (U-Value = 2.4)	2,4	41	48	0,77	13,84	672,40	34,31	720,55	2,34
9.2.2	9	2	2	6 mm / 10 mm / 6 mm - alu. (U-Value = 2.08)	2,08	41	48	0,77	13,84	370,06	19,20	403,10	2,34
9.2.2	9	2	2	6 mm / 10 mm / 6 mm - PVC (U-Value = 1.88)	1,88	41	48	0,77	13,84	346,67	18,03	378,54	2,34
9.2.2	9	2	2	6 mm / 10 mm / 6 mm - wood (U-Value = 1.84)	1,84	41	48	0,77	13,84	678,01	34,59	726,44	2,34
9.2.3	9	2	3	8 mm / 14 mm / 6 mm - alu. (U-Value = 1.84)	1,84	41	48	0,77	13,84	361,45	18,76	394,05	2,34
9.2.3	9	2	3	8 mm / 14 mm / 6 mm - PVC (U-Value = 1.64)	1,64	41	48	0,77	13,84	338,06	17,59	369,49	2,34
9.2.3	9	2	3	8 mm / 14 mm / 6 mm - wood (U-Value = 1.6)	1,6	41	48	0,77	13,84	669,40	34,16	717,40	2,34
9.3.	9	3		Double glass with argon cavity and low e-glazing									
9.3.1	9	3	1	4 mm / 10 mm / 6 mm - alu. (U-Value = 1.76)	1,76	39	48	0,77	13,84	371,09	19,25	404,17	2,98
9.3.1	9	3	1	4 mm / 10 mm / 6 mm - PVC (U-Value = 1.56)	1,56	39	48	0,77	13,84	347,70	18,08	379,61	2,98
9.3.1	9	3	1	4 mm / 10 mm / 6 mm - wood (U-Value = 1.52)	1,52	39	48	0,77	13,84	679,04	34,64	727,52	2,98
9.3.2	9	3	2	6 mm / 12 mm / 6 mm - alu. (U-Value = 1.68)	1,68	39	48	0,77	13,84	376,40	19,51	409,75	2,98
9.3.2	9	3	2	6 mm / 12 mm / 6 mm - PVC (U-Value = 1.48)	1,48	39	48	0,77	13,84	353,01	18,34	385,19	2,98
9.3.2	9	3	2	6 mm / 12 mm / 6 mm - wood (U-Value = 1.44)	1,44	39	48	0,77	13,84	684,35	34,91	733,10	2,98
9.3.3	9	3	3	8 mm / 14 mm / 6 mm - alu. (U-Value = 1.52)	1,52	39	48	0,77	13,84	409,97	21,19	445,00	2,98
9.3.3	9	3	3	8 mm / 14 mm / 6 mm - PVC (U-Value = 1.32)	1,32	39	48	0,77	13,84	386,58	20,02	420,44	2,98
9.3.3	9	3	3	8 mm / 14 mm / 6 mm - wood (U-Value = 1.28)	1,28	39	48	0,77	13,84	717,92	36,59	768,35	2,98
	10			**Windows in Flat Roof**									
10.1.1	10	1	1	600 mm x 600 mm fixed (U-Value = 1.4)	1,4	53	80	0,77	13,84	396,80	20,53	431,18	1,32
10.1.1	10	1	1	600 mm x 600 mm manual (U-Value = 1.4)	1,4	53	80	0,77	13,84	479,08	24,65	517,57	1,32
10.1.2	10	1	2	900 mm x 900 mm fixed (U-Value = 1.4)	1,4	53	80	0,77	13,84	542,72	27,83	584,39	1,32
10.1.2	10	1	2	900 mm x 900 mm manual (U-Value = 1.4)	1,4	53	80	0,77	13,84	646,03	32,99	692,87	1,32
10.1.3	10	1	3	1200 mm x 1200 mm fixed (U-Value = 1.4)	1,4	53	80	0,77	13,84	735,29	37,46	786,59	1,32
10.1.3	10	1	3	1200 mm x 1200 mm manual (U-Value = 1.4)	1,4	53	80	0,77	13,84	858,43	43,61	915,89	1,32

