Comparison between Spain and Belgium in the field of energy performance and passive buildings regulations

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I. Summary

This bachelor thesis will explain how it is possible and which factors are important to obtain buildings which apply for certificates such as passive or active buildings. These buildings belong to a group of buildings called nearly zero energy buildings. This will be done for Spain and Belgium. The main influences such as the climate differences will be explained because they have a significant influence on the building performances. At the end the way we calculate the energy performances of buildings will be explained.

Esta tesis de licenciatura explicará cómo es posible y qué factores son importantes para obtener edificios que soliciten certificados como edificios pasivos o activos. Estos edificios pertenecen a un grupo de edificios llamados edificios de energía casi nula. Esto se hará por España y Bélgica. Las principales influencias como las diferencias climáticas se explicarán porque tienen una influencia significativa en las actuaciones del edificio. Al final se explicará la forma en que calculamos el rendimiento energético de los edificios.

II. Word of thanks

In the first place I would like to thank my home university Vives department of Ostend for this chance that they gave me to extend my knowledge and life experience by helping me throughout the past years and the Erasmus experience.

Second of all I would like to thank the UPV, Universitat de Politècnica de València and the international office who helped me and welcomed me into this educational experience.

Third I would like to thank my mentor who helped me to find the idea of this final bachelor project through her enthusiasm and same interests.

At last I want to thank my parents who have always been there during my educational road trip. They always believed in me and supported me in every choice that I made. Thank you for giving me this incredible experience to study abroad.

III. List of symbols and units

NZEB: Nearly zero energy buildings

EPBD: Energy performance of buildings directive

ESCO: An energy service company in Belgium

KWh/m^2: Kilo Watt hour per square meter

CTE: Código Técnico de la Edificación, Technica Building Code of Spain (TBC)

DHW: Domestic Hot Water

ESTIF: European Solar Thermal Industry Federation

RTIB: Regulation of Thermal Installations and Buildings

VAT: Value Added Tax

CERMA: Calificación Energética Residencial Método Abreviado

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1 Introduction

In this paper I will talk about the measurements that needs to be taken care of if we want to build nearly zero energy buildings. What are the needs to build in this way regarding the different climate that we live in. This factor, the climate will make an enormous difference in how we can achieve this goal. Describing the climate of both countries will be the beginning of the research and will form the basis to explain the difference of constructing a building which answers to the norms of nearly zero energy buildings such as passive and active buildings.

Belgium is divided into three different regions where each region has his own legislation regarding the EPB regulations. In this thesis we will only focus on the Flemish part of Belgium and the regulations that are applicable here. Starting from 2021 every building which applies for a construction licence will need to meet with new standards according to nearly zero energy buildings. This is only for buildings in the private sector. Other buildings such as public buildings and government buildings this will be obligatory starting from 2019. These rules will apply for every building in every country in the European Union.

Numbers and tables given and explained in the thesis are only applicable for residential buildings and do not count for non-residential or industrial buildings. This is important because the regulations are different. Spain and Belgium each use a program which controls if all the regulations that are valid at that time are fulfilled. Both programs will be explained how they work.

A hot topic these days is the developing of passive and active buildings. These types of buildings are the most close to nearly zero energy buildings. There has been much more thought through the developing of buildings like this. Building smarter and innovative will become more and more important, otherwise it will not be possible to apply with the strict norms and standards. The use and production of renewable energy will be made more clear towards the end of the thesis.

Software programs that are used to calculate the energy efficiency of buildings are very helpful and timesaving. The give a clear and correct view of how a building performs and which part are not conforming with the regulations at that moment. The way the software works will be explained and an example of a house will be given.

2 Climate

The weather conditions determine the compositions off the structural elements. These constructions will be different in size and build up. In places where it is colder, we will use more insulation to meet the EPBD standards then in places where it is warmer as in Spain. The composition off the walls, roofs will be different, and not only because of the climate but also because the way we each build our buildings. The climate in Belgium and Spain is totally different from each other and will have an effect on the construction and the investment to build EPBD accepted houses and buildings. Spain has more experience with air-conditioning then with heating systems and in Belgium people are more experienced with insulation and making structures without cold bridges. All these factors depend on the climate where we want to build. If we can study the climate it is possible to see on which factors, we need to work to make our buildings more energy efficient. The climates are divided by the KöppenGeiger classification system which will be explained in this chapter.

2.1 Spanish climate

Spain has one of the most stable climates in the world. Most of the time it is sunny and dry but in the summer months there is a chance for extreme temperatures on land and the islands. We can divide Spain in five different climatic zones.

1. Land climate
2. Sea climate
3. Mediterranean Sea climate
4. Subtropical climate

The Cantabrian mountains mark the first climatologic zone of Spain. In the north of this zone we can find the Part of Spain where it rains most of the time. In this part we can find the following places:

- Basque country
- Cantabria
- Galicia
- Asturias

Figure 1:The Cantabrian mountains

These regions have a similar climate with small temperature changes, mild winters, cool summers and a cloudy sky with frequent rainfall. This type of climate is a typical example if the weather in West-Europe. This surface where we have this type of rainy climate is one third of the total surface of Spain. So that means that we have still two third left. This bigger part is what we call 'dry Spain'.

2.1.1 Land climate

This type of climate can be recognized by variations in temperature and few, irregular rain. The yearly rainfall is in general between 30-64 centimetre and in the biggest part of the central plain 50 centimetre. The northern Meseta has two rain seasons, one in the spring (April – June) and the other one during the fall (October – November). The late part of the spring is the part when we have the most rain off the year.

In the southern Meseta we have the whet seasons, in the spring and in the fall. Even during these seasons, the rain in irregular and unpredictable.

We can say that in this type of climate, the land climate the winters are cold with a strong wind and a high humidity despite the low rainfall. The exceptions are the mountains where it freezes on a regular basis.

The summers are warm and cloudless and have an average temperature during the day of 21°C in the northern Meseta and between 24-27°C in the southern Meseta. In the night the temperature drops to 7-10°C. The place we call 'The Ebor Basin' is located on a lower height and is extremely hot in the summer. In these parts the temperatures can go up to 43°C with a low humidity in central parts. The humidity at places located close to rivers and the sea have a higher humidity level.

2.1.2 Sea climate

The sea climate is found in the northern part of the land and reaches from the Pyrenees till the northwest region characterized by mild winters, warm summers and rain spread during the year. The temperatures variate just a little during the day and seasons and are between 9-18°C. The distance to the Atlantic Ocean has also an influence on the amount of rain. We can say that there is less rain in the East than in the West. We also have a wet season here that begins in October and lasts till December. Because we are located close to the sea, we have a high humidity and wind which causes fog and mist along the northwest coast.

2.1.3 Mediterranean Sea climate

The Mediterranean Sea climate reaches from the Andalusian plain along the southern and eastern coast till the Pyrenees, at the side of the mountains which run parallel with the coast. The total rain in this region is lower than in the rest of Spain and occurs in the late fall-winter period.

If we look at the climate of the south of Spain, we can conclude that the temperatures in the summer and winter are higher and the daily temperature changes are smaller than other regions. The temperatures in January are normally between 10-13°C in the biggest part of the Mediterranean Sea climate. During July and August, we can find temperatures around 22-27°C at the coast and 29-31°C more inland. The air in these places has a lower humidity level, we can say that the air is warm and dry and comes from North-Africa. This wind brings a lot of dust with him from the Sahara Desert.

2.1.4 Subtropical climate

We don't find this climate in Spain itself but only on the Canarian Islands. The average temperatures in the winter months and the summer months are around 18°C and 25°C. The mountainous zones must deal more with rain in the winter period, even in the summer it is possible that it rains only in the mountain areas.

2.2 Belgian climate

Belgium is located on the average latitude of the northern hemisphere at the western edge of the European continent. The two aspects that determine the climate are the cycle of the sun and atmospheric dynamics specific to this latitude and also the nearness of the Atlantic Ocean.

It is typical on this latitude that cold air mass coming from the north meets with the warm air from the subtropical areas. The interface between these two air masses becomes the pool front. The changing position of this front causes the changes in our weather. The more it goes to the north, the better the weather it is. The more it goes to the south the colder it gets. Understanding this principal we can conclude and determine that the pool front in the winter is located more in the south and in the summer more in the north. It is not peculiar if this front in the winter is more in the north. So, it is possible that we have 'summer days' in the winter. This situation is only unusual when this phenomenon lasts for a long time.

This type of climate is characterized by fresh and humid summers and soft rainy winters. It is not unusual that we have exceptions in our weather. We can have extreme temperatures such as +30°C for a longer period just like tropical summers. Beside this the weather can also be really cold that the sea starts to freeze, and it looks like Belgium is part of the pool area. The temperatures are not the only factors that change a lot. The amount of rain is as unstable as the temperatures. Months that normally have an average of 80 mm of rain can be totally dry, without any rainfall or can experience an excessive amount.

Everything summarized this climate type is the result of a consecutive and changing atmospheric conditions caused by the type of air pressure area and the type of air mass.

2.2.1 Annual average temperature

The annual standards of the average air temperature in Belgium fluctuates between 7,5°C more in the south to 11°C in the north. The average temperature is only 9,8°C for Belgium. The warmest month of the year is July with an average of 17,8°C and the coldest month is January with 2,5°C. the annual standards of the daily maximums and minimums fluctuate between 11,5°C and 15°C and 3°C and 7°C. These standards reach their lowest point in the south, the high Veins and the location of the maximum temperatures change during the year.

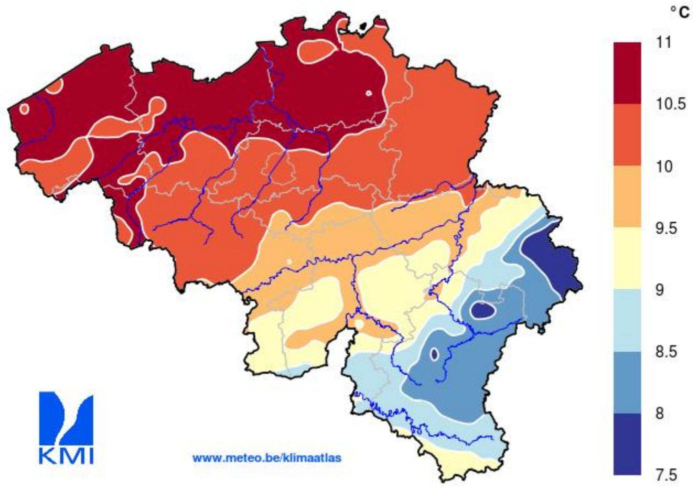


Figure 2: Annual average temperatures in Belgium

When we look to the Belgian territory it is clear that the standards fluctuate with a maximum of 4°C, independently of the month or the season. This distribution is mainly determined by two factors, the distance to the sea and the elevation.

The temperature of the water of the sea changes really slow what causes that the season variation of the temperature at the coast weakens and delays. This is the reason why the winter is softer, and the summer is fresher inlands. This principal has an effect on the average temperature of 1°C more in the winter and 1°C less on the average temperature in the summer. The influence of the sea is noticeable on the standards of the daily maximum temperatures from May till August caused by the colder air of the sea. The moment that the temperature differences between land (warm) and sea (cold) are big enough a thermal circulation forms and creates a sea breeze. It is this breeze that prevents that the air temperature at the coast reaches the same as in inland. The breeze goes 10 to 20 km towards the central land. Outside the coast area the temperature drops 0,6°C for every difference in elevation of 100m height. The average difference between the low plain and high plain is 3°C.

2.2.2 Annual average rainfall

Comparing the highest and the lowest rainfall in the north and the south the numbers almost double. In the areas with the lowest amount of rain there is about 740 mm/year and in areas where there is a lot of rain more than 1400 mm/year. The average amount of rain in Belgium is 925 mm/year. The highest amounts of rain are located in the south, in the high Veins. In general the rainfall is influenced by the relief. The higher you are located the more rainfall you will have. Not only the presence of the relief influences the rainfall but also the orientation and the angle of the ground against the wind who contains the rain. These winds are most likely coming from the Southwest direction.

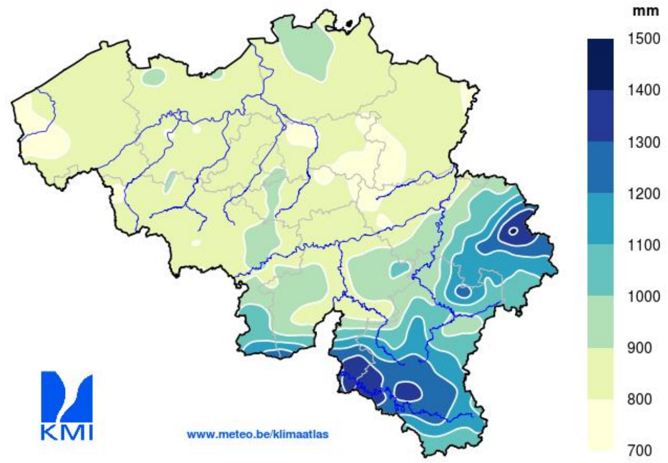


Figure 3: Annual average amount of rainfall in Belgium

Conclusions can be made out of the numbers that represent the amount of rain in each season. In the winter there is the most rainfall and in the spring there is the least. This conclusion counts for Belgium in general. December is the month with the most rain, 90 mm and April is the driest month of all, 60 mm. The monthly amount of rainfall at the coast area is in general the lowest of all. During the period from September till December the least rainfall is measured in Belgium.

2.2.3 Annual amount of solar radiation

Looking at the annual average amount of solar light in a day there is a variation between 2650 Wh/m² in the high Veins and 3000 Wh/m² at the coast. The division between these areas can be explained by the amount of clouds and by the latitude who determines the maximum theoretical amount of radiation. The areas located close to the sea have less clouds, so these places have a higher radiation values then places more land inwards. This is the opposite in the high Veins, the south of Belgium. Beside these two areas it is clear that there is a negative progress from the south towards the north which is partial linked with the decrease of the latitude of the theoretical maximum annual average radiation level. In Belgium the monthly norms variates between 530 Wh/m² in December and 5070 Wh/m² in June.

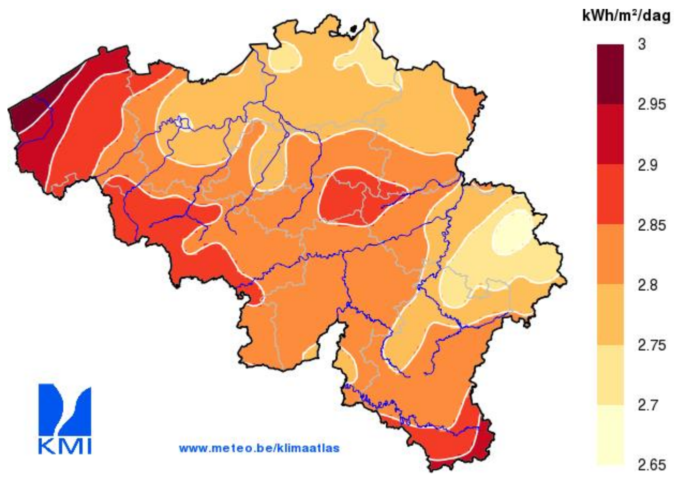


Figure 4: Annual amount of solar radiation in Belgium

2.2.4 Annual average days of snow

A day of snow is a day when there is rain in the form of snow is being observed. This map shows the amount of days in a year that we have snow in Belgium. There is a significant difference between the north and the south areas. This as earlier explained is caused due the height differences along with the temperatures and rainfall. In the north we have about 5 days of snow every year. This number is a lot higher in the south, there we reach about 50 days of snow.

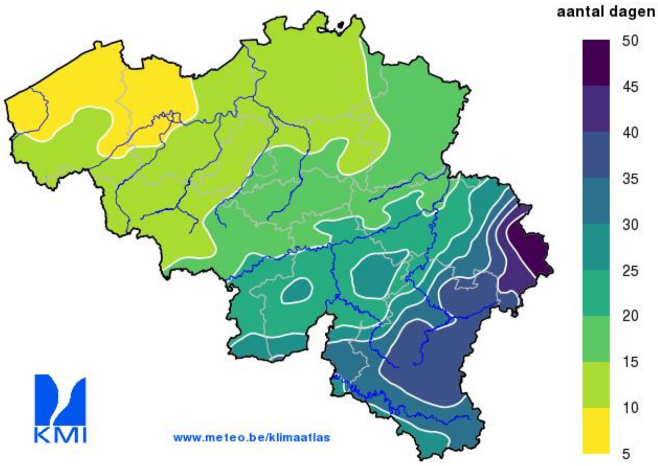


Figure 5: Annual average days of snow in Belgium

2.3 Köppen-Geiger classification

Describing the type of climate is mostly based on the climate classification system of Köppen-Geiger. This system is developed by the biologist Vladimir Köppen and had been refined by the climatologist Rudolf Geiger. This climate classification system is developed in 1918 and based on the grow of plants. Vladimir Köppen discovered that there was a connection between the distribution area of trees and plants and the minimal and maximum average monthly temperatures combined with the rainfall.

By making a map of the boundaries of the main vegetation types the original climate system from 'Köppen' was created. This chart has been redefined by Geiger and together it forms the system as we know it today.

The climate classification system Köppen-Geiger divides the climates in three different levels where the boundaries between the climates can be really obvious or not at all. During the climate changes we face at the moment this chart needs to be updated for areas where the weather conditions deviate for a longer period of time than described in the classification system. Over time it will be clear that the climate areas will move.

As told before is the system containing three main levels is divided in groups. Each group on each level received a letter. The 5 main groups received the letter A – E. The two smaller levels received a smaller letter after the first letter. Due this way it is possible to show that a warm climate can have rain in all seasons (CFa). The B and E climates each receive another capital letter as second letter. In some cases, there is also a fourth letter. On the first level they just make a rough layout based on the temperature and the amount of rain. On the second level they divide it further based on the division of the rainfall during the year. Level three is based on the differences in temperature. Mostly this is the classification of warm, mild or cold climates. Everything can be found in Table 1: Classification of the climate zones

2.3.1 Level 1, Rough categories

A-climates or tropical climates: The average temperature of the coldest month is higher than 18°C.

B-climates or dry climates: There is not enough rain for the grow of tree's and permanent rivers can't have their origin here. This climate is also called the Arid climate. The classification is determined on the Köppen dry index which is based on the annual evaporation.

C-climates or mild climates: The average temperature of the coldest month is between -3°C and 18°C. It's also called as maritime climate.

D-climates or land climates: The average temperatures of the coldest month are lower than -3°C and the average temperature of the warmest month is higher than 10°C.

E-climates or polar climates: The average temperatures of the coldest month are lower than -3°C and the average temperature of the warmest month is lower than 10°C. During the whole year for every month it is colder than 10°C.

2.3.2 Level 2, Rainfall distribution

The A, C and D climates get another letter who indicates dry periods. These letters have the following explanation.

- s: dry summer
- w: dry winter
- f: no dry period
- m: monsoon climate (only in A-climates)

The B climates get another capital letter which explains something more about the amount of rain.

- S: steppe, annual rain amount between 200-400 mm. de limit between steppe-, desert- and other climates is decided with the dry-index.
- W: desert (arid), there is less than 200 mm rain every year.

Just like the B climates, the E climates also get a capital letter. This letter tells something more about the temperature.

- T: tundra, the temperature in the warmest month is between 0-10°C.
- F: icecap, during the whole year the temperature is under the freezing point.
- H: High mountains, this is used when an area is located on lower latitudes than 70 degree.

2.3.3 Level 3, Temperature difference

Only for B-climates there can be an extra small letter what gives more information about the temperature.

- h: warm, annual average temperature is higher than 18°C.
- k: cold, annual average temperature is lower than 18°C.

For C and D climates the following letter mean:

- a: warm, the annual average temperature in the warmest month is higher than 22°C.
- b: mild, the warmest month is colder than 22°C
- c: cold, less than 4 months a year that the average month temperature is higher than 10°C.
- d: very cold, the coldest winter month has an average temperature lower than -38°C.

2.3.4 Level 4, Extra letter

The fourth letter is only used for the B climate. It indicates when the dry period is during the year.

- s: dry during the summer
- w: dry during the winter

Table 1: Classification of the climate zones

1 Rough categories	2 Rainfall distribution	3 Temperature difference	4 Extra letter
A: Tropical climate	s: Savanna (dry) w: Savanna (wet) f: Rainforest m: Monsoon		
B: Arid climate	S: Steppe W: Desert	h: Warm k: Cold	s: Dry in the summer w: Dry in the winter
C: Sea climate	s: Dry summer w: Dry winter f: Without dry season	a: Warm summer b: Mild summer c: Cold summer d: Very cold summer	
E: Polar climate	T: Tundra F: Ice cap H:High mountains		

2.3.5 Possible combinations

A-climates:

- Af: Tropical rainforest climate
- Am: Monsoon climate
- Aw/As: Tropical savanna climate (dry or wet)

B-climates:

- BS: Steppe climate
    - BSh: Warm steppe climate
    - BSk: cold steppe climate
    - BShs: Warm steppe climate with a dry season in the summer
    - BSkw: Cold steppe climate with a dry season in the winter
- BW: Desert climate
    - BWh: Warm desert climate
    - BWk: Cold desert climate
    - BWhs: Warm desert climate with a dry season in the summer
    - BWkw: Cold desert climate with a dry season in the winter

C-climates:

- Cf: Sea - or maritime climate
  - Cfa: Warm sea climate
  - Cfb: Mild sea climate
  - Cfc: Cold sea climate
- Cs: Mediterranean climate
  - Csa: Warm Mediterranean climate
  - Csb: Mild Mediterranean climate
- Cw: China climate
  - Cwa: Warm china climate with a dry winter
  - Cwb: Mild china climate with a dry winter
  - Cwc: Cold china climate with a dry winter

D-climate:

- Df: land or continental climate with rain during the whole year
  - Dfa: Warm land climate with rain during the whole year
  - Dfb: Mild land climate with rain during the whole year
  - Dfc: Cold land climate with rain during the whole year
  - Dfd: Very cold land climate with rain during the whole year
- Dw: land or continental climate with dry winters
  - Dwa: Warm land climate with dry winters
  - Dwb: Mild land climate with dry winters
  - Dwc: Cold land climate with dry winters
  - Dwd: Very cold land climate with dry winters
- Ds: land or continental climate with dry summers
  - Dsa: Warm land climate with dry summers
  - Dsb: Mild land climate with dry summers
  - Dsc: Cold land climate with dry summers
  - Dsd: Very cold land climate with dry summers

E-climate:

- ET: Tundra climate
- EF: Snow/ice climate
- EH: High mountain climate

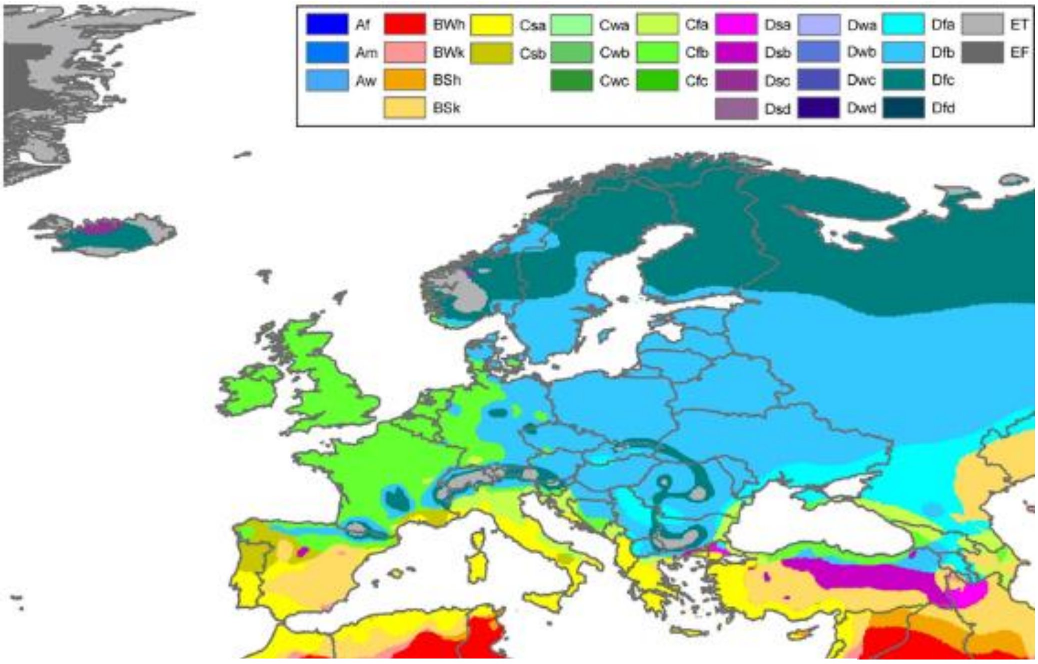


Figure 6: Köppen-Geiger classification system Europe

Table 2: Legend Köppen-Geiger classification system

Af	Equatorial climate	DSa	Warm continental climate/mediterranean continental climate
Am	Monsoon climate	DSb	Temperate continental climate/mediterranean continental climate
Aw	Tropical savanna climate	DSc	Cool continental climate
BWh	Warm desert climate	DSd	Cold continental climate
BWk	Cold desert climate	DWa	Warm continental climate/humid continental climate
BSh	Warm semi-arid climate	DWb	Temperate continental climate/humid continental climate
BSk	Cold semi-arid climate	DWc	Cool continental climate/subarctic climate
CSa	Warm mediterranean climate	DWd	Cold continental climate/subarctic climate
CSb	Temperate mediterranean climate	DFa	Warm continental climate/humid continental climate
CWa	Humid subtropical climate	DFb	Temperate continental climate/humid continental climate
CWb	Humid subtropical climate/subtropical oceanic highland climate	DFc	Cool continental climate/subarctic climate
CWc	Oceanic subpolar climate	DFd	Cold continental climate/subarctic climate
CFa	Warm oceanic climate/humid subtropical climate	ET	Tundra climate
CFb	Temperate oceanic climate	EF	Ice cap climate
CFc	Cool oceanic climate		

3 EPBD

EPBD stands for 'Energy Performance of Buildings Directive. These are European guidelines concerning the energy performance of buildings. These guidelines have been introduced in the European countries who signed the Kyoto Protocol. It makes the people more aware of the energy consumption of their building and stimulates them to build more energy efficient. Through this way people invest more in their buildings by buying systems which produce renewable energy which will save them money in the future. The buildings become more self-sufficient. The EPBD has been implemented in the society starting on the 4th of January 2003, determined by the European parliament and the council of the European Union.