5.2.3 Section 11 (heating system)

Reference	Component/Technology	D.H.W. Capacity kW	Heating capacity kW	Power capacity kW	Seasonal performance (SEER) [%]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/kW]	Labour Cost [EUR/kW]	Material Cost [EUR/kW]	Additional Cost [EUR/kW]	Total Cost [EUR/kW]	Maintenance Cost [EUR/kW year]
11	Heating System																
11.1. 11 1	Oil boiler (conventional)																
11.1.1 11 1 1	25 kW	25	25		67	8,5492	144,99	1850,92	99,80	2095,71	532,22	0,34	5,80	74,04	3,99	83,83	21,29
11.1.1 11 1 1	25 kW With energy accumulation in the primary circuit	25	25		67	8,5492	144,99	2462,02	130,35	2737,36	532,22	0,34	5,80	98,48	5,21	109,49	21,29
11.1.1 11 1 1	25 kW With deposit integrated	25	25		67	8,5492	144,99	2403,82	127,44	2676,25	532,22	0,34	5,80	96,15	5,10	107,05	21,29
11.1.1 11 1 1	40 kW With deposit integrated	40	40		68	8,5492	144,99	2956,72	155,09	3256,80	532,22	0,21	3,62	73,92	3,88	81,42	13,31
11.2. 11 2	Gas boiler (conventional)																
11.2.2 11 2 2	Gas boiler (conventional) - 30 kW	30	30		78	8,544	144,91	1816,68	98,08	2059,67	532,22	0,28	4,83	60,56	3,27	68,66	17,74
11.2.2 11 2 2	Gas boiler (conventional) - 42 kW	42	42		78	8,544	144,91	1903,98	102,44	2151,33	532,22	0,20	3,45	45,33	2,44	51,22	12,67
11.2.2 11 2 2	Gas boiler (conventional) - 54 kW	54	54		79	8,544	144,91	2117,38	113,11	2375,40	532,22	0,16	2,68	39,21	2,09	43,99	9,86
11.3. 11 3	Oil boiler (condensing)																
11.3.1 11 3 1	individual - 30 kW	30	30		93	7,22	122,45	6525,73	332,41	6980,59	532,22	0,24	4,08	217,52	11,08	232,69	17,74
11.3.2 11 3 2	collective -95 kW		95		94	8,748	148,37	5539,69	284,40	5972,46	484,04	0,09	1,56	58,31	2,99	62,87	5,10
11.3.2 11 3 2	collective -510 kW		510		96	9,634	163,39	16578,37	837,09	17578,85	1424,70	0,02	0,32	32,51	1,64	34,47	2,79
11.3.2 11 3 2	collective -1200 kW		1200		97	10,916	185,14	32858,03	1652,16	34695,32	2811,92	0,01	0,15	27,38	1,38	28,91	2,34
11.4. 11 4	Gas boiler (condensing)																
11.4.1 11 4 1	individual - 30 kW	30	25		93	6,408	108,68	2238,32	117,35	2464,35	164,22	0,26	4,35	89,53	4,69	98,57	6,57
11.4.1 11 4 1	individual - 30 kW steel enameled 48 litres	30	24		93	6,408	108,68	2742,35	142,55	2993,58	199,48	0,27	4,53	114,26	5,94	124,73	8,31
11.4.1 11 4 1	individual - 28 kW stainless steel tank of 42 litres	28	24		93	6,408	108,68	3634,75	187,17	3930,60	261,92	0,27	4,53	151,45	7,80	163,78	10,91
11.4.2 11 4 2	collective - 45 kW		45		93	8,64	146,53	3867,09	200,68	4214,31	321,31	0,19	3,26	85,94	4,46	93,65	7,14
11.4.2 11 4 2	collective - 80 kW		80		94	8,716	147,82	4744,59	244,62	5137,03	391,66	0,11	1,85	59,31	3,06	64,21	4,90
11.4.2 11 4 2	collective - 115 kW		115		94	8,79	149,08	11620,43	588,48	12357,98	926,14	0,08	1,30	101,05	5,12	107,46	8,05
11.4.2 11 4 2	collective - 240 kW		240		95	9,058	153,62	17738,10	894,59	18786,31	1407,89	0,04	0,64	73,91	3,73	78,28	5,87
11.4.2 11 4 2	collective - 520 kW		520		96	9,656	163,77	29100,33	1463,20	30727,30	2302,78	0,02	0,31	55,96	2,81	59,09	4,43
11.4.2 11 4 2	collective - 745 kW		745		96	10,136	171,91	34490,35	1733,11	36395,37	2727,57	0,01	0,23	46,30	2,33	48,85	3,66
11.4.2 11 4 2	collective - 1200 kW		1200		97	11,002	186,59	44080,55	2213,36	46480,50	3483,37	0,01	0,16	36,73	1,84	38,73	2,90
11.5. 11 5	Heat pump air																
11.5.1 11 5 1	air-water		21,8		236	19,246	326,41	7113,53	372,00	7811,94	500,25	0,88	14,97	326,31	17,06	358,35	22,95
11.5.1 11 5 1	air-water		63,4		236	63,4	32,08	544,04	28,81	604,93	1156,84	1,00	0,51	8,58	0,45	9,54	18,25
11.6. 11 6	Heat pump ground																
11.6.1 11 6 1	Heat pump ground - 6,95 kW		6,95	5,44	460	14,114	239,37	1460,14	84,98	1784,49	114,27	2,03	34,44	210,09	12,23	256,76	16,44
11.6.1 11 6 1	Heat pump ground - 15,31 kW		15,31	12,27	504	19,246	326,41	3144,93	173,57	3644,91	233,40	1,26	21,32	205,42	11,34	238,07	15,24
11.6.1 11 6 1	Heat pump ground - 49,9 kW		49,9	35,2	402	32,078	544,04	14536,53	754,03	15834,60	1013,99	0,64	10,90	291,31	15,11	317,33	20,32
11.6.1 11 6 1	Heat pump ground - 71,4 kW		100	71,44	415	41,346	701,23	28927,93	1481,46	31110,62	1992,21	0,41	7,01	289,28	14,81	311,11	19,92
11.9. 11 9	Biomass Boiler																
11.9.1 11 9 1	Chip - 35 kW			35,0	88	12,818	217,39	16225,96	822,17	17265,52	240,00	0,37	6,21	463,60	23,49	493,30	6,86
11.9.1 11 9 1	Chip - 80 kW			80,0	88	12,818	217,39	26012,04	1311,47	27540,90	240,00	0,16	2,72	325,15	16,39	344,26	3,00
11.9.1 11 9 1	Chip - 500 kW			500,0	88	96,128	1630,33	99391,51	5051,09	106072,93	240,00	0,19	3,26	198,78	10,10	212,15	0,48
11.9.1 11 9 1	Chip - 1000 kW			1000,0	88	96,128	1630,33	157016,94	7932,36	166579,63	240,00	0,10	1,63	157,02	7,93	166,58	0,24
11.9.2 11 9 2	Pellets - 45 kW			45,0	95	7,264	123,20	15436,22	777,97	16337,39	65,30	0,16	2,74	343,03	17,29	363,05	1,45
11.9.2 11 9 2	Pellets - 80 kW			80,0	95	12,818	217,39	26012,04	1311,47	27540,90	64,00	0,16	2,72	325,15	16,39	344,26	0,80
11.9.2 11 9 2	Pellets - 500 kW			500,0	95	96,128	1630,33	99391,51	5051,09	106072,93	200,00	0,19	3,26	198,78	10,10	212,15	0,40
11.9.2 11 9 2	Pellets - 1000 kW			1000,0	95	96,128	1630,33	157016,94	7932,36	166579,63	200,00	0,10	1,63	157,02	7,93	166,58	0,20