So, what is the purpose of the EPBD? The purpose is simple and clear. By making these guidelines of the Energy Performance of Building directive the energy performance of buildings needs to be improved for all the buildings in the European Union. These guidelines affect the:

- Cost efficiency
- Demands for the indoor climate
- Climatologic and local circumstances outside the building

The EPBD not only gives guidelines but some of them are mandatory. The most important rules that need to be followed are listed here.

1. Article 3 of the guidelines which gives information about the method that needs to be used to calculate the energy performances of buildings. Beside this they look at the building characteristics, the installations of the buildings and the behaviour of residents.
2. Article 4 and 5: The minimum demands for the energy performance of new buildings
3. Article 5 and 6: Focussed on existing big buildings who need to be major renovated.
4. Article 7: The energy certificates of buildings and energy labels.
5. Article 8: Threatens the examination of central heating systems.
6. Article 9: Airconditioning systems in buildings.

The EPBD gives the European Union states a certain degree of freedom to integrate these regulations in their laws depending on the situation of every country.

3.1 Introduction in Belgium

In the field of the EPBD everything is decided by region. In Belgium there are 3 different regions which are responsible for the appliance of these regulations to their own standards. This means that the three different regions each have different norms and standards. In the Flemish region the energy performance decree has been approved on the 7th of May 2004 by the parliament. This decree transforms the articles3, 4, 5, 6, and 7 into regional regulations.

Figure 7: Belgian regions

On the 11th of March 2005 a new implementation decision has been made for the calculation method for the energy performance for new houses, offices and schools. A new software has been created to calculate the energy performance regarding the regulations of each region in Belgium. Beside the energy performance the software can also be used for the insulation, calculate the indoor climate and check If the building still answers to the legislation that applies at that time.

The energy performance regulations must be applied for every building which requested his building permission after January 2006. For the buildings who consume energy to create a specific indoor environment for people there are requirements for thermal insulation, energy performance and indoor climate (ventilation and overheating). There are specific demands which depend of the **nature** of the building activity. These building activities can be:

- New building
- Renovation of small buildings
- Expansion of an existing building
- Renovation of big buildings

Beside the nature we can divide these works also depending on the **destination** of the building. There are 3 different types of destinations for buildings.

- Residential
- Non-residential
- Industrial

The regulations for residential and non-residential are the most strict for the thermal insulation and ventilation demands. The tables that are found in the end of this chapter will give a good impression of the standards regarding the energy performance and indoor climate demands for every year. The tables will show the changes over the years. The maximum and minimum demands for every aspect will be given which have influence on the calculation of the EPB of a building.

Following the new energy performance regulations there will be hold one person who is responsible for the compliance with the EPBD standards. This person, reporter will mostly be the architect or an engineer. He will have to calculate and make reports after the executions of the works with a complete description of the materials and systems used in the building. These calculations will indicate if the standards regarding the region and the European norms have been applied or not. By making the design of a building the architect will give advice and will make draft sketches of the building. These sketches will always meet the standards, but the people are free to change this. If they do not follow the regulations and norms the responsible person will be fined for every aspect that does not meet these regulations. That's why we use the software to calculate the energy performance of a building. This software will show everything very detailed after you put in all the information it needs. This will be explained more detailed in 7.Software Programs. The reporter will be assigned before the start of the works. The start of the work needs to be mentioned to the VEA. This stands for 'Vlaamse EnergieAgentschap', which means Flemish EnergyAgency. This agency will do check-ups on a regular basis on the worksites. Every time a building or aspect in a building don't meet the standards the owner of the building will be fined for that. If mistakes have been made in the report the reporter will be fined for that.

For every new building that applied for a building permission after the January 2006 the building has to follow the norms and regulations as mentioned before. Together with this comes an energy performance certificate which is mandatory for all the new buildings who must follow the legislation. This certificate is also called EPC. Making this certificate is part of the procedure of the EPB declaration. This document is also needed when you want to sell or rent a house to someone else. Making this certificate has been mandatory since 2008 for residential buildings and in 2009 for non-residential buildings.

Table 3: Building projects that applied for a buildings license from 01/01/2006 till 31/12/2009

<table>
<tr><td colspan="2">EPB demands (energy performance and indoor climate</td><td colspan="4">Destination</td></tr>
<tr><td>Nature of the works</td><td></td><td>Residential</td><td>Offices and schools</td><td>Other specific destinations</td><td>Industrial</td></tr>
<tr><td rowspan="3">-New buildings
-Dismantling
-Partial rebuilt with a protected volume > 800 m^3
-Partial rebuild with min. 1 living unit
-Expansion with a protected volume > 800 m^3</td><td>Thermal insulation</td><td colspan="4">Max. K 45 and max. U value’s or min. R value’s</td></tr>
<tr><td>Energy performance</td><td>Max. E100</td><td>Max. E100</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td>Min. ventilation facilities and limit the risk for overheating</td><td colspan="3">Min. ventilation facilities</td></tr>
<tr><td rowspan="3">-Partial rebuilt with a protected volume ≤ 800 m^3 and without living units
-Expansion with a protected volume ≤ 800 m^3 and without living units</td><td>Thermal insulation</td><td colspan="4">Max. U value’s or min. R value’s (for new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="4">-</td></tr>
<tr><td>Indoor climate</td><td colspan="4">Min. ventilation facilities (for new parts)</td></tr>
<tr><td rowspan="3">Renovation</td><td>Thermal insulation</td><td colspan="4">Max. U value’s or min. R value’s (for renovated and new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="4">-</td></tr>
<tr><td>Indoor climate</td><td colspan="4">Ventilation : min. supply openings (if windows have been replaced)</td></tr>
<tr><td rowspan="3">Changing of function with a protected volume > 800 m^3</td><td>Thermal insulation</td><td colspan="4">Max. K 65 (building or a part of the building where the function has been changed)</td></tr>
<tr><td>Energy performance</td><td colspan="4">-</td></tr>
<tr><td>Indoor climate</td><td colspan="4">Min. ventilation facilities (building or a part of the building where the function has been changed)</td></tr>
</table>

Table 4: Building projects that applied for a buildings license from 01/01/2010 till 31/12/2011

EPB demands (energy performance and indoor climate		Destination			
Nature of the works		Residential	Offices and schools	Other specific destinations	Industrial
-New buildings -Dismantling -Partial rebuilt with a protected volume > 800 m³ -Partial rebuild with min. 1 living unit -Expansion with a protected volume > 800 m³	Thermal insulation	Max. K 45 and max. U value's or min. R value's			
	Energy performance	Max. E80	Max. E100	-	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities		
-Partial rebuilt with a protected volume ≤ 800 m³ and without living units -Expansion with a protected volume ≤ 800 m³ and without living units	Thermal insulation	Max. U value's or min. R value's (for new parts)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (for new parts)			
Renovation	Thermal insulation	Max. U value's or min. R value's (for renovated and new parts)			
	Energy performance	-			
	Indoor climate	Ventilation : min. supply openings (if windows have been replaced)			-
Changing of function with a protected volume > 800 m³	Thermal insulation	Max. K 65 (building or a part of the building where the function has been changed)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)			

Table 5: Building projects that applied for a buildings license from 01/01/2012 till 31/12/2012

EPB demands (energy performance and indoor climate		Destination			
Nature of the works		Residential	Offices and schools	Other specific destinations	Industrial
-New buildings -Dismantling -Partial rebuilt with a protected volume > 800 m^3 -Partial rebuild with min. 1 living unit -Expansion with a protected volume > 800 m^3	Thermal insulation	Max. K 40 and max. U value's or min. R value's			
	Energy performance	Max. E70	Max. E70	-	-
	Net energy requirement	Max. 70 kwh/m^2	-	-	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities		
-Partial rebuilt with a protected volume ≤ 800 m^3 and without living units -Expansion with a protected volume ≤ 800 m^3 and without living units	Thermal insulation	Max. U value's or min. R value's (for new parts)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (for new parts)			
Renovation	Thermal insulation	Max. U value's or min. R value's (for renovated and new parts)			
	Energy performance	-			
	Indoor climate	Ventilation : min. supply openings (if windows have been replaced)			-
Changing of function with a protected volume > 800 m^3	Thermal insulation	Max. K 65 and max. U value's or min. R value's (building or a part of the building where the function has been changed)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)			

Table 6: Building projects that applied for a buildings license from 01/01/2013 till 31/12/2013

EPB demands (energy performance and indoor climate		Destination			
Nature of the works		Residential	Offices and schools	Other specific destinations	Industrial
-New buildings -Dismantling -Partial rebuilt with a protected volume > 800 m³ -Partial rebuild with min. 1 living unit -Expansion with a protected volume > 800 m³	Thermal insulation	Max. K 40 and max. U value's or min. R value's			
	Energy performance	Max. E70	Max. E70	-	-
	Net energy requirement	Max. 70 kwh/m²	-	-	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities		
	Renewable energy	-	Min. share (only for schools and offices of public organisations)	-	-
-Partial rebuilt with a protected volume ≤ 800 m³ and without living units -Expansion with a protected volume ≤ 800 m³ and without living units	Thermal insulation	Max. U value's or min. R value's (for new parts)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (for new parts)			
Renovation	Thermal insulation	Max. U value's or min. R value's (for renovated and new parts)			
	Energy performance	-			
	Indoor climate	Ventilation : min. supply openings (if windows have been replaced)			-
Changing of function with a protected volume > 800 m³	Thermal insulation	Max. K 65 and max. U value's or min. R value's (building or a part of the building where the function has been changed)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)			

Table 7: Building projects that applied for a buildings license from 01/01/2014 till 31/12/2014

<table>
<tr><td colspan="2">EPB demands (energy performance and indoor climate</td><td colspan="4">Destination</td></tr>
<tr><td>Nature of the works</td><td></td><td>Residential</td><td>Offices and schools</td><td>Other specific destinations</td><td>Industrial</td></tr>
<tr><td rowspan="5">New buildings
(or similar)</td><td>Thermal insulation</td><td colspan="4">Max. K 40 and max. U value’s or min. R value’s</td></tr>
<tr><td>Energy performance</td><td>Max. E60</td><td>Max. E60</td><td>-</td><td>-</td></tr>
<tr><td>Net energy requirement</td><td>Max. 100-25c
or
70 kwh/m²</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td>Min. ventilation facilities and limit the risk for overheating</td><td colspan="3">Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>Min. share</td><td>Min. share</td><td>-</td><td>-</td></tr>
<tr><td rowspan="3">Renovation</td><td>Thermal insulation</td><td colspan="4">Max. U value’s or min. R value’s (for renovated and new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="4">-</td></tr>
<tr><td>Indoor climate</td><td colspan="3">Min. ventilation facilities
(for existing rooms when windows have been changed and for new rooms)</td><td>Ventilation requirements</td></tr>
<tr><td rowspan="3">Changing of function with a protected volume > 800 m³</td><td>Thermal insulation</td><td colspan="4">Max. K 65 and max. U value’s or min. R value’s
(building or a part of the building where the function has been changed)</td></tr>
<tr><td>Energy performance</td><td colspan="4">-</td></tr>
<tr><td>Indoor climate</td><td colspan="4">Min. ventilation facilities (building or a part of the building where the function has been changed)</td></tr>
</table>

c stands for the compactness of the building.

Table 8: Building projects that applied for a buildings license from 01/01/2015 till 31/12/2015

EPB demands (energy performance and indoor climate		Destination			
Nature of the works		Residential	Offices and schools	Other specific destinations	Industrial
New buildings (or similar)	Thermal insulation	Max. K 40 and max. U value's or min. R value's			
	Energy performance	Max. E60	Max. E60	-	-
	Net energy requirement	Max. 100-25c or 70 kwh/m²	-	-	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities		
	Renewable energy	Min. share	Min. share	-	-
Intensive energetic renovation	Thermal insulation	Max. U value's or min. R value's (For new and after insulated parts)		Follow the requirements from renovation	
	Energy performance	Max. E90	Max E90		
	Installations	-	-		
	Indoor climate	Min. ventilation facilities			
Renovation	Thermal insulation	Max. U value's or min. R value's (for renovated and new parts)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (for existing rooms when windows have been changed and for new rooms)			Ventilation requirements
	Installations	Min. requirements (for new, renewed or replaced installations)			
Changing of function with a protected volume > 800 m³	Thermal insulation	Max. K 65 and max. U value's or min. R value's (building or a part of the building where the function has been changed)			
	Energy performance	-			
	Installations	Min. requirements (for existing rooms when windows have been changed and for new rooms)			
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)			

Table 9: Building projects that applied for a buildings license from 01/01/2016 till 31/12/2016

EPB demands (energy performance and indoor climate		Destination			
Nature of the works		Residential	Offices and schools	Other specific destinations	Industrial
New buildings (or similar)	Thermal insulation	Max. K 40 and max. U value's			
	Energy performance	Max. E50	Max. E55 *	-	-
	Net energy requirement	Max. 100-25c or 70 kwh/m²	-	-	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities		
	Renewable energy	Min. share	Min. share	-	-
Intensive energetic renovation	Thermal insulation	Max. U value's (For new and after insulated parts)		Follow the requirements from renovation	
	Energy performance	Max. E90	Max E90		
	Installations	-	-		
	Indoor climate	Min. ventilation facilities			
Renovation	Thermal insulation	Max. U value's (for renovated and new parts)			
	Energy performance	-			
	Indoor climate	Min. ventilation facilities (for existing rooms when windows have been changed and for new rooms)			Ventilation requirements
	Installations	Min. requirements (for new, renewed or replaced installations)			
Changing of function with a protected volume > 800 m³	Thermal insulation	Max. K 65 and max. U value's (building or a part of the building where the function has been changed)			
	Energy performance	-			
	Installations	Min. requirements (for existing rooms when windows have been changed and for new rooms)			
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)			

*for offices of public organisations, it is E50

Table 10: Building projects that applied for a buildings license from 01/01/2017 till 01/03/2017

<table>
<tr><td colspan="2">EPB demands (energy performance and indoor climate</td><td colspan="3">Destination</td></tr>
<tr><td>Nature of the works</td><td></td><td>Residential</td><td>Non-residential</td><td>Industrial</td></tr>
<tr><td rowspan="5">New buildings
(or similar)</td><td>Thermal insulation</td><td colspan="3">Max. K 40 and max. U value’s</td></tr>
<tr><td>Energy performance</td><td>Max. E50</td><td>Max. E level
(in function of the functional parts)</td><td>-</td></tr>
<tr><td>Net energy requirement</td><td>Max. 100-25c
or
70 kwh/m²</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td>Min. ventilation facilities and limit the risk for overheating</td><td>Min. ventilation facilities</td><td>Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 10 kwh/m² year</td><td>≥ 10 kwh/m² year</td><td>-</td></tr>
<tr><td rowspan="4">Intensive energetic renovation</td><td>Thermal insulation</td><td colspan="2">Max. U value’s
(For new and after insulated parts)</td><td rowspan="4">Follow the requirements from renovation</td></tr>
<tr><td>Energy performance</td><td>Max. E90</td><td>Max. E level
(in function of the functional parts)</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities</td></tr>
<tr><td rowspan="4">Renovation</td><td>Thermal insulation</td><td colspan="3">Max. U value’s (for renovated and new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="3">-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities
(for existing rooms when windows have been changed and for new rooms)</td><td>Ventilation requirements</td></tr>
<tr><td>Installations</td><td colspan="3">Min. requirements (for new, renewed or replaced installations)</td></tr>
<tr><td rowspan="4">Changing of function with a protected volume > 800 m³</td><td>Thermal insulation</td><td colspan="3">Max. K 65 and max. U value’s
(building or a part of the building where the function has been changed)</td></tr>
<tr><td>Energy performance</td><td colspan="3">-</td></tr>
<tr><td>Installations</td><td colspan="3">Min. requirements
(for existing rooms when windows have been changed and for new rooms)</td></tr>
<tr><td>Indoor climate</td><td colspan="3">Min. ventilation facilities (building or a part of the building where the function has been changed)</td></tr>
</table>

Table 11: Building projects that applied for a buildings license from 01/03/2017 till 31/12/2017

<table>
<tr><th colspan="2">EPB demands (energy performance and indoor climate</th><th colspan="3">Destination</th></tr>
<tr><th>Nature of the works</th><th></th><th>Residential</th><th>Non-residential</th><th>Industrial</th></tr>
<tr><td rowspan="6">New buildings
(or similar)</td><td>Thermal insulation</td><td colspan="3">Max. K 40 and max. U value’s</td></tr>
<tr><td>Energy performance</td><td>Max. E50</td><td>Max. E level
(in function of the functional parts)</td><td>-</td></tr>
<tr><td>Net energy requirement</td><td>Max. 100-25c
or
70 kwh/m²</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td>Min. ventilation facilities and limit the risk for overheating</td><td>Min. ventilation facilities</td><td>Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 15 kwh/m² year</td><td>≥ 10 kwh/m² year</td><td>-</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td><td>Min. installation requirements</td></tr>
<tr><td rowspan="5">Intensive energetic renovation</td><td>Thermal insulation</td><td colspan="2">Max. U value’s
(For new and after insulated parts)</td><td rowspan="4">Follow the requirements from renovation</td></tr>
<tr><td>Energy performance</td><td>Max. E90</td><td>Max. E level
(in function of the functional parts)</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 10 kwh/m² year</td><td>≥ 10 kwh/m² year</td><td>-</td></tr>
<tr><td rowspan="5">Renovation</td><td>Thermal insulation</td><td colspan="3">Max. U value’s (for renovated and new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="3">-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities
(for existing rooms when windows have been changed and for new rooms)</td><td>Ventilation requirements</td></tr>
<tr><td>Installations</td><td colspan="3">Min. requirements (for new, renewed or replaced installations)</td></tr>
<tr><td>Indoor climate</td><td colspan="3">Min. ventilation facilities (building or a part of the building where the function has been changed)</td></tr>
</table>

Table 12: Building projects that applied for a buildings license from 01/01/2018 till 31/12/2018

<table>
<tr><th colspan="2">EPB demands (energy performance and indoor climate</th><th colspan="3">Destination</th></tr>
<tr><th>Nature of the works</th><th></th><th>Residential</th><th>Non-residential</th><th>Industrial</th></tr>
<tr><td rowspan="5">New buildings
(or similar)</td><td>Thermal insulation</td><td>Max. S 31 and U value’s</td><td>Max. U value’s</td><td>Max. K 40 and max. U value’s</td></tr>
<tr><td>Energy performance</td><td>Max. E 40</td><td>Max. E level
(in function of the functional parts)</td><td>-</td></tr>
<tr><td>Indoor climate</td><td>Min. ventilation facilities and limit the risk for overheating</td><td>Min. ventilation facilities</td><td>Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 15 kwh/m² year</td><td>≥ 15 kwh/m² year</td><td>-</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td><td>Min. installation requirements</td></tr>
<tr><td rowspan="5">Intensive energetic renovation</td><td>Thermal insulation</td><td colspan="2">Max. U value’s
(For new and after insulated parts)</td><td rowspan="4">Follow the requirements from renovation</td></tr>
<tr><td>Energy performance</td><td>Max. E90</td><td>Max. E level
(in function of the functional parts)</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 15 kwh/m² year</td><td>≥ 15 kwh/m² year</td><td>-</td></tr>
<tr><td rowspan="5">Renovation</td><td>Thermal insulation</td><td colspan="3">Max. U value’s (for renovated and new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="3">-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities
(for existing rooms when windows have been changed and for new rooms)</td><td>Ventilation requirements</td></tr>
<tr><td>Installations</td><td colspan="3">Min. requirements (for new, renewed or replaced installations)</td></tr>
<tr><td>Indoor climate</td><td colspan="3">Min. ventilation facilities (building or a part of the building where the function has been changed)</td></tr>
</table>

Table 13: Building projects that applied for a buildings license from 01/01/2019 till 31/12/2019