5.2.4 Section 12 (heat distribution)

Reference	Component/Technology	Nominal Power W	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/kW]	Labour Cost [EUR/kW]	Material Cost [EUR/kW]	Additional Cost [EUR/kW]	Total Cost [EUR/kW]	Maintenance Cost [EUR/kW year]
12	Heat distribution													
12.1. 12 1	Radiator heating													
12.1.1 12 1 1	Radiator heating - 522 W	522	0,982	16,65	109,75	37,92	164,33	1,86	1,88	31,91	210,25	72,65	314,80	3,56
12.1.1 12 1 1	Radiator heating - 688 W	688	0,982	16,65	110,95	38,28	165,89	1,86	1,43	24,21	161,26	55,64	241,11	2,70
12.1.1 12 1 1	Radiator heating - 731 W	731	0,982	16,65	124,99	42,49	184,14	1,86	1,34	22,78	170,98	58,13	251,90	2,54
12.2. 12 2	Floor heating													
12.2.1 12 2 1	Floor heating - mortar	50	1,544	26,16	26,70	2,64	55,50	0,28	30,88	523,13	533,96	52,85	1109,94	5,56
12.2.1 12 2 1	Floor heating - dry	50	1,436	24,35	48,06	3,62	76,03	0,38	28,72	487,09	961,16	72,41	1520,66	7,60

5.2.5 Section 13 (ventilation)

Reference	Component/Technology	Max flow rate [m3/h] [m3 / h]	Load loss [[Pa]	Auxiliary Power demand [W / (m3/h)]	Heat Recovery [%]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/(m3/h)]	Labour Cost [EUR/(m3/h)]	Material Cost [EUR/(m3/h)]	Additional Cost [EUR/(m3/h)]	Total Cost [EUR/(m3/h)]	Maintenance Cost [EUR/(m3/h) year]
14	Ventilation																
14.3. 14 3	Mechanical Ventilation systems (heat recovery)																
14.3.1 14 3 1	without free-cooling bypass	300	54,7	0,01	90	0,53	9,00	989,80	49,94	1048,74	18,00	0,0018	0,03	3,30	0,17	3,50	0,06
14.3.1 14 3 1	with free-cooling bypass	300	54,7	0,01	90	0,53	9,00	1615,45	81,22	1705,67	29,00	0,0018	0,03	5,38	0,27	5,69	0,10

5.2.6 Section 14 (cooling)

Reference	Component/Technology	Heating capacity [kW]	Cooling capacity [kW]	SEER [%]	SCOP [%]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/kW]	Labour Cost [EUR/kW]	Material Cost [EUR/kW]	Additional Cost [EUR/kW]	Total Cost [EUR/kW]	Maintenance Cost [EUR/kW year]
14	Cooling																
14.1. 14 1	Decentral air conditioning units																
14.1.1 14 1 1	No distribution	3,2	2,5	710	420	4,222	71,61	906,75	48,92	1027,27	52,11	1,32	22,38	283,36	15,29	321,02	16,28
14.1.1 14 1 1	No distribution	5,8	5	630	420	4,222	71,61	1647,75	85,97	1805,32	91,52	0,73	12,35	284,09	14,82	311,26	15,78
14.1.2 14 1 2	With distribution	3,4	2,5	620	400	4,222	71,61	1285,00	67,83	1424,44	72,40	1,24	21,06	377,94	19,95	418,95	21,29
14.1.2 14 1 2	With distribution	4,2	3,5	640	410	4,222	71,61	1505,00	78,83	1655,44	84,14	1,01	17,05	358,33	18,77	394,15	20,03
14.2. 14 2	Chillers																
14.2.1 14 2 1	No distribution		150	397		42,77	725,38	33150,87	1693,81	35570,06	2277,78	0,29	4,84	221,01	11,29	237,13	15,19
14.2.2 14 2 2	No distribution		305,2	430		52,66	893,11	59262,36	3007,77	63163,25	4044,75	0,17	2,93	194,18	9,86	206,96	13,25
14.2.3 14 2 3	No distribution		522,1	457		85,54	1450,79	94337,71	4789,43	100577,93	6440,67	0,16	2,78	180,69	9,17	192,64	12,34

5.2.7 Section 15 (lighting)

Reference	Component/Technology	Life Cicle [h]	Nominal power [W]	Lighted surface [m2]	Luminous efficacy [lm/W]	Lighting power demand [W/m2]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/m2]	Labour Cost [EUR/m2]	Material Cost [EUR/m2]	Additional Cost [EUR/m2]	Total Cost [EUR/m2]	Maintenance Cost [EUR/m2 year]
15	Lighting																	
15.1. 15 1	Conventional Lighting																	
15.1.1 15 1 1	Fluorescent tube 18W	12.000	18	2	72	9	0,2	3,39	2,90	0,31	6,61	0,00	0,1000	1,6960	1,4500	0,1573	3,3033	0,0000
15.1.2 15 1 2	35W Halogen bulb	2.000	35	1,5	5,3	23,33	0,2	3,39	3,79	0,36	7,54	0,00	0,1333	2,2613	2,5267	0,2394	5,0274	0,0000
15.2. 15 2	LED Lighting																	
15.2.1 15 2 1	LED Lighting - Dichroic lamp VS 35W Halogen	40.000	3	4	aprox. 70	0,75	0,2	3,39	16,90	1,01	21,31	0,00	0,0500	0,8480	4,2250	0,2537	5,3267	0,0000
15.2.2 15 2 2	LED Lighting - LED Tube 10,5W VS 18W Fluorescent Tube	50.000	10,5	2	100	5,25	0,2	3,39	25,90	1,46	30,76	0,00	0,1000	1,6960	12,9500	0,7323	15,3783	0,0000
15.2.3 15 2 3	LED Lighting - LED bulb 8W VS 35W Halogen bulb	40.000	8	1,5	53,75	5,33	0,2	3,39	7,90	0,56	11,86	0,00	0,1333	2,2613	5,2667	0,3764	7,9044	0,0000
15.2.4 15 2 4	LED Lighting - LED DL 10W VS DL 26W	50.000	10	2	60	5,00	0,2	3,39	24,90	1,41	29,71	0,00	0,1000	1,6960	12,4500	0,7073	14,8533	0,0000