EPB demands (energy performance and indoor climate		Destination		
Nature of the works		Residential	Non-residential	Industrial
New buildings (or similar)	Thermal insulation	Max. S 31 and U value's	Max. U value's	Max. K 40 and max. U value's
	Energy performance	Max. E 40	Max. E level (in function of the functional parts)	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities	Min. ventilation facilities
	Renewable energy	≥ 15 kwh/m² year	≥ 20 kwh/m² year	-
	Installations	-	-	Min. installation requirements
Intensive energetic renovation	Thermal insulation	Max. U value's (For new and after insulated parts)		Follow the requirements from renovation
	Energy performance	Max. E90	Max. E level (in function of the functional parts)	
	Installations	-	-	
	Indoor climate	Min. ventilation facilities		
	Renewable energy	≥ 15 kwh/m² year	≥ 15 kwh/m² year	-
Renovation	Thermal insulation	Max. U value's (for renovated and new parts)		
	Energy performance	-		
	Indoor climate	Min. ventilation facilities (for existing rooms when windows have been changed and for new rooms)		Ventilation requirements
	Installations	Min. requirements (for new, renewed or replaced installations)		
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)		

Table 14: Building projects that applied for a buildings license from 01/01/2020 till 31/12/2020

EPB demands (energy performance and indoor climate		Destination		
Nature of the works		Residential	Non-residential	Industrial
New buildings (or similar)	Thermal insulation	Max. S 31 and U value's	Max. U value's	Max. K 40 and max. U value's
	Energy performance	Max. E 35	Max. E level (in function of the functional parts)	-
	Indoor climate	Min. ventilation facilities and limit the risk for overheating	Min. ventilation facilities	Min. ventilation facilities
	Renewable energy	≥ 15 kwh/m² year	≥ 20 kwh/m² year	-
	Installations	-	-	Min. installation requirements
Intensive energetic renovation	Thermal insulation	Max. U value's (For new and after insulated parts)		Follow the requirements from renovation
	Energy performance	Max. E70	Max. E level (in function of the functional parts)	
	Installations	-	-	
	Indoor climate	Min. ventilation facilities		
	Renewable energy	≥ 15 kwh/m² year	≥ 15 kwh/m² year	-
Renovation	Thermal insulation	Max. U value's (for renovated and new parts)		
	Energy performance	-		
	Indoor climate	Min. ventilation facilities (for existing rooms when windows have been changed and for new rooms)		Ventilation requirements
	Installations	Min. requirements (for new, renewed or replaced installations)		
	Indoor climate	Min. ventilation facilities (building or a part of the building where the function has been changed)		

Table 15: Building projects that applied for a buildings license after 01/01/2021

<table>
<tr><td colspan="2">EPB demands (energy performance and indoor climate</td><td colspan="3">Destination</td></tr>
<tr><td>Nature of the works</td><td></td><td>Residential</td><td>Non-residential</td><td>Industrial</td></tr>
<tr><td rowspan="5">New buildings
(or similar)</td><td>Thermal insulation</td><td>Max. S 28 and U value’s</td><td>Max. U value’s</td><td>Max. K 40 and max. U value’s</td></tr>
<tr><td>Energy performance</td><td>Max. E 30</td><td>Max. E level
(in function of the functional parts)</td><td>-</td></tr>
<tr><td>Indoor climate</td><td>Min. ventilation facilities and limit the risk for overheating</td><td>Min. ventilation facilities</td><td>Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 15 kwh/m² year</td><td>≥ 20 kwh/m² year</td><td>-</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td><td>Min. installation requirements</td></tr>
<tr><td rowspan="5">Intensive energetic renovation</td><td>Thermal insulation</td><td colspan="2">Max. U value’s
(For new and after insulated parts)</td><td rowspan="4">Follow the requirements from renovation</td></tr>
<tr><td>Energy performance</td><td>Max. E70</td><td>Max. E level
(in function of the functional parts)</td></tr>
<tr><td>Installations</td><td>-</td><td>-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities</td></tr>
<tr><td>Renewable energy</td><td>≥ 15 kwh/m² year</td><td>≥ 15 kwh/m² year</td><td>-</td></tr>
<tr><td rowspan="5">Renovation</td><td>Thermal insulation</td><td colspan="3">Max. U value’s (for renovated and new parts)</td></tr>
<tr><td>Energy performance</td><td colspan="3">-</td></tr>
<tr><td>Indoor climate</td><td colspan="2">Min. ventilation facilities
(for existing rooms when windows have been changed and for new rooms)</td><td>Ventilation requirements</td></tr>
<tr><td>Installations</td><td colspan="3">Min. requirements (for new, renewed or replaced installations)</td></tr>
<tr><td>Indoor climate</td><td colspan="3">Min. ventilation facilities (building or a part of the building where the function has been changed)</td></tr>
</table>

3.2 Regulations in Spain

In March 2006, the Spanish government adopted a new Technical Building Code (TBC, or in Spanish CTE). It includes an obligation to cover 30-70 percent of the Domestic Hot Water (DHW) demand with solar energy. The TBC has great importance, not only for the market of the Spanish heating but also for the current debate on effective support policies for solar thermal and other renewable energy technologies in the heating and cooling sector. ESTIF (European Solar Thermal Industry Federation) believes that the Spanish Technical Building Code will serve as a model policy for all the European member states and beyond. New building projects that are planned today will still be developed with oil and gas, which becomes more and more expensive. Solar thermal, which is already today's one of the most cost-efficient energy generating technology will replace large amounts of the fossil fuels and should be integrated into buildings at the time of construction. Spain is the first European member state that makes the implementation of solar thermal energy obligatory in new and renovated buildings. There is confidence that other European countries will follow this example. The CTE provides all the regulations in Spain. As described before in the chapter 'Climate' Spain exists out of different climate zones. Here will only be the part that is important for Valencia be described because there are in total 16 different climate zones. Different climate zones mean that there are different regulations as well. The CTE has also made a categorisation of the climate zones and Valencia belongs to 'B3' just like the whole coast region of the south of Spain.

3.2.1 Basic energy saving requirements

The aim of the basic energy saving requirements is to obtain a rational use of the energy required for building, reducing their consumption to sustainable limits. Thereby ensuring that part of this consumption come from renewable sources of energy. Thanks to the design, construction use and maintenance characteristics. To reach this objective, buildings shall be planned, constructed used and maintained in accordance with the basic requirements that are described in the next sections. The basic document of energy saving shall specify objective parameters and procedures, which will ensure that the basic requirements are met and that the minimum quality levels that are specific to the basic energy saving regulation are exceeded.

Here in Valencia we are in the district that is defined by the letter B, this means the we have the maximum energy consumption of 45 KWh/m² year. It stands for the primary energy that does not come from renewable energy sources. Meeting the standards is only possible of certain elements are described in the project documents. These are:

- The definition of the climate zone of the location where the building will be constructed.
- The procedure that is used to calculate the energy demand and the energy consumption
- The energy demand for the different technical installations of the building
- A description of the setup of the technical system that is used to comply with the need of the technical services of the building.
- The returned revenues for the different teams of the technical services of the building.
- The consumption of energy not coming from renewable resources.

We will need the next elements to calculate the energy demand of a building:

- The energy consumption for heating and cooling installations
- The energy consumption for sanitary hot water
- Electricity use

3.2.1.1 Energy demand limitation

The energy demand is also depending on the climate zone that you are in. For this specific climate zone of Valencia, this is 14 KWh/m² year. This can be limited by improving the thermal envelope of a building. It means that we have for every element in the building specific U values. Buildings shall have a set of characteristics which are capable of adequately limiting the energy demand that is necessary to foresee:

- The human thermal comfort in accordance with the local climate
- The use of the building
- The summer and winter regime as well as their characteristics of insulation and inertia
- Air permeability and exposure to solar radiation
- Reducing the risk of superficial humidity

Table 16: Table with U values for construction elements

Construction element	U Value (W/m²K)
Roofs	0,65
Floors	0,65
Walls	0,1
All elements in contact with the ground	0,1

3.2.1.2 Efficiency of thermal installations

Buildings shall feature appropriate thermal installations to ensure the human thermal comfort by regulating the efficiency of these installations and their equipment. These requirements are currently being developed in the Regulation of Thermal Installations and Buildings (RTIB). Its application will be defined in the plan of the building.

3.2.1.3 Energy efficiency of lightning installations

The buildings will have an adequate lighting installation for the needs of their users. All the installations will also be energy efficient and will have a control system to adjust the light to the actual needs of an area. Beside this it will also have a regulation system to optimise the supply of natural light in areas that meet certain conditions.

3.2.1.4 Minimum solar contribution to DHW

In every building there needs to be a minimum solar contribution to the Domestic Hot Water. In buildings with a foreseen demand for hot water or the conditioning of a covered swimming pool, a part of the thermal energy will be covered by incorporating systems for the collection, storage and use of low temperature solar energy. These incorporating systems will be suitable for the global solar radiation of their location and the hot water demand of the building. The values that come from these basic requirements will be considered as minimum values, without prejudice to stricter values that may be established by the authorities.

3.2.1.5 Minimum photovoltaic contribution to electric power

In buildings there must be incorporate systems for the gain and transformation of solar energy into electric power. The solar energy will be collected through a photovoltaic process for proprietary use or supply to the network. The values derived from these basic requirements will be considered as minimum values without prejudice to stricter values that may be established by the authorities.

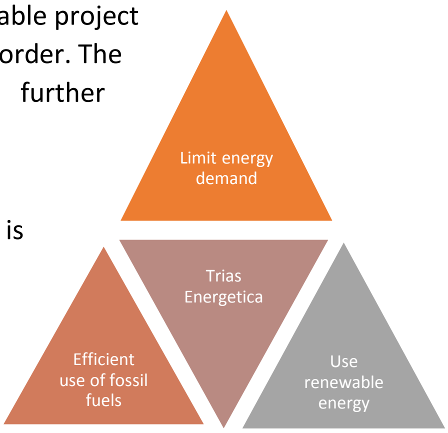
4 EPB and the Influential parts

All the regulations concerning the energy laws and efficiency in Belgium is summarized in the EPB, Energie Prestatie en Binnenklimaat or the Energy Efficiency and Indoor climate. As mentioned before in chapter 9, these regulations are mandatory for all the buildings who applied for a building permission after January 2006. The EPB is calculated with the 3G software in Belgium and depends on a few factors who have influence on these calculations. These factors will be described in this chapter. The EPB is normally for every new building but there are exceptions for some buildings under special circumstances. These buildings will have a full exemption, partial or none which will be explained underneath.

The EPB is based on two old philosophy's, namely the Trias Energetica and Trias Ecologica.

4.1 Trias energetica

This is a system which has been developed to create a sustainable project in only 3 steps. These 3 steps need to be executed in the right order. The steps can be found in this scheme and are explained further underneath.



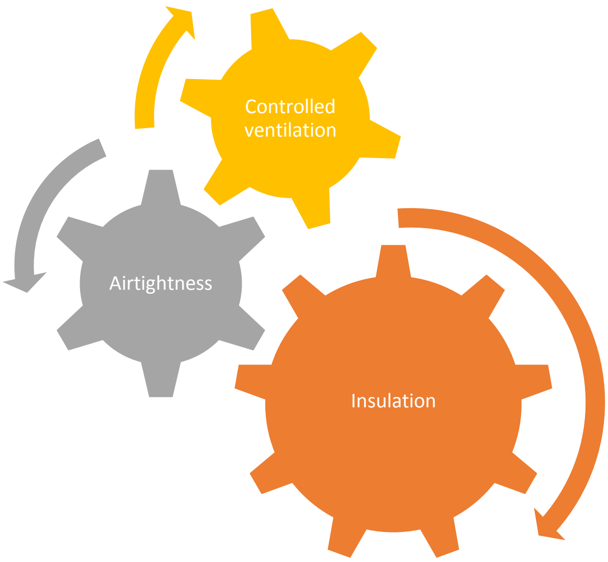
1. **Limit the energy demand:**
   Creating a building with as less as possible energy loss is what we want. This is possible by developing the building in a way that we don't have a lot of energy loss caused by a lack of insulation, airtightness or uncontrolled ventilation.
2. **Use renewable energy:**
   The use of energy sources which will always be there such as: sunlight, wind, water or earth heat.
3. **The use of fossil fuels in the most efficient way:**
   If we can't avoid the use of fossil fuels, we need to make sure that we use them as efficient as possible. To do this we will use systems with the highest efficiency's such as heat pumps.

This system has been invented in the Netherlands and is now used worldwide. There are many forms that are used based on this system where people use sunlight, wind and other natural sources to make energy and heat. Beside this the quality of materials such as insulation is increasing by the day. All of this makes it possible to design more and more environmentally friendly houses and buildings. This gives us the opportunity to create NZEB (nearly zero energy buildings) and passive buildings using the principles of Trias Energetica. Towards the future it will be really important to create more buildings like this to reduce the impact on the climate and environment by reducing the CO_2. This type of housings will be mandatory because it has been determined in the climate objectives made by the European Union.

Table 17: Trias energetica

Trias Energetica	
Limit energy demand	Max. U-level Max. R-level K-level (industry) E-level (res. And non-residential) S-level Net energy requirement Construction nodes
Renewable energy	The use of systems which transforms natural forces into energy a heat.
Efficient use of fossil fuels	Technical demands of the installations System requirements for installation

There are three aspects that need to be executed with a high precision which will make the difference for a building to meet the regulation according at that moment. These three characteristics can't be seen separately and are connected with each other in many ways.



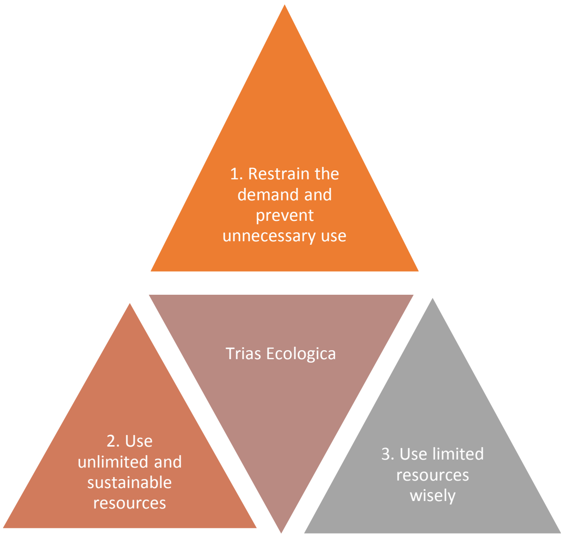
4.2 Trias ecologica

This is an important part in the story of Trias Energetica. The system gives more information about building or rebuilding of nearly – and zero energy buildings and the sustainable use of materials in 3 different categories.

1. In terms of energy (Trias Energetica):
   Prevent the demand for energy
   Use renewable energy
   Use the fossil resources in an efficient way
2. In terms of water:
   Prevent the demand for water
   Use infinite water resources
   Use the water efficient
3. In terms of raw resources
   Prevent the demand for these resources
   Use renewable and infinite resources

Use the resources efficient

The system emphasizes more on the prevention of the use of resources that are limited. Instead it says that the use of endless material resources such as sun and wind should be used. This kind of resources should be used wisely.



4.3 Exceptions for the EPB regulations

For some cases a building can be excluded for the EPB regulations that normally should be applied. The exception can be for the full building, partial or no exception at all. In the next tables everything will be explained.

Table 18: Complete exemptions EPB-regulations

Overview of the exceptions, deviations, EPB-regulations or the procedures		
EXCEPTOINS	EPB-REGULATIONS	PROCEDURE
Complete exemptions of the EPB-regulations		
Building with a simple file and a protected volume of <3000m³	No regulations	No procedure
Building with a temporary permission of max. 2 year	Application before 21/06/2008, all EPB-reg. need to be followed depending on the nature of the works	Mention in statement + EPB submit declaration
	Application after 21/06/2008, no EPB-reg.	No procedure
Freestanding buildings with a total useful floor surface <50m²	Application before 21/06/2008, all EPB-reg. need to be followed depending on the nature of the works	Mention in statement + EPB submit declaration
	Application after 21/06/2008, no EPB-reg.	No procedure
Building parts with a total useful floor surface <50m²	Application before 18/05/2014, all EPB-reg. need to be followed depending on the nature of the works	Mention in statement + EPB submit declaration

• In an industrial building where no energy is being used to create a specific inside temperature • A building which is not intended to live in within an agriculture company	Application after 18/05/2014, no EPB-reg.	No procedure

Agriculture buildings with a low energy demand belong to this list as well. This means that buildings who foresee warm corps (except for conservatories), stables for pigs and poultry, buildings for energy intensive productions, storage and treatment of vegetable products do not have to follow the EPB-regulations. Some examples are:

- Dairy stables
- Meat stables
- Sheep-and goat stables
- Horse stables
- Conservatories for cold corps

The last point on the list for complete exemption is an renovation or a function change where the existing boiler will remain and is not older than 10 years on the moment of the application and the floor surface that is warmed up by new installed heating devices is less than 25% of the total floor surface.

Table 19: Partial exemptions EPB-regulations

Overview of the exceptions, deviations, EPB-regulations or the procedures		
EXCEPTOINS	EPB-REGULATIONS	PROCEDURE
Partial exemptions of the EPB-regulations		
Normal renovations or function changes of protected monuments and existing buildings in a protected environment, city or village	Application before 08/09/2011, no EPB-reg.	No procedure
	Application after 08/09/2011, max. U-and R values for builded roofs and floors	Mention in statement + EPB submit declaration
	Application after 01/01/2015, max. U-and R values for builded or after insulated roofs and floors Min. demands for new or renewed installations	Mention in statement + EPB submit declaration
Normal renovation of function change of buildings registered in the inventory of architectural heritage	Application before 14/09/2009, follow all the EPB-reg.	Mention in statement + EPB submit declaration
	Application after 14/09/2009, Max. U-and R values for rebuilt facades who are now visible from the street, roofs and floors. Foresee ventilation in spaces where windows have been replaced who are not visible from the street.	Mention in statement + EPB submit declaration

	Application after 01/01/2015, Max. U-and R values for rebuilt or after insulated facades who are not visible from the street and after insulated roofs and floors. Foresee ventilation in spaces where windows have been replaced who are not visible from the street. Min- demands for new or renewed installations	Mention in statement + EPB submit declaration
Expenses, partial rebuild or major energy renovation of buildings	Application before 01/01/2015, follow EPB-reg.	Mention in statement + EPB submit declaration
	Application after 01/01/2015, Max. U and R-values for rebuilt or after insulated roofs and floors. Min. demands for new or renewed installations.	Mention in statement + EPB submit declaration

For some of the previous parts there are deviations on the EPB-regulations. These deviations can be found in the next tables.

Table 20: Different requirements on the EPB-regulations

Overview of the exceptions, deviations, EPB-regulations or the procedures		
EXCEPTOINS	EPB-REGULATIONS	PROCEDURE
Partial exemptions of the EPB-regulations		
Greenhouses for warm crops	Application before 01/01/2015, no EPB-reg.	No procedure
	Application after 01/01/2015, Min. 1 energy screen The indoor climate is arranged automatically for the temperature and the humidity	No procedure
Stables for pigs and poultry	Application before 01/01/2015, no EPB-reg.	No procedure
	Application after 01/01/2015, Max. U value for new, renewed and after insulated roofs: 0,40 W/m²K Max. U value for new and renewed walls not in contact with the ground: 0,40 W/m²K The new and renewed transparent constructions, doors and gates are determined. The ventilation requirements are also determined.	No procedure
	Application before 01/01/2015, no EPB-reg.	No procedure

Buildings for energy intensive production, storage or treatment of vegetable products	Application after 01/01/2015, Max. U value for new, renewed and after insulated roofs: 0,40 W/m²K Max. U value for new and renewed walls not in contact with the ground: 0,40 W/m²K The new and renewed transparent constructions, doors and gates are determined. The ventilation requirements are also determined.	No procedure

4.4 Influential parts

The next parameters all have an influence on the calculation that will be made of a building. The result also known as the EPC, gives all the information about the building in the form of a report which you need if you want to sell a house. These standards almost change every year and they become more and more strict. Towards the future it gets harder to meet for all these levels so it gets more expensive to design and execute a building. The more strict the level become, the closer we build to nearly zero energy building and passive buildings.

4.4.1 U and R level

The heat transfer coefficient U represents the amount of heat that goes through a construction part divided with the surface where the heat goes through and the temperature difference between the inner-and outer area. The unit of U is in W/m²K The calculation off the heat transfer coefficient depends on the nature of the construction. This can be:

- Opaque partition structures like walls, roofs and floors
- Transparent partitions structures like windows, doors and curtain walls

$$U = \frac{R}{d}$$

$$R = \frac{d}{\lambda}$$

$$U = \frac{1}{R}$$

To find R we have to divide the thickness ‘d‘ of the tested surface with the conductivity coefficient ‘λ’. The relationship between het heat transfer coefficient and the heat resistance is the inverse of each other. The heat resistance ‘R’ is the

4.4.2 Transparent partition structures

Transparent partition constructions are composed out of different components such as frames, fixed and opening profiles, glazing,… Examples of this are windows, slight facades, glazed doors and gates, glass brick walls,… The following characteristics of transparent partition constructions have an influence on the energy performance of the building.

- The insulating capacity of the glass
- The sun permeability off the glass
- The orientation of the construction part

- The pitch of the construction part
- The shading of the construction part

To prevent energy loss, it is the best to restrict the amount of glass surface in a building. This part, the transparent partition constructions are responsible for 15% of the energy loss in a building and has so the biggest influence on the energy performance and overheating.

This part contains all the glass inside a building. It can be redefined into other, more specific aspects:

- Windows
- Doors and gates
- Slight facades
- Glass building blocks
- Transparent partition structures different then glass

The total U value depends on the heat losses through these different components and the mutual connections. The average U value of the transparent components must meet the U_{max} demands. To meet these standards the right type of windows/glass needs to be used in the structure. Glass can be divided into several groups depending on its characteristics. The biggest groups on how glass can be classified are:

Table 21: Classification of glass

Type of glass	U_g max (W/m²K)
Single plated glass	5,9
Double plated glass	2,8
Triple plated glass	1,9
HR glass	1,5
HR+ glass	1,2
HR++ glass	0,6

A short explanation of HR glass will be given in the next chapter.

4.4.2.1 High efficiency glass (HR-glass)

High efficiency glass insulates two to three times better than normal double glass and four to five times better then single plated glass. This type of glass has a very thin insulating metal layer at the inside of the glass plates and the space in between the glass panels is filled with a noble gas. This gas can be krypton or argon instead of using air.

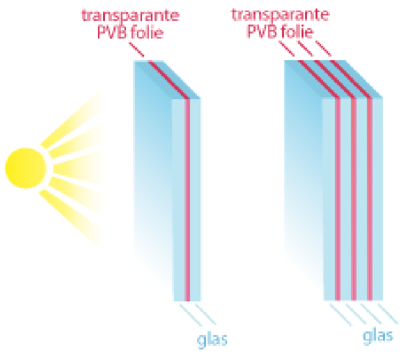


Figure 8: Double and triple plated glass with PVB foil

High efficiency glass has e few characteristics which improve the U value significant. These characteristics can be:

- Heat insulating
  HR-glass is meant for thermal insulation. This means that it tries to contain the heat at the inside in the winter periods and keep the heat outside during the summer.
- Acoustic insulation
  It will reduce the sounds coming from the outside, another level or room.
- Sun protection
  It reduces the amount of sunlight that goes through the window which can heat up the room.

HR glass looks perfectly the same as normal glass, but it is provided with a coating which improves the thermal capacities of the glass. This layer is the same metal layer as mentioned before and it is not visible with the eye because it is really thin. Beside the coating that has influence on the thermal insulation capacities of a window there is also the noble gas. Due to this gas the hot air inside will not extract so fast through the window then with normal air between the glass plates. This has the same effect the opposite way, the cold air from outside will not transfer through the window that fast. Which leads to less energy consumption for heating systems and money savings. The U value of glass is based on the thickness of the glass, the amount of layers, if there is a coating and the type of gas between the glass panels.