5.2.8 Section 16 (shading)

Reference	Component/Technology	Shaded Window area m2	Solar heat reduction [%]	Schading factor	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/m2]	Labour Cost [EUR/m2]	Material Cost [EUR/m2]	Additional Cost [EUR/m2]	Total Cost [EUR/m2]	Maintenance Cost [EUR/m2 year]
16	**Shading**															
16.1. 16 1	**Drop-arm awnings installation**															
16.1.1 16 1 1	Manual	1	aprox. 70	variable	2,28	38,70	94,58	6,66	139,95	8,03	2,2800	38,7030	94,5842	6,6644	139,9516	8,0263
16.1.2 16 1 2	Automatic	1	aprox. 70	variable	2,28	38,70	433,42	23,61	495,73	11,08	2,2800	38,7030	433,4200	23,6062	495,7292	11,0789
16.1.3 16 1 3	Motorized	1	aprox. 70	variable	3,02	51,91	344,58	19,82	416,32	14,21	3,0210	51,9076	344,5842	19,8246	416,3164	14,2105
16.2. 16 2	**External window blinds**															
16.2.1 16 2 1	PVC 37 mm slats	1	aprox. 90	variable	0,46	7,74	18,16	1,30	27,20	3,00	0,4560	7,7406	18,1636	1,2952	27,1994	3,0000
16.2.2 16 2 2	Cast aluminium 33 mm slats	1	aprox. 90	variable	0,48	8,11	26,33	1,72	36,16	3,00	0,4780	8,1141	26,3273	1,7221	36,1634	3,0000
16.3. 16 3	**Automation of solar shading devices**															
16.3.1 16 3 1	PVC fixed	1	aprox. 80	variable	0,32	5,39	32,08	1,87	39,35	3,00	0,3200	5,3936	32,0800	1,8737	39,3473	3,0000
16.3.2 16 3 2	PVC adjustable	1	aprox. 80	variable	0,46	7,69	47,54	2,76	57,99	3,00	0,4560	7,6859	47,5400	2,7613	57,9872	3,0000
16.3.3 16 3 3	Aluminium horizontal	1	aprox. 80	variable	0,46	7,69	106,04	5,69	119,41	3,00	0,4560	7,6859	106,0400	5,6863	119,4122	3,0000
16.3.4 16 3 4	Aluminium vertical	1	aprox. 80	variable	0,32	5,39	101,04	5,32	111,76	3,00	0,3200	5,3936	101,0400	5,3217	111,7553	3,0000
16.4. 16 4	**Solar control vinyl film**															
16.4.1 16 4 1	With 70% light transmition	1	38	0,58	1,44	24,25	58,39	4,13	86,77	0,00	1,4430	24,2507	58,3900	4,1320	86,7728	0,0000
16.4.2 16 4 2	With 60% light transmition	1	42	0,54	1,44	24,25	70,08	4,72	99,05	0,00	1,4430	24,2507	70,0800	4,7165	99,0473	0,0000
16.4.2 16 4 2	With 50% light transmition	1	46	0,5	1,44	24,25	81,75	5,30	111,30	0,00	1,4430	24,2507	81,7500	5,3000	111,3008	0,0000

5.2.9 Section 17 (solar thermal collectors)

Reference	Component/Technology	Collector Area m2	Optical Performance [%]	Primary loss coeficcient	Tank Capacity l	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Labour Intensity [h/m2]	Labour Cost [EUR/m2]	Material Cost [EUR/m2]	Additional Cost [EUR/m2]	Total Cost [EUR/m2]
17	**Solarthermal Collectors**														
17.1. 17 1	**Flat solar collector**														
17.1.1 17 1 1	1 panel (Single home) - flat roof	2,1	0,75	3,993	200	10,03	170,11	2807,65	148,89	3126,65	4,7762	81,0042	1336,9762	70,8990	1488,8794
17.1.2 17 1 2	4 panels battery - flat roof	8,4	0,75	3,993	500	23,562	399,61	6418,05	340,88	7158,54	2,8050	47,5728	764,0536	40,5813	852,2077
17.1.3 17 1 3	10 panels battery - flat roof	21	0,75	3,993	2500	51,366	871,17	14755,35	781,33	16407,84	2,4460	41,4842	702,6357	37,2060	781,3259
17.1.1 17 1 1	1 panel (Single home) - titled roof	2,1	0,75	3,993	200	10,03	170,11	2711,55	144,08	3025,74	4,7762	81,0042	1291,2143	68,6109	1440,8294
17.1.2 17 1 2	4 panels battery - titled roof	8,4	0,75	3,993	500	23,562	399,61	6033,65	321,66	6754,92	2,8050	47,5728	718,2917	38,2932	804,1577
17.1.3 17 1 3	10 panels battery - titled roof	21	0,75	3,993	2500	51,366	871,17	13794,35	733,28	15398,79	2,4460	41,4842	656,8738	34,9179	733,2759
17.2. 17 2	**Vacuum tube solar collector**														
17.2.1 17 2 1	1 panel (Single home) - flat roof	1,125	0,73	0,18	200	10,03	170,11	3274,99	172,25	3617,35	8,9156	151,2078	2911,1022	153,1155	3215,4255
17.2.1 17 2 1	3 panels battery - flat roof	4,5	0,73	0,18	500	23,562	399,61	8287,41	434,35	9121,37	5,2360	88,8026	1841,6467	96,5225	2026,9717
17.2.1 17 2 1	10 panels battery - flat roof	11,25	0,73	0,18	1500	49,244	140,63	15375,05	775,78	16291,46	4,3772	12,5004	1366,6711	68,9586	1448,1301
17.2.1 17 2 1	1 panel (Single home) - titled roof	1,125	0,73	0,18	200	8,199	140,63	3150,10	164,54	3455,27	7,2880	125,0042	2800,0889	146,2547	3071,3477
17.2.2 17 2 2	3 panels battery - titled roof	4,5	0,73	0,18	500	23,562	399,61	7787,85	409,37	8596,83	5,2360	88,8026	1730,6333	90,9718	1910,4077
17.2.2 17 2 2	10 panels battery - titled roof	11,25	0,73	0,18	1500	49,244	835,18	14126,15	748,07	15709,39	4,3772	74,2381	1255,6578	66,4948	1396,3906

5.2.10 Section 18 (storage tank)

Reference	Component/Technology	Capacity [l]	Nominal power [kW]	Heat Generation Efficiency [%]	Heat loss capacity rate (UA) [W/K]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/l]	Labour Cost [EUR/l]	Material Cost [EUR/l]	Additional Cost [EUR/l]	Total Cost [EUR/l]	Maintenance Cost [EUR/l year]
18	**Storage Tank**																
18.1. 18 1	Hotwater tank																
18.1.1 18 1 1	Hotwater tank - 300 l	300	0,07		3,5	3,92	66,48	750,00	40,82	861,23	457,50	0,0131	0,22	2,50	0,14	2,87	1,53
18.1.1 18 1 1	Hotwater tank - 500 l	500	0,07		3,5	4,58	77,68	1250,00	66,38	1398,64	505,20	0,0092	0,16	2,50	0,13	2,80	1,01
18.1.1 18 1 1	Hotwater tank - 1000 l	1000	0,07		3,5	5,52	93,62	1600,00	84,68	1783,82	940,30	0,0055	0,09	1,60	0,08	1,78	0,94
18.2. 18 2	Hotwater tank with electrical boiler																
18.2.1 18 2 1	Hotwater tank with electrical boiler - 75 l	75	2	99,8	1,1	1,698	28,80	224,19	12,65	267,34	19,88	0,0226	0,38	2,99	0,17	3,56	0,27
18.2.1 18 2 1	Hotwater tank with electrical boiler - 150 l	150	2,2	99,8	1,1	1,91	32,39	443,41	23,79	501,50	37,39	0,0127	0,22	2,96	0,16	3,34	0,25
18.2.1 18 2 1	Hotwater tank with electrical boiler - 300 l	300	3	99,8	1,2	2,122	35,99	761,21	39,86	839,18	62,64	0,0071	0,12	2,54	0,13	2,80	0,21
18.3. 18 3	Hotwater tank from thermosolar	same as 8.1															