The difference between HR+ and HR++ is that the cavity is bigger. This cavity can have a width up to 15 mm and will reduce the sounds even more. This is one of the reasons why this type of glass is one of the most bought in Belgium.

One of the characteristics is that HR glass can be sun reflecting. The glass is then provided with a special coating which reflect the infrared radiation of the sun. because of this coating the rooms foreseen with a lot of windows don't heat up that much and it gives a cooler feeling inside.

The picture underneath shows with a small graphic how the temperature from outside can affect the inside temperature depending on the type of glass. On the left we find the outside temperature and on the right the inside temperature. Depending on the type of glass the inside temperature changes. This temperature change depends on the U value of the glass. The higher the U value the lower the inside temperature will be and the more energy you will need for the heating systems in the house.

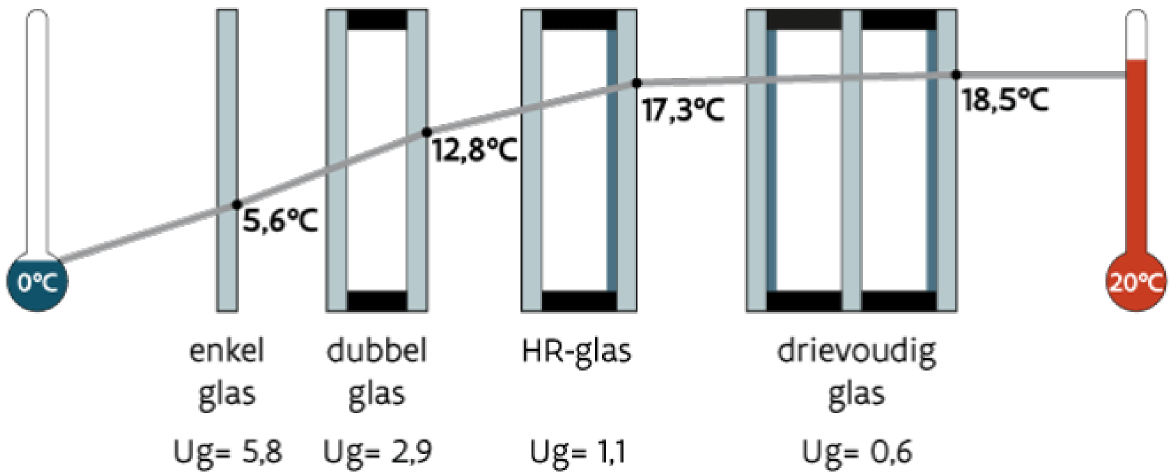


Figure 9: Temperature gradient depending on the glass type

4.4.3 Opaque partition constructions

This kind of partition constructions are made out of one or more composed, non-transparent building layers. Examples of these constructions are cavity walls, pitched roofs, floors with a direct contact to the ground,… So it can be every construction element except for doors and gates and light facades. These kinds of structures have a maximum U value of 0,24 W/m²K. These next characteristics of opaque constructions have an influence on the energy prestation of a building.

- The insulating characteristics of the composed layers
- The nature of the composed layers
- The pitch of the construction part

The orientation of the opaque construction part does not have any influence here.

Light facades also known as curtain walls are non-structural elements of a buildings which separate the building from the outside environment. This type off walls do not have the same U value as normal walls. The must have a minimum U value of 2,0 W/m²K.

4.4.4 Doors and gates

If we want to calculate the U value of a door or a gate we need to implement the component such as the framework in it as well. These do have a big influence on the heat transfer coefficient. The framework can be made of wood, aluminium, steel or other materials. If you choose a framework of aluminium or steel you need to indicate how mane 'rooms' there are in the framework. This is important because the amount of rooms will improve the thermal insulation and the airtightness of the framework which will improve the u value. This is one way to put in the heat transfer coefficient in the software, we can also just put in the number given by the manufacturer. The moment we do this we need to add the technical report of the manufacturer into the program to prove this. The maximum allowed heat transfer coefficient of doors and gates is the same as for glass brick walls and transparent partition constructions, 2,0 W/m²K. The next formula shows how the U value of a window is calculated in detail. The U represents the heat transfer coefficient of every part and A stand for the surface.

$$U_w = \frac{A_g * U_g + A_f * U_f + A_p * U_p + l_g * \psi_g + l_p * \psi_p + A_{grid} * U_{grid}}{A_g + A_f + A_p + A_r}$$

U_g= Heat transfer coefficient of the glass

U_F= Heat transfer coefficient of the profile

U_P= Heat transfer coefficient of the door panel

U_R= Heat transfer coefficient of the ventilation grid

U_W= Heat transfer coefficient of the window

Ψ= linear heat transfer coefficient

$$[U] = \frac{W}{m^2K} \qquad [A] = m^2$$

4.4.5 Maximum allowable heat transfer coefficients

For every aspect in a building the construction parts have a maximum U value as explained before. Everything possible situation is described underneath each shown with the heat transfer coefficient that belongs to it. These values are applicable to regulations from 2018.

Table 22: Maximum allowed U value (anno 2018)

CONSTRUCTIONPART	U_{max} (W/m²K)
1. Partition structures who envelop the protected volume *(with exception of structures which are connected with another protected volume)*	
1.1 Transparent partition structures *(with exception of doors, gates, slight facades or construction parts different then glass)*	1,5 $U_{g,max}$=1,1

1.2 Opaque partition structures *(with exception of doors, gates and slight facades)* 1.2.1 Roofs and ceilings 1.2.2 Walls not in contact with the ground, except the walls mentioned in part 1.2.4 1.2.3 Walls in contact with the ground 1.2.4 Vertical and pitched partition structures in contact with a basement outside the protected volume 1.2.5 Floors in contact with the outdoor environment 1.2.6 Other floors *(floors on ground, above a basement who is not part of the protected volume, buried basement floors)*	0,24
1.3 Doors and gates	2,0
1.4 Curtain walls	2,0 $U_{g,max}$=1,1
1.5 Glass building blocks	2,0
1.6 Transparent partition structures different than glass *(except doors, gates (1.3) and slight facades (1.4))*	2,0
2. Partition structures between 2 protected volumes on adjacent plots	0,6
3. Opaque partition structures within the protected volume or adjacent to an existing protected volume on the plot	
3.1 Walls 3.1.1 Between different accommodation units 3.1.2 Between accommodation units and common areas 3.1.3 Between accommodation units and areas with other destinations	0,6
3.2 Ceilings and floors 3.2.1 Between different accommodation units 3.2.2 Between accommodation units and common areas 3.2.3 Between accommodation units and areas with other destinations 3.3 Between areas with an industrial purpose and areas with another specific destination	1,0
4. After insulation of existing partition structures who envelop the protected volume	
4.1 Opaque structures *(except the partition structures who separate with another protected volume)* 4.1.1 Existing roofs and ceilings with after insulation *(between or on the outside of the load-bearing construction in contact with the outdoor environment or an adjacent unheated room)* 4.1.2 Existing walls with after insulation *(on the outside of an existing construction in contact with the outdoor environment)*	0,24
4.1.3 Existing cavity wall with after insulation 4.1.4 Existing walls with after insulation at the inside of an existing construction	0,55
4.1.5 Existing floors with after insulation *(at the outside of an existing construction in contact with the outdoor environment)*	0,24

4.4.6 K-level

This level or value indicates the global heat-insulation of a building. It is based on the heat losses of a building trough the outer walls, roofs, floors and windows. The better the building is insulated the lower the number will be. The compactness and the amount of cold construction bridges also effect this value. The more complicated or the more strange the form of a house is the higher/worse the K level will be. The best choice is to make a rectangular form which reduces the amount of heat loss surfaces.

The K value is calculated per building. This means that for an apartment building with several apartments in it you will only have one K level. This changed in the beginning of 2018. Starting from January 2018 the K level is no longer applied on residential and non-residential buildings. It only applies for the industrial sector. This means that we have to find another unit for the residential and non-residential buildings to indicate how well insulated they are. For this we use the E level which will be explained in the next chapter.

Table 23: Changes after 01/2018 for the calculation of the energy efficiency of buildings

Demands on the quality of the layers	Residential buildings	Non-residential buildings	Industrial sector
Before 2018	K-level Max. U value Net energy requirements for heating	K-level Max. U value	K-level Max. U value
After 01/2018	S-level Max. U value	Max. U value	K-level Max. U value

4.4.7 S-level

As explained in the previous chapter we replaced the K value for residential and non-residential buildings by the S-level. This new level merges all the qualities of all the layers together and solves some imperfections of the K level. It also takes other aspects in calculation which gives a more accurate number of the energy performance of a building. These aspects will be shown in the table below.

Table 24: Difference between the S-and K-level

The difference between the S-and K-level	
K level	**S level**
Average U value + building construction points	Average U value + building construction points Solar gains Ventilation losses: only the airtightness
One level per building	One level for every unit or apartment
Based on the compactness of a building	Based on the form efficiency of a building
Losses outdoor environment and adjacent unheated spaces	Losses outdoor environment, adjacent unheated spaces + adjacent heated spaces
Amount of insulation	Insulation, airtightness and overheating

The table tells us that for the calculation of the K level only one calculation will be made for the entire building. The S level does this for every unit in that building. This means that the K level is not accurate and gives the wrong impression of a living unit. For bigger buildings with several EPB units it is more useful to calculate the value per unit instead of calculating one for the whole building. For people who want to buy a house the K level is not useful because it indicates the energy efficiency of the layers of the building and not specifically on the energy efficiency of the apartment that they are looking for.

Another difference between these two values is that the S-level calculates with the form efficiency and the K-level with the compactness of a building. This means that there will be no negative influence anymore on the calculation of smaller buildings. A small building mostly already has a small compactness and should have a lower average U value to lower the level. In the calculation of the S-level the net energy requirements are divided with the equivalent sphere surface. Due to this normalisation the disadvantage disappears. The next calculation makes the difference between these two levels clearer.

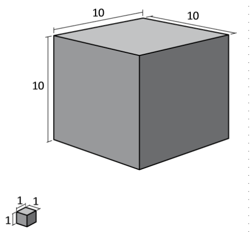


Table 25: Comparison between compactness and form efficiency

	Small cube	Big cube
Rib	1 m	10 m
Volume (V)	1 m^3	1000 m^3
Loss surface (A_r)	6 m^2	600 m^2
Equivalent sphere surface (A_b)	4,84 m^2	484 m^2
Compactness (C=C/A_r	**0,16 m**	**1,6 m**
Form efficiency (V=A_b/A_r)	**0,81**	**0,81**

This table shows us that using the form efficiency will be more accurate then working with the compactness of a building. The volume here will not make the difference on the calculation because we work with the equivalent sphere surface.

4.4.8 E-level

This mark says something more about the energy performance of a building. The lower this mark is the better and the more energy efficient a building is . It will be calculated with the software called '3G-software' made by the EPB reporter. This calculation is based on how much energy there will be needed for heating and cooling. This includes calculation for heating installations for sanitary hot water. The mark depends on:

- Thermal insulation
- Airtightness
- Compactness
- The orientation
- The amount of sun
- Ventilation losses
- Used installations in the building

This mark becomes every year more strict to fulfil on the demands of the European Union. This value that we calculate is just an estimation of the energy needed in the building. It does not contain small lose devices (fridge, washing machine,…) and lights.

Mark when you don't meet the requirement for the minimum amount of renewable energy in a building the E level becomes stricter with 10 percent. Due to this exception a building where you cannot meet the demands for renewable energy the house still can be EPB-accepted.

The next table shows the changes during the years of the E level.

Table 26: Changes of the E mark over the years

Year	E value
2006	E100
2010	E80
2012	E70
2014	E60
2016	E50
2018	E40
2021*	E30

*In the year 2021 it will be mandatory to build nearly zero energy buildings where the E level will need to be 30 or lower.

4.4.9 Renewable energy

Energy coming from natural and inexhaustible energy sources such as wind, sun, water and earth heat is called renewable energy. The minimum share of renewable energy is expressed as the minimal primary energy amount (KWh) per unit floor surface (m²) every year. The minimum amount of renewable energy that is needed is 15KWh/m²year. This amount is the same as for nearly zero energy buildings that will be mandatory in 2021. This amount can be acquired through four different ways which will be explained underneath.

1. Minimum 15 KWh of renewable energy need is to be produces if it is a residential building and minimum 20 KWh for non-residential buildings per m² floor surface per year. The energy can be produced by one of the following systems.
    a. Solar panels (PV)
    b. Sun boilers
    c. Heatpump and heatpump boiler
    d. Boiler, stove or cogeneration on biofuel*
    e. City heating or cooling
2. The total energy demand for space heating covered by one or more of the following techniques.
    a. Heatpump
    b. Boiler, stove or cogeneration on biofuel*
    c. City heating or cooling with a 100 percent share of renewable energy
3. Placing a sun boiler with an installation surface of minimum 2,5 percent of the floor surface. Having a house of 150 m² you will need a surface off 3,75 m².
4. Participation in a project which creates renewable energy, this should be
    a. Minimum 20 euro/m²
    b. Minimum 15 KWh/m²

*Mark that when you use a biomass boiler or stove that you fulfil on the requirements that have been described in the royal decree on the 12th of October 2010. The efficiency of the installation must be minimum 85 percent and the emission level does not go exceed the limits.

For every major energy renovation with building permission applied after 1 January of 2018 there should be a minimum of 15 KWh/m² of renewable energy. This applies for residential and non-residential buildings. As mentioned before, houses who do not meet the demands for the amount of renewable energy in a building the E value will be 10 percent stricter. Due to this way a house where it is not possible to foresee renewable energy it can still be EPB-approved.

5 NZEB Belgium and Spain

Nearly zero energy buildings, shortened NZEB are the buildings of the future. This special type of housing will be obligatory starting from 2021. This only applies on all new buildings in the private sector. This has been decided by the European Union and is mandatory for all the country's that signed up for the Kyoto Protocol. For all public buildings these rules are already mandatory from 2019. The most important part of the nearly zero energy buildings and what defines them is that they use as less as possible energy for heating, cooling, ventilation and sanitary water. If there is any need for energy the house must provide it by itself. This means that the house needs to have an energy source but more specific, green energy. In 2010 the decisions have been made that every member of the European Union needs to make a plan on how to improve buildings in the field of energy performance. To goal is to build more and if possible only buildings that have the label of nearly zero energy. These regulations have been made on a European level so that means that they overwrite the current laws of every member state and that every country will have to adapt those laws to fulfil on the new demands of the European Union regarding the energy use in new buildings. This chapter will explain the NZEB for the Flemish part of Belgium and Spain.

The EPBD defines a nearly zero energy building as follows: it is a building that has a very high energy performance. The nearly zero or very low amount of energy required should to a very significant extent be covered by energy from renewable sources, including renewable energy produced on-site or nearby.

Acknowledging the variety in building culture and climate differences throughout the European Union, the EPBD does not describe one uniform approach for implementing the nearly zero energy buildings. Neither does is describe a calculation methodology for the energy balance of a building. This means that all the countries can enjoy of a kind of flexibility. Because of this it gives the opportunity for the member states to draw up specifically designed national plans for increasing the amount of nearly zero energy buildings. These national plans will have to translate the concept of NZEB into practical measures and definitions to increase the number of this type of buildings. Throughout Europe there is a large variety of concepts and examples for very high energy efficient buildings or climate neutral buildings:

- Passive house
- Zero energy
- 3-litre
- Plus energy
- Minergie
- Effinergie

5.1 NZEB for the Flemish region

As explained before, every member had to make up a plan on how to achieve this goal. In Belgium we have three different regions where each region has his own legislation regarding the EPB norms and standards. The Flemish energy agency made an action plan which is based on five different areas. These parts will each be explained in this chapter. In each section there are propositions on how to achieve this goal and make it doable.

1. Innovation
2. Integral framework
3. Communication
4. Financing
5. Energy politics

5.1.1 Innovation

The transition towards nearly zero energy buildings till 2021 will come faster than the realised evolution in the energy performance of the last 10 years. An accelerated market introduction of the provides innovative systems, technologies and services with better energy performances will be necessary. The Flemish confederation of the construction asked the government to fulfil the role to search for payable, healthy, comfortable and technical sustainable solutions for four big social challenges.

1. Making Flanders a green logistic hub
2. Increasing the energy efficiency of the buildings
3. Decreasing the use of fossil fuels
4. Increasing the building types, for the aging population

Innovation in the construction sector only exists out of the innovation of existing building methods. It does not mean that the building sector needs to develop itself to a high-tech sector. But it should have the ambition to become a mid-tech sector. There needs to be a thorough research to find the most efficient way to build nearly zero energy buildings (prefabrication, collective systems for energy supply). There must be new developments regarding new and acceptable methods for the existing buildings without insulation and mostly without any air cavity in the wall to make these buildings in 10 years in an efficient and payable way more energy efficient. This transition will definitely create new economic opportunities for the building sector. More attention for innovation will lead to new activities in this sector, new materials, design concepts, technologies and services. New activities will create more jobs. To realise in 2021 nearly zero energy buildings we will need integrated technological solutions and innovations where different building dimensions in an integrated way will be optimized. These building dimensions which need to be improved are:

- Insulation
- Heating
- Cooling
- Ventilation
- Lightning
- Glazing
- Sun protection
- Renewable energy technologies

5.1.1.1 Optimisation research and develop innovation

Out of the innovation policy, the developments and the research to innovative systems, technologies or services which improve the energy performances of buildings will be supported and stimulated stronger. Government resources for innovation will contribute to help with the big social and economic challenges where our society and economy has been confronted with. The government will invest in the research in the field of:

- Logistic and transport
- New materials and nanotechnology
- Energy and environment

Green energy (energy efficiency, renewable energy and cleantech) will be considered as a multidisciplinary innovation point. A new Flemish energy company had to be founded which will have the opportunity to support the innovation for durable energy consumption. For these there has been made a list filled with propositions for the innovative studies.

- Inventarisation research to advanced energetic renovations of buildings
- Research to the relation between the theoretical and the actual energy use, counting with the different parameters such as family circumstances, temperature settings,…
- Innovative tendering for new technologies of energy saving measurements
- Collective systems for heating and sanitary warm water
- Feasibility local energy companies and how can they be optimally developed
- The most optimal controlled ventilation systems
- Double façade systems
- Industrialised or prefab building systems for nearly zero energy buildings, new buildings and renovations
- Realisation of a platform where combinations of integrated product technologies can be developed
- Integrated systems for sustainable energy applications

5.1.1.2 Locate the precursors

There are two types of precursors. At one side you have the suppliers and at the other side you have the demands. The precursors at the supply side have an essential role. To locate them, there have been started up and realised different initiatives. People that belong to this group are:

- Contractors
- Installers
- Architects
- Engineering bureaus
- Suppliers
- …

There has been done less research for the motivation and other characteristics for the precursors at the demanding side. However, this is important to take actions and measures. The research that's been going on is targeting on the social-economic and engineering factors. At first the focus will be on the landlords for houses, this for new houses and renovations. If the results are clear another research can be started for non-residential buildings.

5.1.1.3 EPB framework for Valorisation of innovative systems or technologies

There needs to be provided a flexible mechanism for all innovative systems of technologies. This will be needed for the calculating methodology for the energy performance of new and existing buildings.

5.1.1.4 Improvement of airtightness and ventilation

Due to check-ups from files which qualify for the analysis of the EPB declarations it is clear that the low energy certificate has been accomplished by using technological measures like the D-ventilation system, heatpumps, sun boilers and solar panels. The precursors have attention for the appliances of renewable energy but the amount of buildings with an inherent building quality such as strongly insulated or airtightness is still low. Because there is more attention for airtightness it is absolutely necessary to reach the NZEB level. More actions will have to be taken which improve the airtightness significant of the building envelop.

The more airtight a building is, the more important the role of the ventilation system is. The knowledge about the right ventilation debits, systems, installations and the use is present but the appliance is mostly wrong. Therefor it is really important to install and use the ventilation systems in the right way.

5.1.1.5 From demo - to volume market

A collaboration has been set up with partners out of the building sector who will on a short time period realise a big amount of demonstrative NZEB buildings. Therefor it is important that the collaboration is made between persons with precursors at the supply side. Repetition and redo this on a bigger scale will have a positive influence on the financial feasibility. The creating of a big amount of NZEB buildings will show any compatibility problems between new materials really fast. In meanwhile these projects will be important show cases for all parties who are involved in the construction.

Mainly because of the mandatory energy performance demands, there is a strong improvement in the energy performance of new buildings. Existing buildings cannot stay behind. To avoid a big gap between the new building and the buildings that need to be renovated, the demo projects are also focused on renovations. For the renovations there is a collaboration between prefabricated systems. These systems are developed in a way that radical renovations are financial achievable, and that the execution is efficient. Performed Belgian and European studies can be an example for this. The increasing interest of collective building projects is an important factor in the acceleration of renovations. A more collective way of working means that there is more chance to build nearly zero energy buildings on big scales. Through this way the costs for a scratch and the search for an economic optimum can be divided over the different buildings. The used techniques can also be more standarized. It will be more important to find innovative and efficient methods to decrease the amount of working hours on the worksite and foresee to construction elements with a higher quality.

5.1.2 Integral quality framework

The realisation of the social policy that puts nearly zero energy buildings as a reachable standard is a really important social challenge. This means that investments by landlords, companies and by the government are needed. It is important that the investment on engineering wise are correct and that they have a long lifespan. To ensure a qualitative execution is a condition for the realisation of a big market introduction. This is only possible within an integral quality framework where the goal is to increase the knowledge.

5.1.2.1 Knowledge increase in the construction sector

The first step to become an integral quality framework is by improving the knowledge in the construction sector. Due to educations and specialisations, the knowledge needs to be transferred for the different aspects needed to build nearly zero energy buildings in an optimal and qualitative way. This means that we will have to learn a lifetime long and improve every day. The most frequent problems are the importance of building airtight, the presence of thermal bridges and after insulation of existing walls, wrong dimensioned installations,…

5.1.2.1.1 Overview and roadmap of professional education in the building sector

There is a need for transparent and a structured overview for all the existing NZEB related professional educations. Thereafter a projection can be made towards 2020 where the buildings sector is able to realise nearly zero energy buildings. The current situation and the projection to 2020 can be compared wherefor there can be gaps detected. The process to get rid of these gaps and the evolution towards this milestone can be made through a roadmap. In the next phase this roadmap will have to be realised.

5.1.2.1.2 From energy conscious to NZEB architect

In practice, the architects only integrate the energy saving measures on the end of the design process. The cause of that cannot always be found on the architect but mostly the landlord has a part in this as well. This is because the landlords are too scared for the extra costs that will come along with the interventions. The is of big importance that from the start of the design phase energy saving measures are implemented into the project. The architect is here one of the most important people. He is the person that needs to make sure that the landlord understands the process and the importance to build in an energy efficient way. As potential landlord, it is rather difficult to find architects which have the knowledge of energy efficient buildings. People that are looking for this type of architect can have a look on a website that has been specifically made to help people finding these architects. At the other side architects that want to make themselves public that they master this knowledge can apply on this website. The voluntary education for these architects treats important aspects to succeed in building energy efficient buildings who meet:

- Insulation demand
- Airtightness of the building
- Ventilation
- Energy efficient techniques
- Economic justified low energy built

Architects who can prove that they have done enough effort to build in an energy efficient way do not have to follow this education.

5.1.2.1.3 Energy conscious contractors

After creating the website for the energy conscious architects, a new platform has been made for the contractors and installation companies. This website follows the same labelling process as before. It is important here is that the focus is on the NZEB. Therefore, the contractors and the installers have enough input to support the transition towards 2020. The trainings that the contractors follow need to able to apply in practice and need to be focussed on the activities where they are employed.

5.1.2.1.4 Specific info sessions and trainings for building professionals

For the certification of the installers of renewable energy and energy efficiency there has been developed new educations. These specific info sessions for the building professionals will be complementary to the certified educations. These specific info sessions do not have an exam, threaten other subjects and last less long. Possible subject can be:

- Thermal bridges
- Airtightness
- Energetic renovation
- Ventilation systems
- Avoid overheating
- Small decentral energy production

5.1.2.1.5 Education for real estate industry and unite owners

The real estate sector and associations of owners can have an important role by giving advice about energy savings in buildings. The buying and negotiation moments serve a good chance to draw the attention on energy saving measures. Short sessions can be organised to make aware that the real estate sector and the associations of owners have an advising role.

5.1.2.1.6 Education for landlords

It is not only important that the architects and the contractors are well educated but also the landlords. One-sided for the people who do it their selves and on the other side for possible quality control of the building process. These educations or info sessions should be organised by the local authorities or special organisations who provide educations.

5.1.2.1.7 Education for building professionals of the future

There is a need for a continuous flow of competent talent in de construction world in every building sector and on every level (architect, contractor, workers, engineers,…). Only qualified people can guarantee the development of innovative solutions and for qualitative execution of the construction elements. Universities, high schools, secondary schools and education centres who provide educations to professionals of the future need to have wider competences which support a qualitative execution beside energy related measures. This can be project management, collaborations,…

5.1.2.1.8 Train the trainer

A frequent appearing problem with the development of educations is to find the right teachers for them. Because of the fact of the professional background of the auteurs, they expect that they know the theoretical knowledge and the practical experience. To guarantee the quality of the education there must be worked out an offer to support the education of teachers (train the trainer). Beside this the teachers need to have the opportunity to maintain their knowledge about the still changing market.

5.1.2.2 Realisation of a quality framework for the construction sector

The realisation of a quality framework for the construction sector is made out of four different aspects. They are responsible for the control on the quality in the construction. Every day new products, materials and installations are brought onto the market which not always work perfectly together with other existing products. That's way there must be done a control if all of these products are compatible. The way that the product work together and how they are implemented in the building determine the quality.

5.1.2.2.1 Developing a vision for an t-integral quality framework in the construction industry

There has been developed a vision for a quality framework in the construction sector which has to be adjusted as much as possible on the specific quality risks connected with the technology. The Flemish government must cooperate to work out an integral quality policy together with different partners in the construction sector. There partners can be:

- FOD economy
- WTCB

- Building union Flemish Confederation Of Construction
- BCCA

Basic principles for an integral quality policy for the building sector are:

- Realisation in different phases
- Minimal administrative load
- Integration of existing systems
- Clearness towards the market
    - Minimal amount of labels and clear communication
- All relevant actors are involved
- Clear advantage for the consumer

5.1.2.2.2 Individual certification for installation companies

The guideline for renewable energy says that starting from 31 December 2012 there has to be a certification system for the installers of installation which produce renewable energy. This counts for the next installations:

- Biomass
- Solar panels
- Thermal systems on sun energy
- Geothermically systems
- Heatpumps

Trough 'Enover' a workgroup, certification for installers is to work towards a national harmonised approach for the development of certified educations. These need to correspond with the guidelines for renewable energy. This means that there will be individual certification which are based on the course and one exam. This individual certification can be integrated, and it is compatible with the quality policy on business level.

5.1.2.2.3 Quality label for energy efficiency and renewable energy on business level

Particulars, and mostly architects, can't find easily a proper contractor or installation company which is specialised in energy performance improving techniques like we want them for the nearly zero energy buildings. Placing solar panels, energy saving ventilation systems, insulation appliance,… In new buildings they more often use different of these techniques whether or not combined applied. This results in more chances, but is also demands to reach a good result, more and better cooperation with de developer, the producent and with technical experts. An individual certification, like the certification in execution of the European guidelines for renewable energy, and a quality label are complementary. The company label can impose conditions like services towards the buyer, product standards,… The individual certification can be implemented into conditions for execution competency. The criteria for the company labels can be adjusted depending on the technique. This means that when there have been STS (Special Technical Specifications) or ATG (General technical approval) published, that the condition described in there have to followed.

5.1.2.2.4 Stimulating of construction teams with energy adviser

To realise nearly zero energy buildings, there must be an optimal exchange between different techniques like insulation, ventilation, heating installations,… This asks for a perfect preparation before the execution and installation. All the work people that work on the building are involved and must align all their work. The composition of building teams needs to be stimulated for that. There has to be done a research to investigate the added value of the energy advisor in a construction team so the financial feasibility can be evaluated. One person with the right education can fulfil this role of energy advisor. It is recommended that this person is an energy reporter (new buildings) or energy expert (renovations).

5.1.3 Communication

With the current systems on the market, technologies and services it is possible to decrease the primary energy needs of buildings till energy neutral level. The knowledge about this is rather inadequate known for the different actors. Because of this prejudgement arises, wrong decisions have been made, the execution goes wrong, renovations are phased wrong,… Communication, with the goal to provide information are essential to make correct decisions. Communication and increasing knowledge provide an essential support for the integral quality policy.

5.1.3.1 The making of NZEB

For the buildings that are categorised as a nearly zero energy building a new brand was invented. This was done with the purpose to make a new brand which places NZEB in the spotlights. Through this way contractors, financial institutions, architects and engineers can use it to show what their new project is made of. This label, certification is available for the precursors which developed their building according to the regulations of nearly zero energy buildings. At the moment there is a research that investigates on how contractors specialised in a certain field can use this. Beside the contractors, installers that are specialised in the placing of these kind of systems can also make use of the brand to show to people that they have a certain level of experience with it.

5.1.3.2 Creating knowledge platforms

With the current building technologies and techniques, it is possible to create nearly zero energy buildings. Therefor it is important that the present knowledge transfers to all the construction sectors. For this it can be desirable to create a platform for all the stakeholders. The platform is there to support all the parties that collaborate in the project. Existing platforms are:

- Innovation group ‘construction’
- Innovation group ‘Green energy’
- Round table construction
- Duwobo

5.1.3.3 Sensibilisation and information campaign focussed on precursors

Landlords who fit in the profile of precursors will be informed through information campaigns about specific themes.

- Total actual costs about the economic lifespan
- NZEB renovation
- NZEB new buildings
- Collective NZEB housings
- Certification and quality guarantee
- Construction teams

These campaigns are in the first place intended for landlords who fit the profile of the precursors. It will be investigated if similar campaigns are also possible for companies, installers, architects,…

5.1.3.4 Development of demonstration projects

There have been already a few demonstration buildings built in the Flemish part of Belgium. There is a lot of interest from the specific and the public to visit one of these demonstration buildings. The low energy and passive buildings which can be visited trough the yearly visiting days receives a lot of visitors.

5.1.3.4.1 Residential demonstration buildings

In association with DUBO-partners and the private sectors different NZEB buildings can be developed where the energy saving installation have been applied. By the realisation of the demonstration projects there should be a distribution of different types of buildings:

- New buildings
- Renovations
- Social buildings
- Collective housings
- Wooden structure buildings

The remaining energy demand for the demonstration projects has to come out of renewable energy sources which are installed close to the building.

5.1.3.5 Advise for NZEB projects

Comprehensive plan advises and construction guidance as complementary task of the architect has an advantage by increasing the feasibility of the realisation of NZEB-buildings. Important is that the market developments are supported without any interruptions. Particulars with building or renovation plans can get building advise from the local authorities. The advisors screen the building projects in the field of sustainability where the energy aspect is really important. They examine the project and give advice for:

- Energy – and water performance
- Sustainable energy sources
- A healthy indoor climate
- Accessibility of the building
- …

The amount of plan advices has to be increased and needs to focus more on NZEB for new buildings. For renovation projects the intensive renovation should be stimulated more to go for the NZEB certificate. The impact is the best when the advice is given directly to the architect. This advice can be taken to the next project that he will develop, so mistakes will not be made twice. In practice, the advice plans are given to the landlords because the architects do not always have the time for this.

5.1.4 Financing

An important point of attention is that nearly zero energy buildings should remain payable. It is not easy to finance the initial extra cost for an energy efficient building. Financial stimulants and alternative financial methods who take into account the total actual costs for the economic lifespan are necessary to change from precursors to a grow and volume market. An adequate financial support can have effect on bigger scales. The amount of financial institutions with specific products for new low – or zero energy buildings in the Flemish part are at the moment limited. The maximum loan the you can get is based on the incoming and the estimated value of the building. In most cases of the financial institutions they do not look at the estimated total actual cost or to the increasing value of an energy efficient building. The energy cost is one of the main consumer costs in a building.

5.1.4.1 Shifting conditions

The eligibility conditions for the financial support measures have to shift with the requirements and the market evolution. This route should be transparent and clear. Shifting the conditions is possible through a double-track policy which is linked to the long-term path of the precursors. The concept of the general financial supports will evolve into financial bonuses for specific groups like the precursors, elder people and people who rent a house.

5.1.4.2 Linking of support to the global improvement of the energy performance

The support for energy renovation towards the NZEB label will no longer be based on individual financial support for every measure but on the global achieved improvement of the energy performance. Therefor the rating of the global improvement, based on the EPC (energy performance certificate),needs to have a bigger reliability. For intensive renovations it needs to be checked if the full E value calculation is still possible.

5.1.4.3 Third party financing for excessive energetic renovations

For most of the groups the pre financing for the realisation of an NZEB renovation is quite difficult. That is why there is the possibility for a third-party financial support. This support can finance excessive energetic renovations and has a huge potential in energy saving buildings. For this reason, it is important that it expands further. In the proposition for the energy efficiency there goes a lot of attention to improve the energy services and the access for the small and medium big companies.

A third-party financial support and the determination of the energy performance which improve the measures trough energy saving will be coordinated by energy an energy service company. This company is called ESCO.

5.1.5 Energy policy

Within the building sector there is still unclearness about the long-term path towards the nearly zero energy buildings performance level mandatory in 2019 and 2021. What, when and how the implementation needs to be done is the day of today not completely clear and causes some insecurities. Out of the building sector, the locale authorities and the different organisations there is clearly a need for the long-term path vision about the tightening and the energy performance regulations. Transparency and clearness about this create a stable environment to make new developments.

5.1.5.1 Determination and communication long term path for energy performance regulations

5.1.5.1.1 Define the entanglement path of the energy performance requirements for new buildings

If we want to map out this long-term path it must be done through different factors: building sector, architects individuals, Important elements for this are:

- Transparent time laps for the implementation
- A clear overall stimulus for the check-up for measurements
- Effective systems for auditing and monitoring

The Flemish government has approved the follow legislation on the 20th of May 2011 to tightening up the regulations according energy efficient buildings. In the beginning of 2012, the definition of the energy neutral buildings and further tightening of the regulations will be made. Conform the EPBD recast, the further tightening path till 2021 will be determined. The moment this path will be determined it is important that it has a certain level of flexibility. This ned necessary to solve any exceptions and difficulties in the construction world.

5.1.5.1.2 Defining a two-track policy with a long-term precursors path (shadow path)

In analogy to the long-term path for the mandatory energy performance demands, a trajectory can be developed focussed on the support of precursors, which can evolve to a two-track policy. Stimuli and goals can be connected to this shadow path. As example, when the E value is mandatory E60, there will be less support for the E50 level and more for the E35.

5.1.5.1.3 Mandatory minimum level of renewable energy in houses

As mentioned before there is a minimum demand for the amount of renewable energy in a building for new buildings and buildings that have been renovated intensive. The EPB calculation method calculates at the moment al the primary energy consumption and the contribution out of renewable energy sources. The energy performance legislation is because of that a perfect tool to implement a minimum amount of renewable energy sources in all new or intensive renovated buildings where there it is necessary to have an E level calculation. Both with new as existing buildings it is not always technical possible to apply several techniques. For that it is really important that the imposed minimum level for renewable energy sources can be accomplished in a flexible way. Only European countries have the minimum demands for the appliance of renewable energy already implemented into the building prescriptions on national level.

5.1.5.2 Development of on integrated calculation method

It is checked if the developments of an integrated calculation method for the energy performance of new buildings and existing building is feasible. An integrated calculation method should make it possible to compare the energy performance with uniform support measures. The 'VEA', Flemish Energy Agency built up an execution plan for the implementing of an integrated calculation method for the energy performance of buildings. This plan contains that EPC non-residential and the study of other specific destinations, should be followed up parallel and be coordinated with each other as much as possible. This is necessary to create an integrated method for non-residential an existing building.

5.1.5.3 Path for new social houses to almost energy neutral

Social building construction communities have an important social task in providing energy efficient houses. A lot of social tenants have limited financial resources. Limit their energy costs by providing energy efficient social houses. The Flemish society for social living has to achieve different policies:

- Foresee enough social houses
- Improve the energy efficient of existing buildings
- Realise energy efficient new buildings

For social new buildings there must be developed a long-term path for the intensive energy renovations of the existing buildings. For this it should be perfect to give financial support based on the optimisation of the EPC

Nearly zero energy building regulations

5.2 NZEB for Spain

The EPBD requires for all the new buildings that are built after 2021, that they must be nearly zero energy. Nearly zero energy buildings are described as buildings that have very high energy performance. The nearly zero or very low amount of energy required should be covered to a very significant extent from renewable sources, including sources produces on-site or nearby.

Spain has not yet officially putted the nearly zero energy buildings into the legislation.

As concrete numeric limits or ranges are not defined into the EPBD, the requirements leave some space for the interruption. This means that the member states can define their own nearly zero energy buildings in a flexible way. This flexibility allows the country to tune these regulations depending on their own country specific:

- Climate condition
- Primary energy factors

- Ambition level
- Calculation methods
- Building traditions

This is also the main reason why the existing definitions of nearly zero energy buildings differ significantly from country to country. Therefor it is a challenge to find a common definition to define these NZEB. The European Union sets clear a method for how nearly NZEB are defined in the context of market tracking. The NZEB radar allows combining qualitative and quantitative analysis of building standards in a specific region. These buildings radar clusters energy efficiency qualities in four different categories that have been defined at national level:

1. Net zero energy buildings
2. NZEB according to national definitions
3. Buildings with an energy performance better than the national requirements in 2012
4. Buildings constructed/renovated according to national minimum requirements 2012

In Spain there will be measures taken for the economic stimulation and financial instruments. This means that there will be a reduction on the Spanish incoming tax(VAT). It improves the opportunity for improvement works on residential housing. For these renovations works will increase in amount. As explained earlier in the chapter of EPBD, you can find the measures that Spain will take into the future to meet with the European regulations.

6 Passive and active buildings

Trying to make a more sustainable world reducing the use of energy is a very important aspect. Previous decennia people spend a lot of time and thoughts on how to achieve this goal. Techniques and methods have been adjusted who will reduce the energy use of buildings by restricting the heat losses or decreasing the need for cooling. The first step is making nearly zero energy buildings. There are 2 types of buildings who will make a big difference in achieving that goal. We call these houses passive and active houses. The difference between these two types of housing can be found in the way that they heat up the house. Passive houses will use as much as natural sun light to warm up the indoor environment. Making this possible a few factors will need to be taking in thought. Active houses will rather use as less as possible energy to warm op the house but still needs a small amount of energy. This energy will be produces by renewable energy resources.

Energy use is only one of the aspects of building in a sustainable way. If a house is passive, neutral or active does not say anything about the fact that people thought about the consequences for the environment for gaining, using or demolishing of the used materials or the way energy is produced that is used in the building. The question is if people thought about the used materials and techniques if these lead to the healthiest living environment. This is a question most people still forget.

6.1 Passive buildings

A building is called a passive building when the energy use is reduced back to a minimum of 15 KWh/m² per year. To reach this norm there are a few measures that need to be taken care of. The energy loss needs to be limited and prevented as much as possible. Beside these measures we need to mind that we keep as much as possible the energy we have without losing it. First of all, the energy that we produced cannot be lost. This means that we must insulate as much as possible. Make sure that there are is not a single place where the energy can escape through leaks such as nodes between construction elements. Unnecessary loss of energy can be prevented by integrating mass into the building. The higher the mass the more these construction parts can keep the heat or the cold and the longer they can give of this heat to the rooms. The mass will save the energy in the form of warmth which will make sure that the temperature in the building will stabilise.

The next step is to maintain the energy by using techniques. The most important system in a passive building is the ventilation system. This system will make sure that there is a constant balance between the fresh cold air that comes in the building and the warm hot air that will be extracted out of the building. The energy in the form of warm inside air will be extracted to the outside trough a heat exchanger. The cold air that comes in the building will be guided through this system as well. Because of the heat exchanger the warm air from inside will heat up the cold fresh air that comes from outside. This system is a key point and very important.

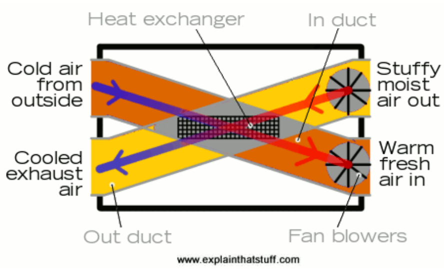


Figure 10: Principle of a heat exchanger

Passive buildings need to be orientated towards the south to make use of the sun light. Windows that are orientated towards the south give free sun during the winter period. Placing rooms which are intended to be warm rooms such as sleeping rooms and living rooms can be placed at the south side of the building. Applying this principle will decrease the use of systems to heat up the building. Rooms that do not need to be heated are rooms that produce heat will be placed at the north side.

There are six main principles that are really important to construct a passive building. These factors need to be executed with a high level of finishing and accuracy. The principles are:

- Thermal insulation
- Windows
- Ventilation heat recovery
- Thermal bridges
- Airtightness of the building
- Innovative building services
- Solar orientation and use

Figure 11: Principles passive buildings

6.1.1 Thermal insulation

In low energy buildings where there is a heating demand it is important that the entire building envelope is well insulated. This means that all the building elements which separate the inside of the house and the outside environment. By insulating we provide the building of a comfortable indoor climate which will not be affected by the weather conditions of the outside. The more we insulate the more this indoor climate can be determined to each preference.

Heat loss trough the walls and the roofs are responsible for more than 70 percent of the total heat losses in buildings. Therefor it is really important to improve the thermal insulation in a building to save energy. By insulating more, we improve the thermal comfort in the building and we prevent structural damage.

The thermal transmittance, the U value of external walls, floors and roofs of passive buildings must be lower than 0,15 W/m²K. The heat losses during the colder periods in the year are really small where the temperatures of the interior surfaces are nearly the same as the air temperatures, irrespective of the type of heating system that has been used to heat up the building. All of this leads to a very high level of comfort which participates in the prevention of building damage due to moisture build up. In warmer climates such as in Spain or during the summer months in Belgium the insulation provides protection against the heat. Sunshades for the windows and ventilation systems are also essential to ensure a maximum level of comfort during these warm periods. So, the insulation works in two ways.

In passive houses or buildings is has proved that good insulation and airtight construction parts are extremely effective. This means that we must insulate a building without any thermal bridges, so no weak spots in the insulation and heat loss.

6.1.2 Airtight construction

The indoor air has a higher humidity level than the air from outside. Buildings in a cold climate where the indoor air is cooled down and extracts out of the building, the colder air cannot keep the high amount of water in the air. The more the air cools down the more condensation will appear. In some cases, it is possible that the condensation takes place within the construction elements. This can lead to serious damage to those construction parts. This is the same for hot and humid climates where the warm air is at the outside of the building. Here the warm and humid air will infiltrate in the building and the occupied rooms are going to be cooled. Through this airflow the same moisture problems will occur.

The process here is the main reason why external building structures need to be built airtight. For the passive building standards, a really good airtightness is required. To test the airtightness of a building a test will be performed that is called 'the blower door test'. This test will be performed with an air pressure difference between inside and outside of 50 Pascale. The air loss cannot be bigger than 60 percent of the volume of the building per hour. So, we can say that n50 needs to be smaller than 0,6/hour.

The key to make a building complete airtight is done following the principle of a continuous tight building envelope. This can be illustrated using the red pencil method. It means it should be possible to trace the airtightness layer in the building envelope with a pencil without any breaks in this layer. That is why we call it continuous. In the details regarding to a project it must be clear how the airtightness is accomplished and how the airtight layers are connected with each other. Making a building airtight is primarily a planning task. It is essential that only one airtight layer is planned and implemented in the building. So, we avoid using two nearly airtight layers which will have no purpose because there is a higher chance for leakage.

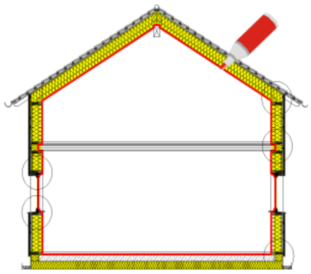


Figure 12: Airtightness layer which envelops the building

The level of airtightness can be determined by creating high and low pressure inside the building. The air pressure test as mentioned before, the blower door test will be executed. This test, or the n50 value measures the total leakage trough the building envelope. This factor describes the amount of air changes in a situation with differential air pressure of 50 Pa. This air differential pressure of 50 Pa is created between the inside and the outside of the building. The blower door that separates the inside and the outside of the building consists out of a compressor built into an opening in the envelope. This opening can be a door as example. It creates an underpressure inside the building which helps to detect any possible leaks in the airtight layer of a building. During this test a series of underpressure and overpressure measurements will be executed and will determine the leakage rate in relation with the volume of the tested room.

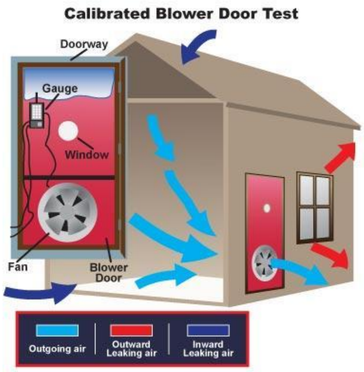


Figure 13: Illustration of the blower door test

Airtightness is an important requirement for a building who wants to be energy efficient. But it is not the most important factor of all. The most important is the amount and level of execution of thermal insulation in a building.

6.1.3 Heat recovery ventilation

For many occupants the most important aspect within a building is the health and comfort. Having an excellent air quality in the building is essential and can only be achieved if the used and polluted air is regularly replaced by fresh clear air. This does not mean that opening a window a few times during the day will be enough. Having a ventilation system in a passive house is there for indispensable. A regular exchange of the air in the winter is only possible if we can ventilate in a comfortable way. This means that we must make sure that the health and comfort of the occupants is retained. The indoor air quality (IAQ) has a higher priority than the energy consumption of using a ventilation system. This means that we must work with efficient components.

The solution of having a comfort and healthy indoor environment is to make use of a supply and exhaust air system with heat recovery. A ventilation system will only work properly is the used air is continuously being removed in places with a high pollution and humidity. These types of rooms are also called wet rooms and can be: a kitchen, bathroom, toilet,… This polluted air will be replaced by fresh, unused external air from outside which will be supplied in the dry rooms. This can be the living room are bedrooms. During the design of a building the architects need to be aware of this and construct the building in a way that there is a natural air flow through the building caused by the supply and extraction of the air.