5.2.11 Section 19 (photovoltaic)

Reference	Component/Technology	Peak power [Wp]	Efficiency [%]	Area Panel [m2]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/Wp]	Labour Cost [EUR/Wp]	Material Cost [EUR/Wp]	Additional Cost [EUR/Wp]	Total Cost [EUR/Wp]	Maintenance Cost [EUR/Wp year]
19	**Photovoltaic**															
19.1. 19 1	Amorph-Silica Modules															
19.1.1 19 1 1	Amorph-Silica Modules - 215 Wp	215	17,1	1,26	0,858	14,55	380,69	19,76	415,86	2,15	0,0040	0,07	1,77	0,09	1,93	0,01
19.1.1 19 1 1	Amorph-Silica Modules - 235 Wp	235	18,6	1,26	0,858	14,55	646,93	33,07	695,41	2,35	0,0037	0,06	2,75	0,14	2,96	0,01
19.2. 19 2	CIS Modules															
19.2.1 19 2 1	CIS Modules -50 Wp	50	6,3	0,79	0,858	14,55	38,50	2,65	56,56	0,50	0,0172	0,29	0,77	0,05	1,13	0,01
19.2.1 19 2 1	CIS Modules -90 Wp	90	11,4	0,99	0,858	14,55	280,80	14,77	310,98	0,90	0,0095	0,16	3,12	0,16	3,46	0,01
19.2.1 19 2 1	CIS Modules -250 Wp	250	10,5	2,82	0,858	14,55	780,00	39,73	835,14	2,50	0,0034	0,06	3,12	0,16	3,34	0,01
19.3. 19 3	monocrystalin-Silica Modules															
19.3.1 19 3 1	monocrystalin-Silica Modules - 180 Wp	180	14,41	1,28	0,858	14,55	88,38	5,15	108,94	1,80	0,0048	0,08	0,49	0,03	0,61	0,01
19.3.1 19 3 1	monocrystalin-Silica Modules - 200 Wp	200	15,37	1,28	0,858	14,55	98,20	5,64	119,25	2,00	0,0043	0,07	0,49	0,03	0,60	0,01
19.3.1 19 3 1	monocrystalin-Silica Modules - 235 Wp	235	14,35	1,63	0,858	14,55	115,38	6,50	137,29	2,35	0,0037	0,06	0,49	0,03	0,58	0,01
19.3.1 19 3 1	monocrystalin-Silica Modules - 255 Wp	255	15,57	1,63	0,858	14,55	125,20	6,99	147,60	2,55	0,0034	0,06	0,49	0,03	0,58	0,01
19.3.1 19 3 1	monocrystalin-Silica Modules - 300 Wp	300	15,46	1,94	0,858	14,55	147,30	8,09	170,80	3,00	0,0029	0,05	0,49	0,03	0,57	0,01
19.4. 19 4	polycrystalin-Silica Modules															
19.4.1 19 4 1	polycrystalin-Silica Modules - 180 Wp	180	14,1	1,47	0,858	14,55	77,22	4,59	97,22	1,80	0,0048	0,08	0,43	0,03	0,54	0,01
19.4.1 19 4 1	polycrystalin-Silica Modules - 200 Wp	200	15,7	1,47	0,858	14,55	85,80	5,02	106,23	2,00	0,0043	0,07	0,43	0,03	0,53	0,01
19.4.1 19 4 1	polycrystalin-Silica Modules - 240 Wp	240	14,75	1,63	0,858	14,55	102,96	5,88	124,25	2,40	0,0036	0,06	0,43	0,02	0,52	0,01
19.4.1 19 4 1	polycrystalin-Silica Modules - 260 Wp	260	15,98	1,63	0,858	14,55	111,54	6,30	133,25	2,60	0,0033	0,06	0,43	0,02	0,51	0,01
19.4.1 19 4 1	polycrystalin-Silica Modules - 300 Wp	300	15,98	1,94	0,858	14,55	128,70	7,16	151,27	3,00	0,0029	0,05	0,43	0,02	0,50	0,01