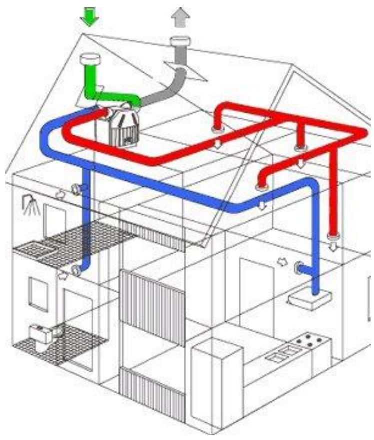


Figure 14: Ventilation system with supply and extraction of the air

The Principle behind home ventilation is that the used air (blue line) continuously is being removed from the rooms that contain the high polluted and humid air. Trough the supply pipes (red lines) fresh air is supplied to the living areas

It is important to supply the right quantities of fresh air the create the perfect health and comfort environment in the building for the occupants. Only untreated air will be supplied in the living areas and there is no recirculation of air.

Ventilation can also take place if a simple ventilation system and external air inlets are used. These external inlets provide fresh cold air into the required supply rooms with the right calculated amount. However, for passive buildings the ventilation heat losses that would be caused by the disposal of the unused extract air would be way to high. The only way to adjust the energy balance is to have a high heating output. If we want to build passive houses located in central Europe, we will use highly efficient heat recovery systems in the houses. This heat recovery system recovers the heat from the exhaust air by using a heat exchanger. This exchanger takes the heat out of the polluted air from in the building and transfers it back into the supplied cold air from outside. This is done without mixing the warm polluted air and the fresh cold air. On the market heat recovery systems can be found with a recovery rate between 75 and 95 percent. This good recovery rate is possible due to counterflow heat exchangers and special energy efficient fans (with so called EC motors with a particular high effectiveness). Because of this the recovered heat is 8 to 15 times the electricity consumed.

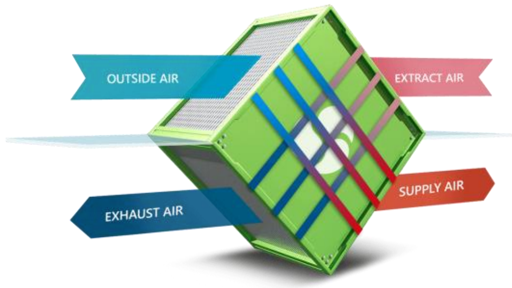


Figure 15: Heat exchanger system

A heat exchanger works as following. The extract air flows through a duct and transfers its heat to the plates. It cools down and exits as exhaust air. The unused fresh air streams in through separate ducts on the other side of the plates. It takes up the heat and is available as warm supply air. The counterflow principle makes up for almost 100 percent of the temperature difference. Saving energy by using heat recovery is not only cost effective and environmentally friendly but also healthy. Due to the heat exchanger the temperature of the supply air is raised to near room air temperature. Because of that the air that enters the room coming from the heat exchanger is not cold anymore. Together with a very good insulation level of the building and the windows, it is possible to get along with very little heating power and also reduce the effort for the installation.

Due to this principle of directed air flow, the fresh air will be optimally used. By this way it will provide high quality air in the living areas and it will extract any bad polluted air from the transferred air zones. Supply air and the exhaust air ducts allow the heat coming from the extracted warm polluted air to be recovered. The ventilation heat loss without heat recovery is between 20 and 30 KWh/m² in apartments with adequate ventilation. These numbers are very high if we compare them with all other heat flows in well insulated passive buildings. This highly efficient heat recovery system was specially developed for use in passive buildings. These devices ensure the separation of exhaust air and supply air, don't consume a lot of energy and they are very silent.

An exclusive advantage of the passive buildings is that heating, using the supply air is possible. The fresh air is supplied into the living room, bedrooms and other dry rooms where the air can also be used to provide warmth. The air that is supplied is fresh cold air and will be supplied in a limited quantity. We do this because if we supply to much fresh air the air will become very dry.

The next picture represents a thermographic view of an opened counterflow heat recovery system. The actual heat exchanger can be seen as a hexagon. It will recover more than 75 percent of the sensible heat from the extracted air.

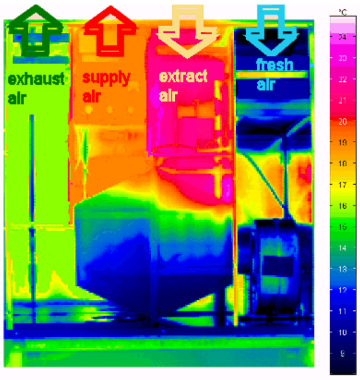


Figure 16: Counterflow heat recovery system

The highly efficient ventilation units developed for the passive buildings also proved to be effective in modernisations of existing buildings. Here they will contribute to the improvement of the air quality and ensure that mould growth does not occur at weak points in external building components. In hot climates such as in Spain, air to air counterflow heat exchangers can also help to recover cool temperatures from the exhaust air and to reduce the temperature of the supplied air in times when the fresh air is uncomfortably hot. To do this we need low energy fans in order to reduce heat loads caused by the ventilators.

6.1.4 High insulating windows

The windows in a passive house play an excellent role in two ways. Firstly, the heat loss can be reduced despite the large glass areas and secondly the windows open up possibilities for heat gain trough solar irradiation. Highly thermally insulating windows fulfil this double role.

The passive house windows are not really a type of window. The term passive house windows relate to the thermal characteristics of the windows. These kind of windows with passive house standards features a particularly high thermal insulation value. The heat transfer coefficient Ug must comply with the European standards and be less than or equal to 0,8 W/m²K. Every window with a heat transfer coefficient less than or equal to 0,8 W/m²K is there for a passive house window and suitable for installation in passive houses.


Figure 17: Triple glazing with metal frame (passive house window)

Windows that are made with this heat transfer coefficient are almost always triple glazed windows with a thermal improved frame to meet with the high requirements of the thermal insulation for windows. In detail, the passive house windows offer you the following advantages:

- Highly thermally insulating glazing
- Highly thermally insulating frame
- Thermally optimised edge compound
- Professional, thermally optimised installation

The positioning and the orientation of passive house windows needs to be carefully planned to guarantee the necessary solar gains. The windows have the task in the winter to let more solar energy into the building to heat up the rooms. Larger glazing areas should ideally be positioned towards the south. As the sun stands higher in the sky in the summer, less sunlight will reach the interior of the building and the majority of it is reflected. Therefore, solar irradiation on south facing windows is reduced in the summer and normally no extra sun protection is necessary. East or west orientated windows because of the low position of early morning and late evening sun in the summer can easier lead to overheating and possibly requires relevant sun protection. We can estimate that an east or west facing window receives 60 percent and a north facing window 40 percent of the usable solar irradiation to that of a south facing window. Passive houses should keep to a maximum deviation from south facing by 10°.

6.2 Active buildings

Active building sounds better then passive building because the building itself produces energy. The point of building in an active way is that besides the positive energy balance the active building also a healthy environment is for the users and it needs to have a minimal impact on the climate. An active building uses its energy in a very efficient way and all the energy that it uses has been produced in a responsible manner which derived from renewable sources. It offers a healthy and comfortable living and work environment where light and fresh air is more than present. An active building has a positive effect on the climate: both on the direct environment as on the long term. These buildings are made of ecological or bio-based materials. The energy sources and the building materials which will be used are renewable and don’t have harmful consequences. Building in an active way offers a complete response on the current climatic and ecologic developments for energy use, living environment and climate. Limiting the energy use is essential in the development towards a more sustainable economy and that is way building passive or neutral advantageous developments.

This type of buildings provides their own energy. These buildings are also known as zero energy buildings and they consume as much energy as they produce per year. This principle is also based on the Trias energetica.

Buildings are changing as concepts of sustainability are easier to attain and easier to monitor today. New buildings are designed to meet the current regulations however they become more and more strict and necessary over time. These higher standards of comfort are more challenging to execute and to obtain. Building a house is a way of static building. This means that we build a house, but it can’t change are be adapted in an easy way. We speak of a dynamic building if we can adapt the building systems which evolves over time. In this chapter we will speak about parts that have impact on a building so we can meet up with the standards according to the regulatory for active buildings.

A building designed to meet the regulations is not monitored continuously over time to improve or assess the quality of performance over time. With an active house, the ability to track the performance becomes easier. This improves the ability to provide long term analysis which forms the basis of the study. An integrated approach will take the principles to build on regulations and will put together the requirements with customised data.

The active house is a vision for creating sustainable buildings all over the world. This vision wants to create healthier spaces and more occupant comfort without any negatively impact on the climate. It defines highly ambitious goals to unite the design and energy efficiency of buildings to ensure a positive contribution to human health and wellbeing. This type of housing, active houses are evaluated at the intersection of interaction between energy consumption, indoor climate conditions and the impact on the environment. There are 3 concepts where an active house deal with.

1. Comfort
   Creates a healthier and more comfortable indoor conditions for the occupants
2. Energy
   The houses are energy efficient
3. Environment
   It interacts positively with the environment through an optimized relationship with the local environment.

These categories can be further categorised by the next parameters which a building performance can be designed.

Table 27: Categorisation building performance

Comfort	Energy	Environment
Daylight	Energy demand	Environmental load
Thermal comfort	Energy supply	Freshwater consumption
Indoor air quality	Primary energy performance	Environment loads
Noise and acoustics	Energy validation on site	

The parameters defined under these categories represent the performance of the space under that categories. The ability to measure the parameters enables the principles to be dynamic and change over time. Some of the parameters above do not lend themselves to sensing while other do without any loss in accuracy. Both, energy and comfort as categories are easy to measure during the lifetime of the building. Within the category of environment, only freshwater consumption is an easy parameter to measure.

6.2.1 Thermal environment

Having a pleasant thermal environment is essential for a comfortable space with adequate comfort across seasons. The aim of a pleasant thermal environment is to minimise overheating in the summer periods and optimise indoor temperatures in winter without unnecessary energy use. In spaces with air conditioning, the maximum and the minimum operative temperatures are provided it in the table below. The performances above represent the zones, 1 being the highest performance and 4 being the lowest performance. Ideally, most spaces are built using a dynamic thermal insulation tool to determine the hourly indoor operative temperatures at room level. when there is no mechanical ventilation system, the maximum temperatures are linked to the outside weather. It is also really important to maintain these temperature zones for a minimum of 95 percent of the occupancy time. Note that it is important that the minimum and the maximum operative temperatures, regardless of the performance zone must be maintain for minimum of 95 percent of the time the space is occupied.

Table 28: Operative temperatures regarding to its performance zone

Minimum operative temperatures (°C)	Maximum operative temperatures (°C)	Performance zone
20	25,5	1
20	26	2
19	27	3
18	28	4

6.2.2 Indoor air quality

Having a good indoor quality is quite simply dependant on fresh air supply. This can be evaluated by examining the carbon dioxide concentrations in the rooms. During occupancy, the CO_2 levels continuously increase but with fresh air supply the indoor levels should decrease to the ambient levels of CO_2 outdoors. The different level of CO_2 concentrations for different performance zones are defined by this relative level compared to the mean outdoor concentrations. The indoor air quality is an important criterion for the health, allergies and diseases.

Table 29: Maximum level of co_2 regarding to its performance zone

Carbon dioxide levels	Performance zone
500	1
750	2
1000	3
1200	4

The requirements of validity are the same as the thermal environment case with the values being recorded for at least 95 percent of the time the space is occupied. Additionally, the classification is based as a time weighted hourly average instead of a onetime value case.

In an active house there is a need to a fresh air supply and this without a big energy use. That's why it is important to have to choose for a natural ventilation throughout the building. Only the opening of windows will not be enough and can't be done during the whole year. That is why will make the choice to choose for a hybrid system. This means we will install a system which is a combination between a natural and a mechanical system. These kinds of systems provide the best energy performance for ventilation. The next figure shows 4 different ventilation systems, mechanical and natural.

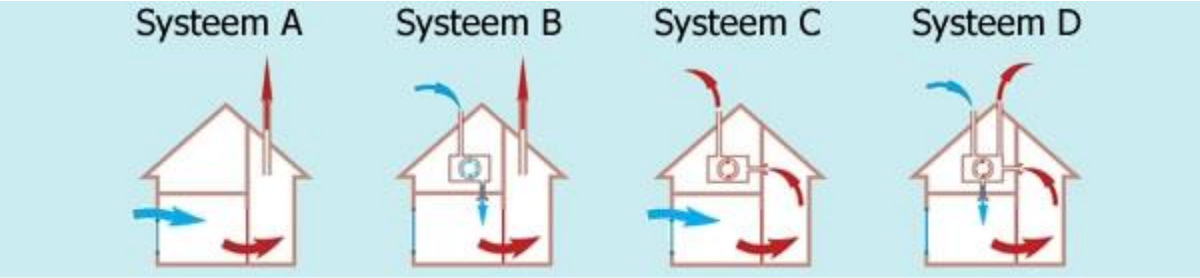


Figure 18:Different ventilation systems

System A: This is a complete natural system with a natural supply and extraction of the air. This means that we don't have any mechanical installation parts who cooperate in the ventilation trough the building. Opening doors and windows will provide the building of fresh air.

System B: Instead of having a natural supply the fresh air will be provided with a mechanical system. The extraction of the warm polluted air is still done in a natural way. The mechanical supply of the fresh air will take place in the dry rooms such as: bedrooms, living rooms,…

System C: This system is the opposite of the previous one. Here the air will be supplied in a natural way and will be extracted with a mechanical system. The difference here is that the natural supply will be done with ventilation raster in the frame of the windows. These raster's will be chosen depending on the volume of the room.

System D: This system is the best system to reach the regulations and the norms. It has a mechanical supply and a mechanical extraction of the air in the building.

Another important aspect that fall under the terms of the indoor air quality is the humidity of the air inside the house. Having a to high humidity is not comfortable and will not comply with the health requirements. Lowering the humidity level in the house will also prevent dampness and mould damage to the structure. Preventing this will extend the lifespan of the building. That's why it is important that there is enough extraction in rooms where the humidity can be higher during a specific time. The rooms where we will need to have extraction of high humid air are kitchens, bathrooms, toilets,… The minimum extraction of the air should be calculated in advance and depending on these calculations the right installation and tubes will be installed. It is important that the humidity level stays below 80 percent.

6.2.3 Energy

The combination of sustainable building technologies along with dynamic data collection provides the active houses the capability to realise energy efficiency. An active house is energy efficient and supplied with renewable energy sources integrated in a building or from the nearby collective energy systems and electricity grid. The overall plan for the active houses is to be optimise the use as little energy as possible and to utilise renewable energy sources. The focus for an active house is to:

- Reduce the energy demand
- Use sustainable energy sources
- Use fossil fuels efficiently

These guidelines describe the Trias energetica.

The energy used for heating, cooling and electricity in buildings are responsible for 40 percent of all global energy consumption. This makes energy an important topic for the active houses. the active houses design is based on the Trias Energetica as described earlier.

The energy demand in active houses is based on a yearly basis. This is important and needs to be taken in account because we have periods with less and periods with more energy demand. The main goal is to minimize the energy demand of a building and this can be achieved by reducing the use of the energy and reducing the total heat and cooling loss from a building. This part also includes transmission loos trough construction elements and thermal bridges. Active houses should use innovative solutions that are not energy intensive. This can be done due to the use of solar winnings, natural lighting and natural cooling for example. The techniques described above are also important regarding the need for cooling of the building. That is why shading is also an important factor to prevent overheating in the building. One of the possibilities is permanent summer shading or dynamic shading which can be controlled by sensors.

The goal is that all energy supplied into an active house should be based on renewable energy and by CO_2 neutral sources. Therefor are no special requirements for how and where the renewable energy has been produced. The production or installation can be placed on the building itself, somewhere on the plot near the building or it can come from a nearby system. The only requirement is that it must be documented that the produced energy comes from renewable energy sources.

6.2.4 Environment

The aim of an active house is to limit the environmental loads during the whole life cycle of the building. The process of constructing and renovating buildings causes various emissions to the air, water and soil. These emissions all have different impacts on the environment and are handled as different categories:

- Primary Energy (PE)
- Global Warming Potential (GWP)
- Ozone Depletion Potential (ODP)
- Photochemical Ozone Creation Potential (POCP)
- Acidification Potential (AP)
- Eutrophication (EP)

The environment is also an important factor while constructing an active house. Any harm done to the environment, soil, water and air needs to me minimised. When constructing the house there should be an LCA (Life Cycle Analise). Making this analyse it is clear and possible to know which kind of impact a material has on the environment. An active house sets requirements to evaluate six environmental loads as described earlier.

6.2.5 Fresh water consumption

The water consumption and water treatment are also an important factor that is included in the active house specifications. The consumption of freshwater can be reduced by installing water saving tanks which will store the water. This water can be used as grey water which will provide the toilets and the garden with water.

7 Software Programs

Calculating the energy efficiency of a building will be done using a programme/software. These programs will make it possible to make a calculation for all the aspects that are important and at the end it will show you the information that you need. Before that the program can calculate all the data that is necessary to apply for a building construction license you have to give in manually all the data of the house. This is all the data from the installations that are being used to heat up or cool down a room, ventilation installations, volumes of rooms, floor surfaces and so much more. After the input of all the data necessary for the calculation, a report can be made of the project. This report will show all the important information. The same house is also made in the Spanish software and the report can be found in the annexes.

The Belgian software is created in a way that we can give in the construction points like they are builded. It means that we can give in all the layers with there specific thickness and material that you can find back in the database that is included in the software. Before you can start with putting in all the data of the house construction wise, you need to know how everything is built. For that some examples of the Belgian construction systems will be shown underneath.

7.1 Construction points

7.1.1 Foundation – wall – floor

This is a detail of the connection between the insulated floor, the wall composition and the foundation. In this detail the inner brick wall is made of a double layer of bricks. This way of building is an old way and we do not built like this anymore. The detail represents a renovation of an old wall where we still use the inner brick wall to carry the concrete floor of the first floor.

Against the inner brick wall we place the necessary insulation. In this case there has been used 16 cm of Phenolic foam. We anchor these plates into the inner brick wall which are made of metal of PVC. After the insulation plates we place an air cavity and then we build up the façade. The inside is finished with plaster and placed with a thickness of 1,5 cm.

The floor composition is made out of the concrete floor slab which is supported by the foundation feet with a thickness of 20 cm. This concrete floor slab is reinforced. On top of this concrete slab we place a filler layer where we hide pipes and on top of that we place a PE-foil. In the renovation project there has been used a special insulation type. The insulation panels are from Kingspan and are called vacuum plates. These plates have a very good heat transfer coefficient that you can’t find in normal insulation plates. The only think about these panels is that they cost a lot of money and that you need to be very careful in the installation of them but they save a lot of space because they are really thin to have this U value. On top of them we place another PE-foil an another layer of light concrete to hide mare pipes in.

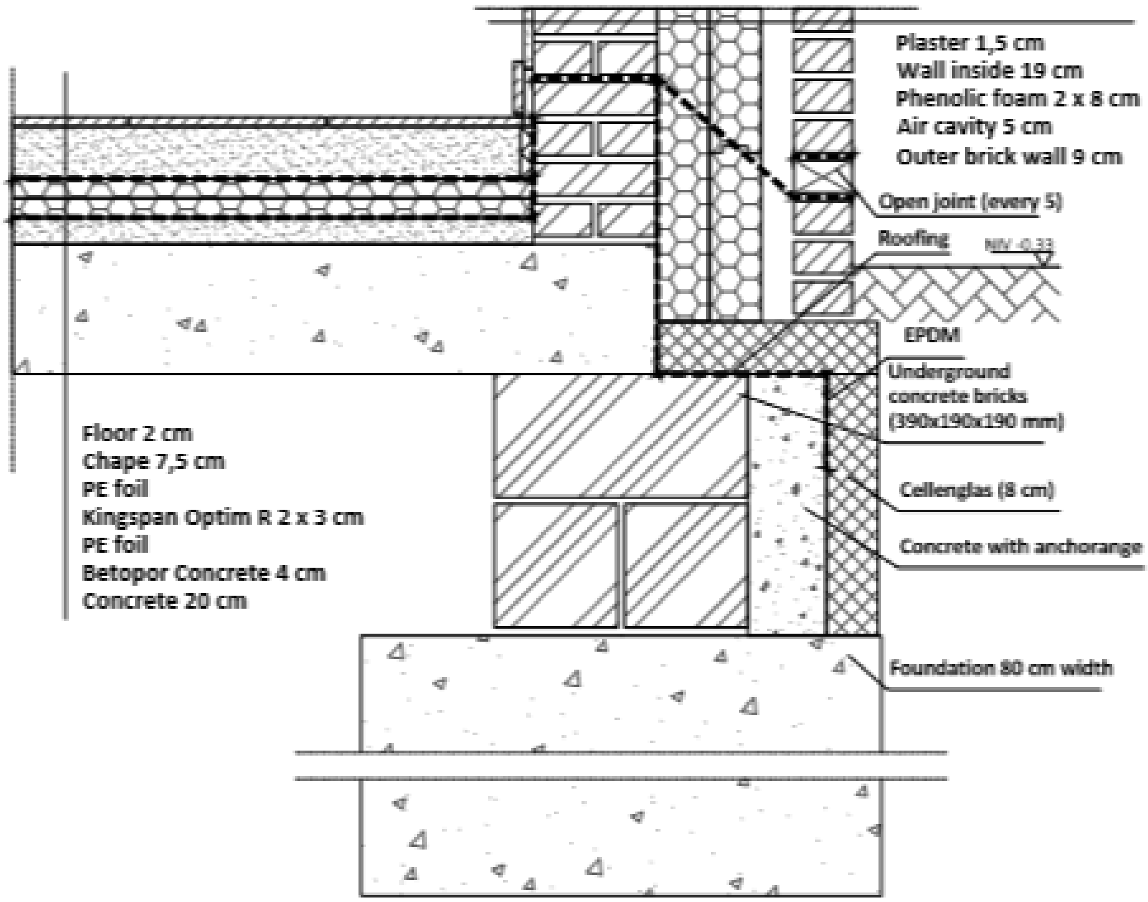


Figure 19: Detail of a foundation, wall and floor connection

7.1.2 Mid floor and wall connection

In the detail the mid floor is not build as a massive reinforced concrete slab. A special system has been used instead. This is a known system that we use a lot in renovation projects. The floor is not that heavy as a full concrete floor slab and is partially prefab. The bottom part is delivered on site with the triangle reinforcement. You place these parts next to each other on the inner brick walls and then a reinforcement net is placed on top. After placing the formwork at the sides the concrete can be poured. On top of this concrete floor system we place the acoustic insulation and a light concrete to hide pipes. The build up of the wall is similar as in the previous detail.

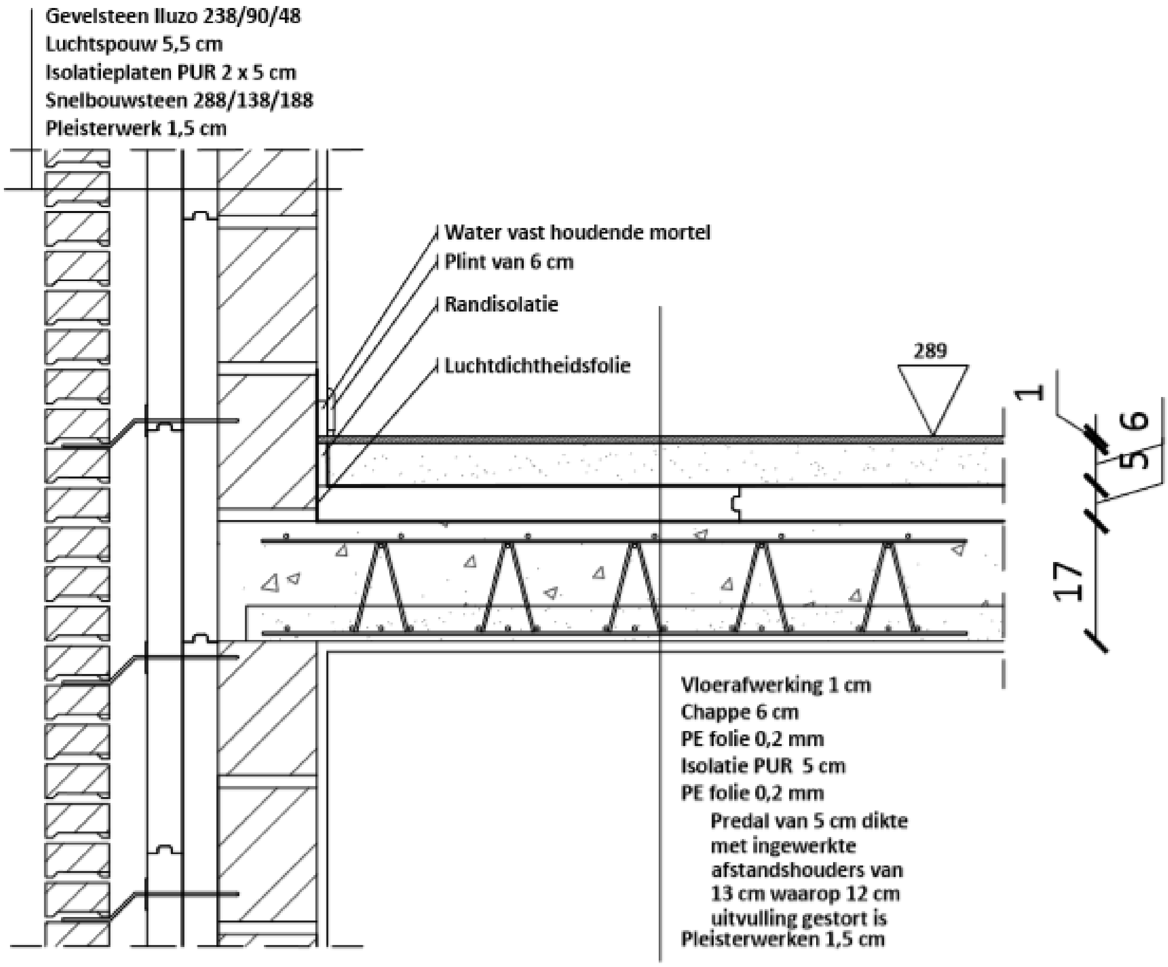


Figure 20: Detail of a floor construction system

7.1.3 ETICS

Modern houses in Belgium are more and more built with etics. This finishing layer has a modern look and more and more construction companies are specialised in it. Etics stands for, External Thermal Insulation Composite System. The layer is built out of several layers that make these mechanical characteristics of etics. The composition is as follow:

- Glue or mortar
- Insulation material
- Mechanical anchor system
- Reinforcement layer
- Intermediate layer (possibly)
- Finishing layer
- Painting (possibly)

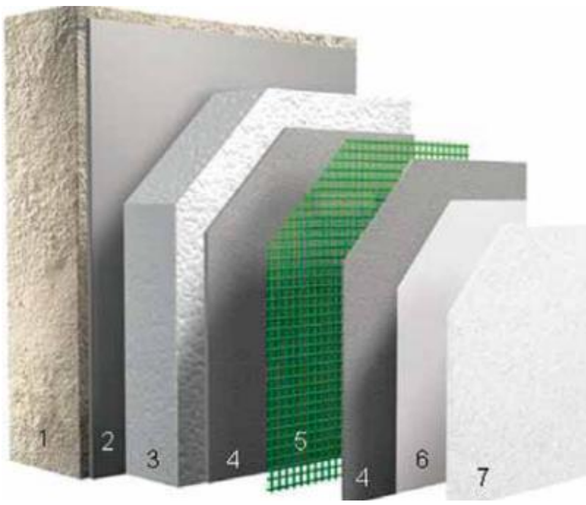


Figure 21: Composition of etics

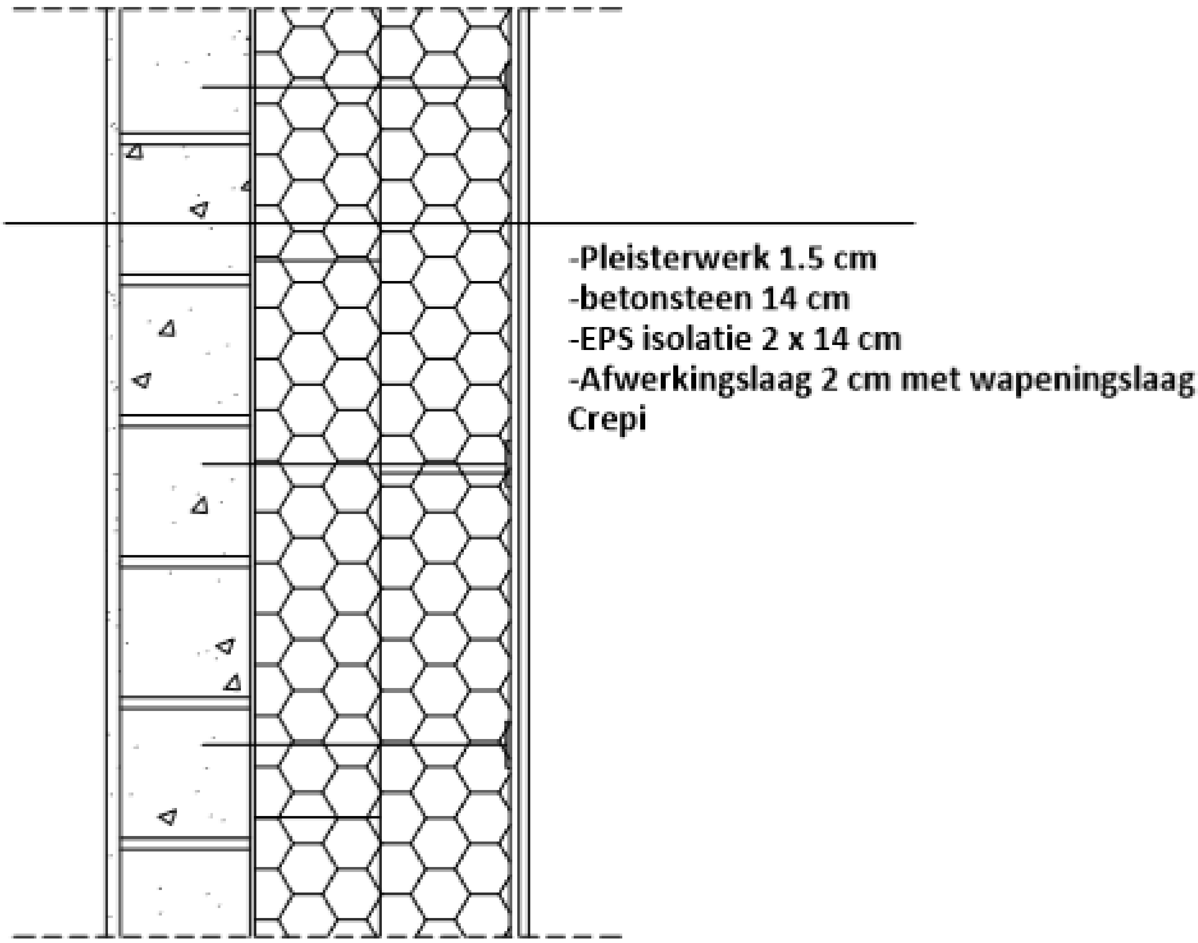
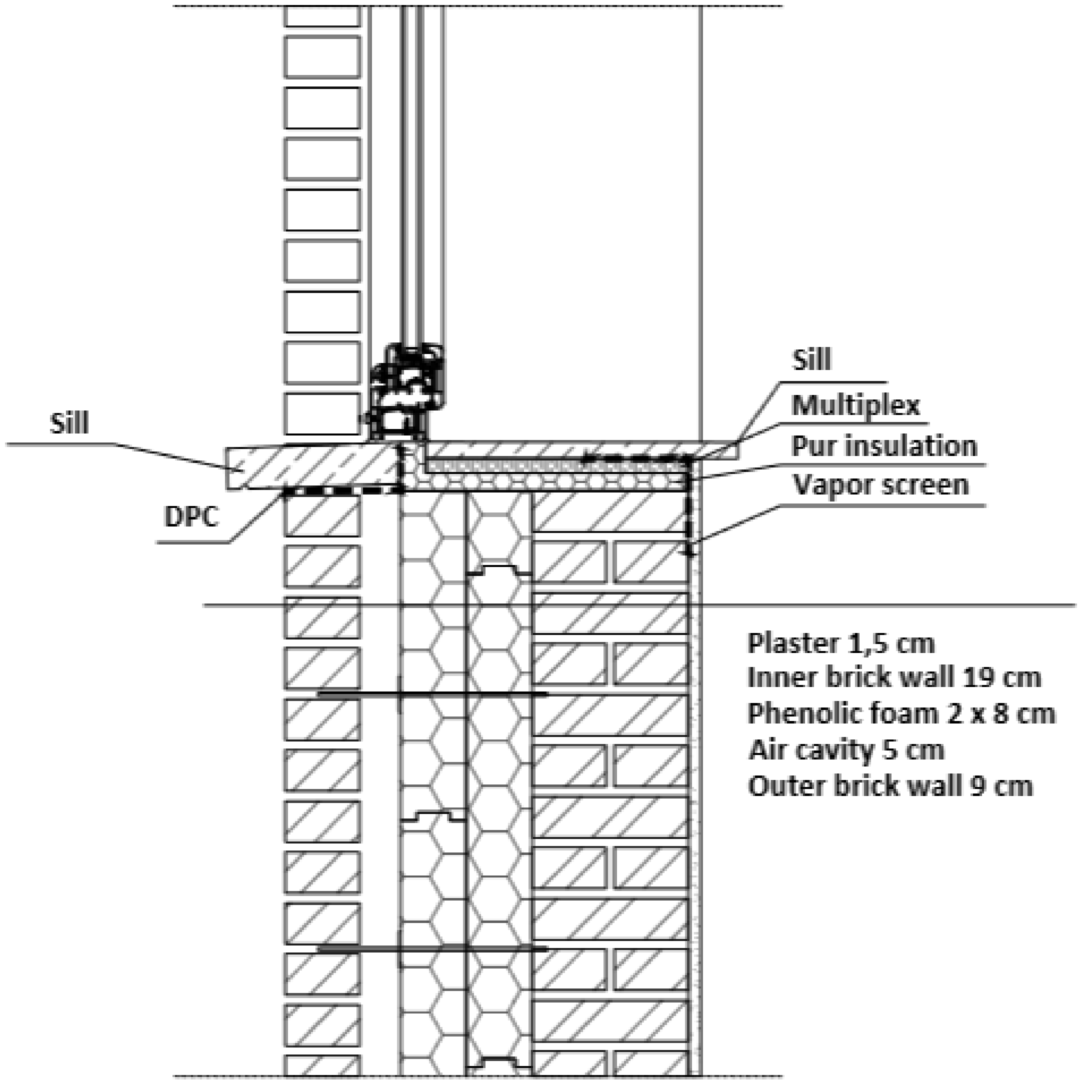


Figure 22: Detail of an etics wall

7.1.4 Detail of a window

Because of the bigger thickness of the walls caused by the amount of insulation the placement of the window is slightly different. We place the sill in the façade and place a waterproofing sheet, the DPC underneath. The sill are made out of aluminium, PVC or mineral stone.



7.2 Belgium – 3G software

As explained before Belgium is divided into three different part. In each part there are slightly different requirements to meet with the EPB regulation. This also means that we must choose before we start with the input of the data of all the installations of the house in which region the house is located. The name of this software that calculates the energy performance of the building is called '3G software'. The three stands for the three different regions in Belgium which each has his own regulations for the energy performance of buildings as explained before. This software is free and can be downloaded by everyone. Before starting with the input of all the data you must choose in which region the building is located. The moment you start up the program, you will have to decide in which region it is located and which kind of project it is. So, you choose the nature of the project. This can be a new building, renovation or an intensive renovation. It is really important that you choose this right because this cannot be changed afterwards.

Everything starts with the design and the development of the building by the architect. When the first scratch is finished of the building, all the information will be put into the program. This can be done by an EPB reporter. In some cases, this can also be the architect, only possible if he has the license for it or not. At first there will be made a start declaration of the building which will give an estimation of the energy performance of the building. This is not definitive and can still be changed afterwards. Throughout the building development, the EPB reporter or architect needs to control and watch the building process to see if there is any room for improvements are if changes must be made. If there are changes during the building process these changes will also have to adapted in the software. These changes can be construction points or thermal bridges that have been executed in a different way which have influence on the final mark of the energy performance of the building. When the building is completely executed the EPB responsible will have to make a final report/declaration of the building how it has been executed. When all the data has been implemented in the software a final report can be made automatically. This report needs to be sent to the energy performance database. Keep In mind that this report needs to be finished within the first six months after the inauguration of the building. This report is really important because it shows if the building does or does not comply with the regulations that are effective at that time. If a building contains parts that do not comply with the regulations at that time, the report will show this. In case there are parts that are not following the EPB regulations there will be a fine for that part. The amount or the size of the fine depends on how match the difference is between the value that you have and the value that needs to be obtained for that part. This fine will be charged to the owner of the building.

In this chapter I will explain how the software works and how it is been built up. This will be done with an example of a small house located in the Flemish part of Belgium.

7.2.1 Main screen

After choosing the nature of the project and the region where the building will be made, we receive this screen. It shows us a lot of information about several aspects.

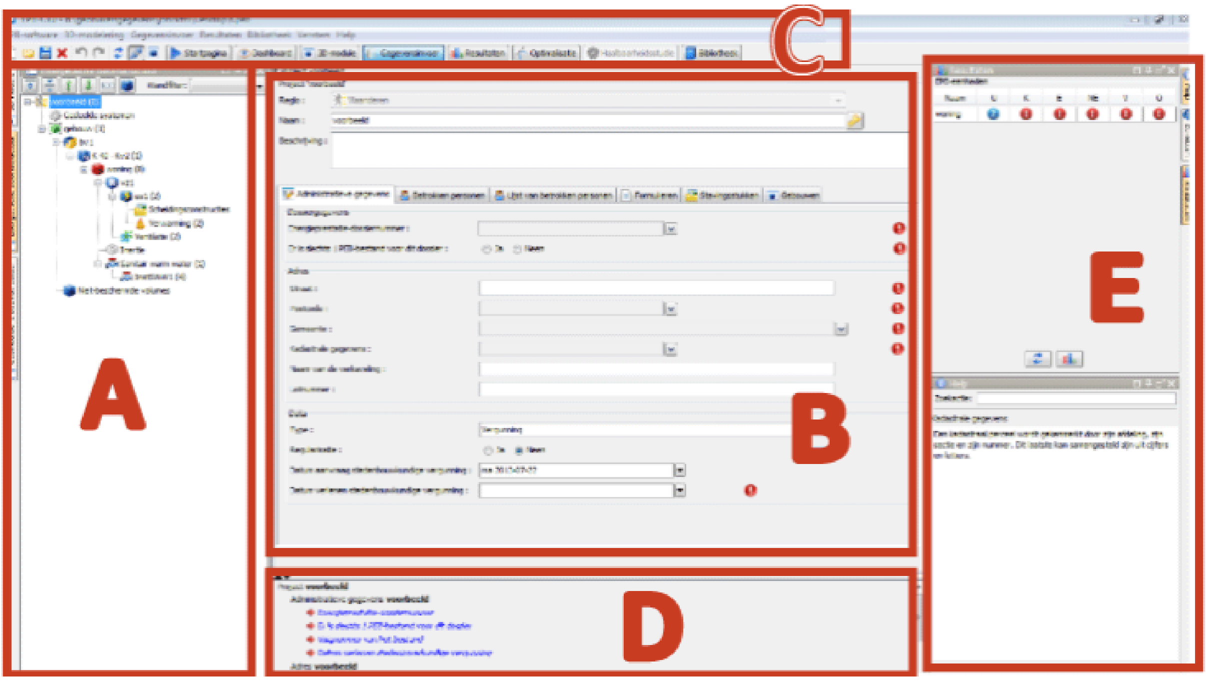


Figure 23: Main screen of the 3G software

Part A: On the left side of the main screen we find the energetic structure of the project. When we want to give in the data of the building you click on the right part where the data should be put in. In here we give in:

- General information
- Heating systems
- Renewable energy installations
- Ventilation system
- Information about sanitary installations
- Data for the ventilation system regarding the floor surface which calculates the debits
- …

Part B: Depending on the chapter that you selected in the energetic structure of the building the screen will show you what you will have to do. In here we put in all the data that is required.

Part C: The top of the program shows all the different menus where you can work in or gives you the information that you need. These menus are:

- Start: Here you can go back to the start-up screen.
- Dashboard: It shows If there is information missing in one of the chapters.
- Information input: This is the screen where we give in all the data.
- Results: All the information that you need can be found here with the necessary calculations the program did. It only shows the results of the chapter that you have selected.
- 3D-module: It is possible to give in a project through the 3D-module but it is recommended to not work like this because the module still contains some mistakes.

Part D: When you are in a specific chapter it will show on the bottom of the screen if there are some elements missing or if the input of the data is wrong. If everything has been inserted in the right way there will be no notes.

Part E: In this field on the right side of the screen there is a help function and the results can be se shown. You have the possibility to hide this screen if you want to or u can move them wherever you like.

In a building there are many ways how the heat can transfer through the construction elements to the outside environment. That is way we must make sure that every construction element has enough thermal resistance to keep in or to keep out the heat. The roof is the most important one because it is responsible for 35 percent of the heat loss in a building. Windows and doors are respectively responsible for 10 and 15 percent of the heat loss. The walls are the second most important part of the structure because it has the biggest surface of all. At last we must heat loss that goes to the ground trough the floor slab, it is responsible for 15 percent of the heat loss.

Figure 24: Heat loss in a building

7.2.2 Walls

The built up of the walls needs to be given in really detailed. Every layer with the right dimension and the right compositions. We start with the brick wall where we must give in the type of bricks found in the data base and the type of mortar that has been used. The type of mortar will also have a small influence on the heat transfer coefficient of the wall. Even if there is an air cavity in between the outer brick wall and the insulation you will have to put it in. In cases where there is an air cavity it is possible that the outer brick wall will not help to get a better heat transfer coefficient. The software will make you aware of this, but you still keep in mind that it is important to give in the complete composition of the construction elements. When every part of the composition has been inserted in the software it will make a temperature curve on the right side of the screen. This curve will show you where the biggest thermal losses will be. On top of the screen you give in the total surface of the wall. Every wall with the same composition can be summed up. If a wall has a slightly different composition, you will have to make a now built up and calculate how big the surface is of this type of wall. When you calculate the surface of the wall it is important that you distract all the surfaces of the windows. We do this because we only want to calculate the heat loss trough this type of structure. We will give in every window separately with all its specific dimensions. The software provides us with a list of all the materials that are on the market. All these materials can be chosen out of the EPBD database or out of the local library database. If there is a material not in the list, it is possible to create a 'new material'. In this case you give in all the data that is requested to calculate the heat transfer coefficient of that specific material. The local database only contains general materials such as wood, plaster, bricks, metal, natural stones,… In this project it is not necessary to put in the inner walls because all of the units belong to the same protected volume. We don't have to do this because if there is any heat loss trough an inner wall the heat will go to another room of this protected volume and it will not change anything to the energy performance of a building.

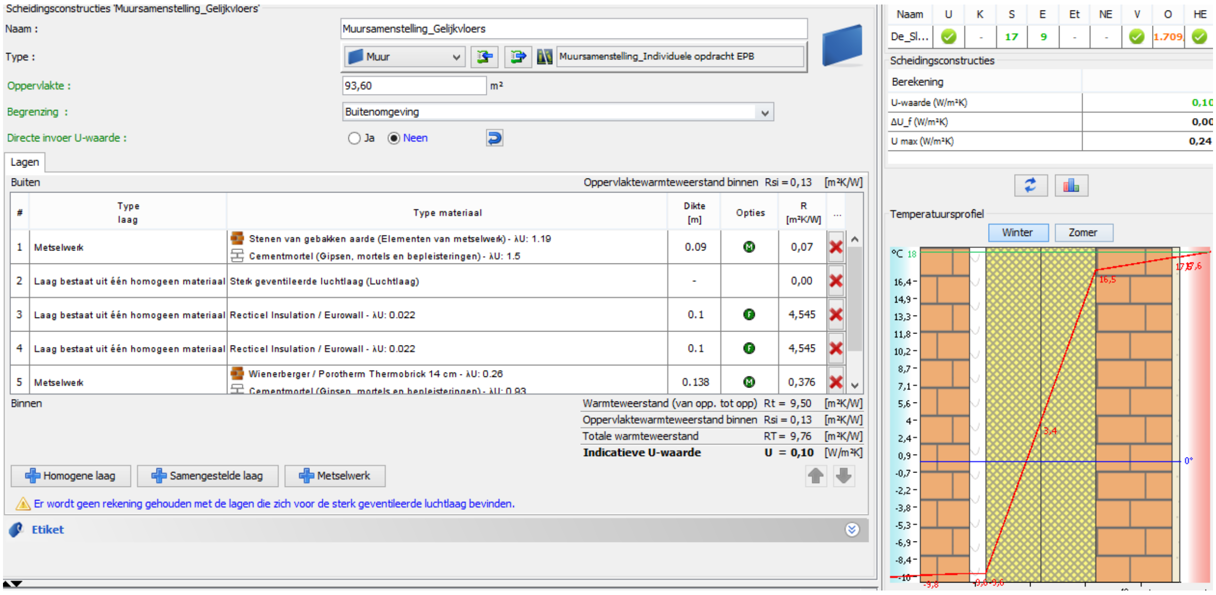


Figure 25: Composition of the wall structure

7.2.3 Floors

When we want to put in a floor composition it is important that we give in every layer that is there. This means that we give on every layer such as the concrete slab, the insulation and if possible, the floor finishing level as well. The software does not just calculate the U value immediately but will first calculate R_t, R_{si} and R_T. Before we give in the composition of the floor we will put in the total surface of the floor and to which room or space it adjacent to. A room can adjacent to:

- Outdoor area
- Adjacent heated or unheated areas
- A space that belongs to another EPB unit
- A space in the same EPB unit
- Ground
- Basement
- Crawlspace

We have the opportunity to also just give in the U value of the structure, but it is recommended to insert every building structure in a detailed way. For every layer you give in the thickness and you select the right material from the database. For the insulation layers you also give in the information when plugs have been used to attach the different layers of the insulation with each other.