5.2.12 Section 20 (control systems)

Reference				Component/Technology	Reference Unit	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Labour Intensity [h/Ref-Unit]	Labour Cost [EUR/Ref-Unit]	Material Cost [EUR/Ref-Unit]	Additional Cost [EUR/Ref-Unit]	Total Cost [EUR/Ref-Unit]	Maintenance Cost [EUR/Ref-Unit year]
	20			Control Systems													
20.1.	**20**	**1**		**Climatic control system for heating/cooling**													
20.1.1	20	1	1	Cooling Control System (up to 60 FC)	1,00	4,44	75,27	4588,00	233,16	4896,43	171,47	4,44	75,27	4588,00	233,16	4896,43	171,47
20.1.2	20	1	2	Central Heating and DHW Control	1,00	24,13	409,31	715,00	56,22	1180,53	41,34	24,13	409,31	715,00	56,22	1180,53	41,34
20.2.	**20**	**2**		**Indoor thermostatic control system**													
20.2.1	20	2	1	FC thermostatic control system	1,00	2,38	40,36	248,05	14,42	302,84	8,49	2,38	40,36	248,05	14,42	302,84	8,49
20.1.2	20	1	2	Boiler 2wires (ON/OFF) thermostatic control system	1,00	0,60	10,18	35,00	1,36	46,53	0,00	0,60	10,18	35,00	1,36	46,53	0,00
20.1.3	20	1	3	Boiler 3 wires (Modulating) thermostatic control system	1,00	0,60	10,18	60,00	2,11	72,28	0,00	0,60	10,18	60,00	2,11	72,28	0,00
20.1.4	20	1	4	Boiler wifi thermostatic (presence detection) control system	1,00	0,60	10,18	250,00	7,81	267,98	0,00	0,60	10,18	250,00	7,81	267,98	0,00
20.3.	**20**	**3**		**Climatic-indoor thermostatic system**													
20.3.1	20	3	1	V2V+Thermostat	1,00	1,50	25,44	128,88	7,72	162,04	0,81	1,50	25,44	128,88	7,72	162,04	0,81
20.3.2	20	3	2	V3V+Thermostat	1,00	1,50	25,44	130,02	7,77	163,23	0,81	1,50	25,44	130,02	7,77	163,23	0,81
20.4.	**20**	**4**		**Occupancy sensors for lighting**													
20.4.1	20	4	1	Occupancy sensors for lighting	1,00	0,42	7,19	28,26	1,77	37,22	1,08	0,42	7,19	28,26	1,77	37,22	1,08
20.5.	**20**	**5**		**Automatic daylight dimming systems**													
20.5.1	20	5	1	Daylight wireless sensor	1,00	1,00	16,96	80,00	4,85	101,81	0,00	1,00	16,96	80,00	4,85	101,81	0,00
20.6.	**20**	**6**		**Solar thermal control systems**													
20.6.1	20	6	1	Solar thermal control systems	1,00	21,76	369,12	259,00	31,41	659,52	23,01	21,76	369,12	259,00	31,41	659,52	23,01

5.2.13 Section 21 (battery)

Reference				Component/Technology	Capacity [kWh]	Round trip Efficiency [%]	Depth of discharge [%]	Labour Intensity [h]	Labour Cost [EUR]	Material Cost [EUR]	Additional Cost [EUR]	Total Cost [EUR]	Maintenance Cost [EUR/year]	Operational lifetime [year]	Labour Intensity [h/kWh]	Labour Cost [EUR/kWh]	Material Cost [EUR/kWh]	Additional Cost [EUR/kWh]	Total Cost [EUR/kWh]	Maintenance Cost [EUR/kWh year]
	21			Battery																
21.1.	21	1		Lead battery																
21.1.1	21	1	1	Lead acid battery - 8,2 kWh	8,2	80	50	0,86	14,55	2862,00	143,83	3020,38	no maintenance cost	8,00	0,1046	1,77	349,02	17,54	368,34	no maintenance cost
21.2.	21	2		LI-Ion Battery																
21.2.1	21	2	1	LI-Ion Battery - 7 kWh	7	92	50	0,86	14,55	2770,00	139,23	2923,78	no maintenance cost	15,00	0,1226	2,08	395,71	19,89	417,68	no maintenance cost
21.2.1	21	2	1	LI-Ion Battery - 10 kWh	10	92	80	0,86	14,55	3231,00	162,28	3407,83	no maintenance cost	15,00	0,0858	1,46	323,10	16,23	340,78	no maintenance cost

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