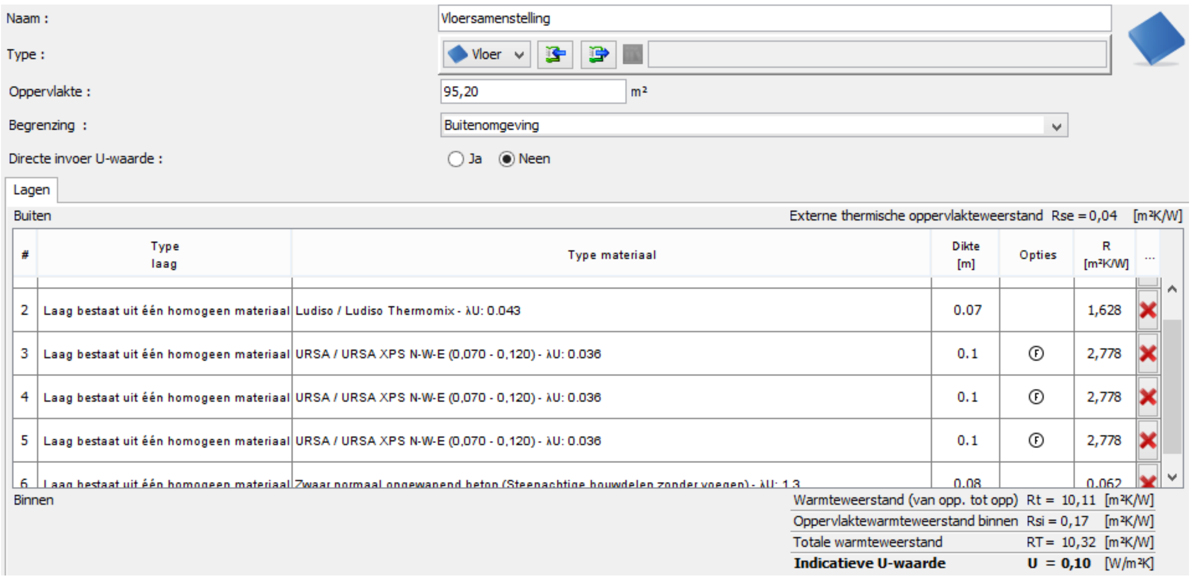


Figure 26: Composition of the floor

7.2.4 Roofs

The roof structure is one of the most important parts of the building as explained before. There are a few important factors which have influence on the heat loss of the roof structure. It speaks for itself that the total surface of the roof will play a part in this. Beside this the pitch of the roof will be a factor. There is a big difference between a flat roof and a pitched roof. After inserting the amount of the surface of the roof you must choose which kind of roof it is. We have to possibility to choose a roof with an angle between 0-60 degrees or a roof with an angle between 60-90 degrees.

In Belgium the roofs are made of a wooden structure. There is no concrete in the roofs like roofs are being made in Spain. The composition of the roof will be inserted completely. This means that we will give in all the layers, also just thin wooden boards and the air cavity. The layer with the wooden beams which make the pitch of the roof and the insulation in between will be given in perfectly like it has been executed. We will calculate how big the part of the insulation is and how big the part of the beams is. Through this way we calculate all the fractions which we will give in into the software. When everything is been inserted in the program the total U value will be calculated.

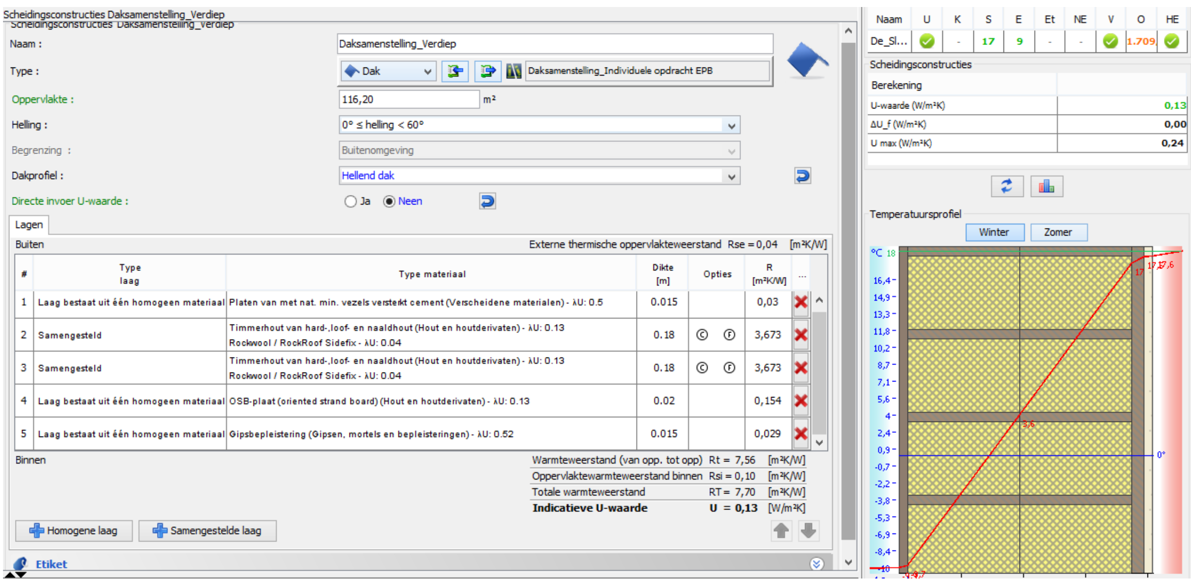


Figure 27: Composition of the roof structure

7.2.5 Windows

As mentioned before, the surfaces of the windows will be distracted from the surface of the wall. This is because we must insert every window separately with its own specific dimensions. The input of a window is most likely the most difficult aspect together with doors to give in right into the software. There are a lot of important factors that you need to calculate yourself and give in into the software. Information that needs to be given for the windows are the surface (the glass and the frame), the pitch, the orientation and the type of window. This shows that a window has influence on the overheating and solar winnings of a building. The overheating is an important factor that also is taken into account for the energy performance of a building. This value can be improved by placing blinders but then there is the problem that you have a thermal bridge at that point. You look up the U and the G factor of the windows in the technical files of the manufacturer and insert them into the software. It is important that this technical file that indicates which the values of the U and the G factor are is added as an annex in the program. It's like a piece of evidence that needs be given as proof. Otherwise the values are not valid. Beside the characteristics of the glass, the information of the frame also needs to be given. This will also make a big difference for the heat transfer coefficient of the window.

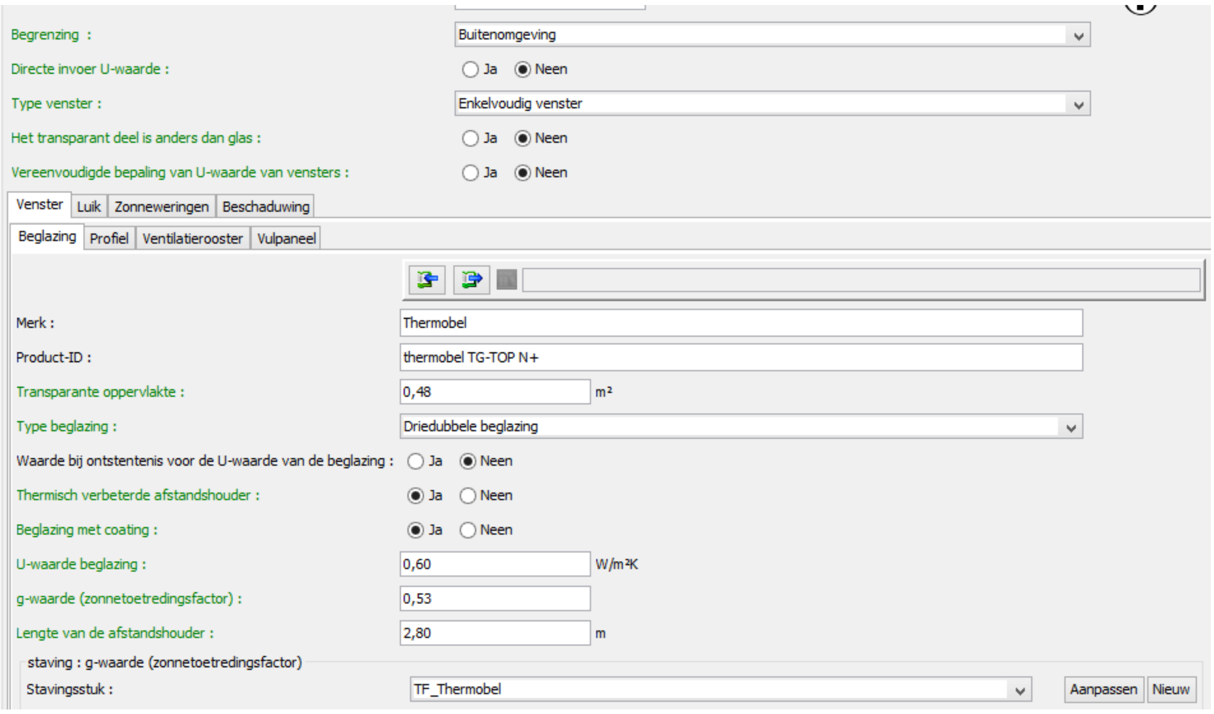


Figure 28: Input of a window in the 3G software

7.2.6 Doors

Doors are also an element that have be given in into the software. These are a different kind of element than the windows. Here it is easier to just give in the U value that is given by the manufacturer. Also, for this the technical file that proves this value needs to be uploaded into the software, otherwise the information is not valid, and you will be fined for not given the document that supports this data.

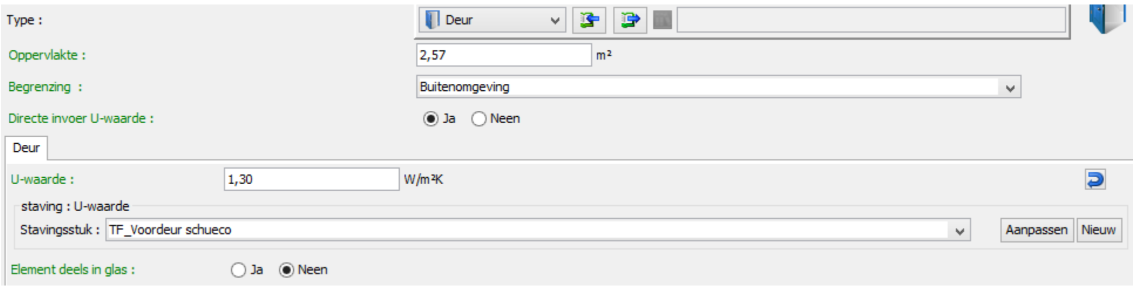


Figure 29: Input of a door in the 3G software

7.2.7 Ventilation

Another important aspect in the developing of a building is the ventilation system. We already have explained the different ventilation systems that are available on the market. Only the systems C and D will allow you to fulfil on the high energy performance demands of a building. After choosing the type of ventilation system that you want to use in the building, we divide all the rooms into three different classes. We have dry rooms where the ventilation system will supply the fresh air, wet rooms where the ventilation system will extract the humid and polluted air and as last, we have rooms that pass the air from dry rooms to the wet rooms such as hallways.

The amount that needs to be supplied or be extracted can be calculated easily. There are minimum and maximum debits for every type of room. The next table will show how everything is calculated. At the end of the calculations it is important that the amount of supplied and extracted air is approximately the same when you have a D ventilation system, also known as balance system.

Table 30:Classification of the rooms

Dry rooms	Transit rooms	Wet rooms
Living room	Entrance	Bathroom
Bedroom	Night hall	Toilet
Study room		Kitchen

Table 31: Calculation of the ventilation debits for every type of room

Room		Nominal debit: General rule	Nominal debit: Minimal debit	Debit limited to	Minimal section under the door
Supply	Living room	3,6 m^3/h	75 m^3/h	150 m^3/h	
	Bedroom Study room Playroom		25 m^3/h	72 m^3/h	
Transit Extracted out of the room	Living room Bedroom Study room Playroom		25 m^3/h		70 cm^2
Transit Supply to the room	Kitchen		50 m^3/h		140 cm^2
	Bathroom Laundry room Toilet		25 m^3/h		70 cm^2
Extraction	Kitchen Bathroom Laundry room	3,6 m^3/h	50 m^3/h	75 m^3/h	
	Open kitchen		75 m^3/h		
	Toilet	25 m^3/h			

7.2.8 Heating and sanitary warm water

The heating system that has been installed in this building is a condensation gas boiler. The installation will provide the building of warm sanitary water and it will heat up the building trough radiation panels. When you want to insert all the information of the installation you have to make sure that the technical file of the manufacturer is uploaded as an annex to prove this data. The technical file will help you give in the information of the system right. If not all the data can be found on the sheet of the manufacturer the information can be looked up on the website of the installation. Some installation can also be found in the database of the software, so you don't have to fill in everything manually. After choosing which type of heating system that you will install in the building you have to choose the right fuel for the particular system. The power and the efficiency of the installation will be required to give in next. One of the information that needs to be given is that the installation has any storage room for warm water or not.

Figure 30:Sanitary hot water data

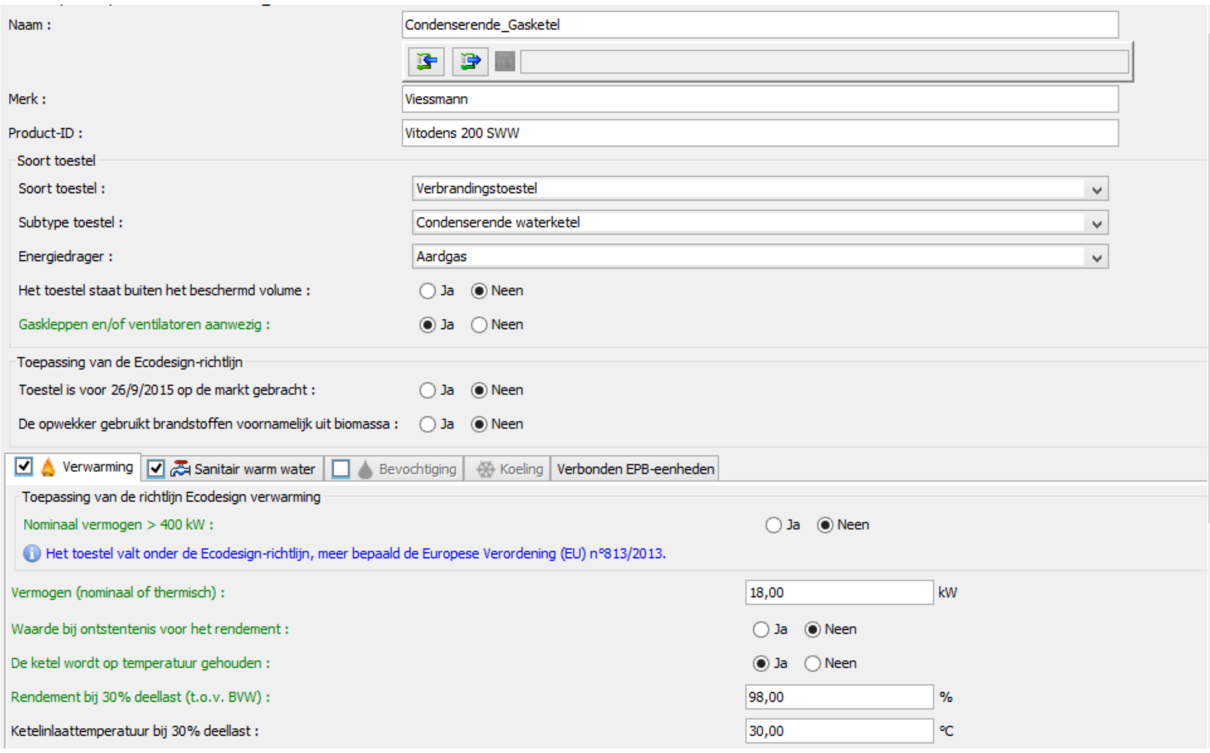


Figure 31: Information about the heating installation

7.2.9 Renewable energy

Every person that applies for a building permission to build a new house these days it is mandatory to have a minimal amount of renewable energy that provides the building of energy. There are many ways to fulfil on this demand which already have been explained earlier in this thesis. In this particular case the house has been equipped with solar panels which are located on the roof. This is an important detail, if the solar panels are located on the building or if they are placed somewhere else. The type of the panels will also make a difference. There are three types of solar panels.

1. Monocrystalline
2. Polycrystalline
3. Amorphous Silicon Solar Panels

Instead of placing the panels on top of the roof they also can just built in the roof surface. The most important is the performance of the panels. Make sure before installing the panels if you checked the ideal angle how the panels will be placed and the orientation of them. Make sure that the panels will not be placed into the shade.

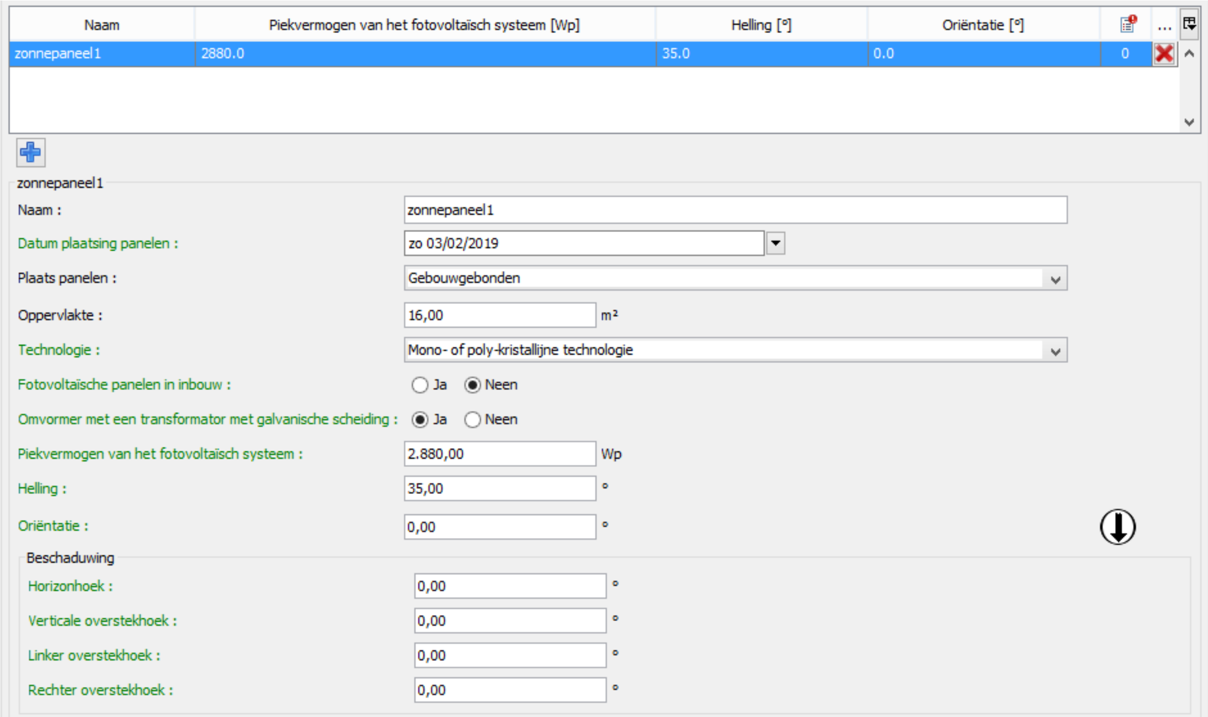


Figure 32: Input of solar panels into the 3G software

7.3 CERMA

As we have the 3G software, there is another platform that they use to calculate the energy performance in Spain. This platform is called CERMA. It stands for (Calificación Energética Residencial Método Abreviado). This software has been developed together with the UPV, Universitat Politecnica de Valencia. This program helps during the development to indicate if a building is designed following the current regulations according energy efficiency. The next pictures in this chapter will gave in indication of this software and how it is used.

7.3.1 Overview

We start by clicking on the enter icon after launching the software. Afterwards we enter the next window, the main starting page of the software where you can find all the information that belongs to the building. We select if the project is a new building or an existing building. We also make a choice if it is for a certification and verification or only certification or verification. The tool allows you to save the certifier date, so they can be loaded afterwards. This is done by clicking on the recover certifier date icon. The software is designed in a way that it automatically chooses the climate zone that the building in is.

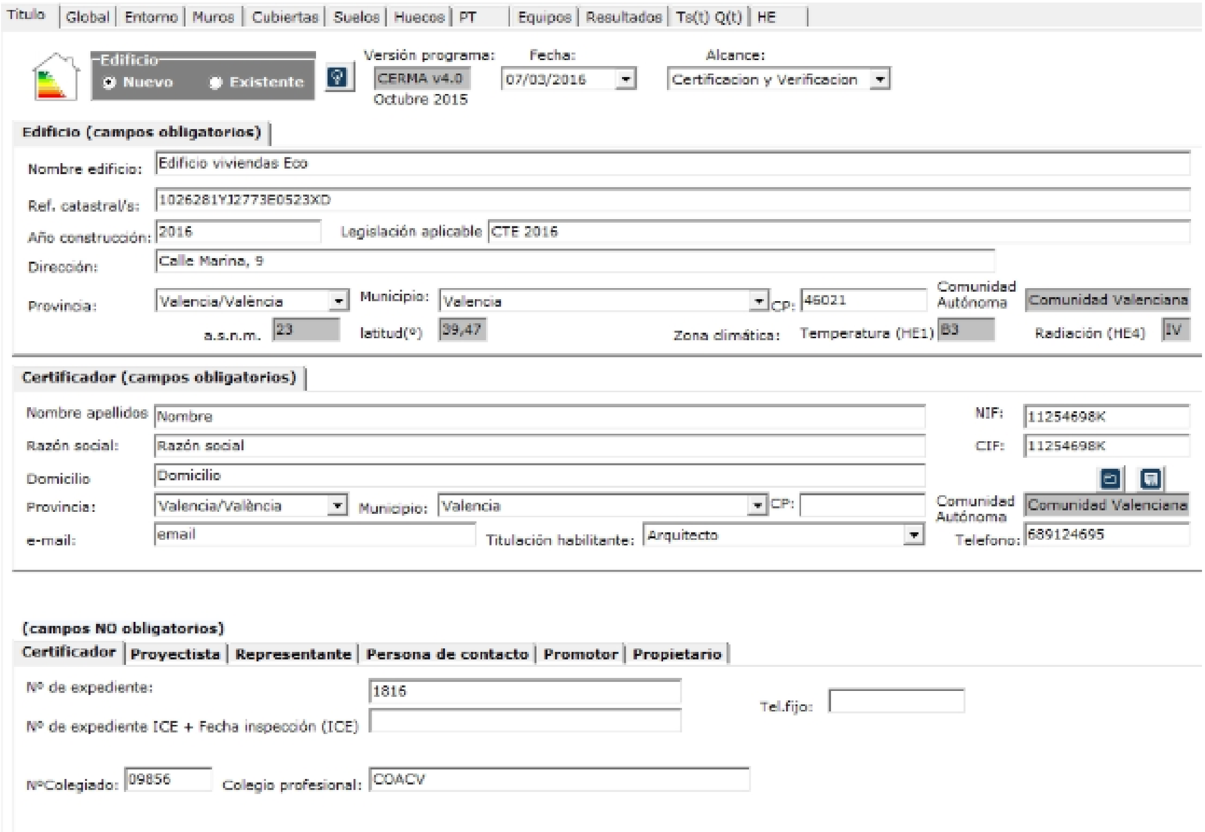


Figure 33: Introduction of the data in CERMA

7.3.2 Calculation of the minimum ventilation requirements

The next panel introduces the values that are related to the functional program and the geometric characteristics of the building such as: surface, volume, hygrometry class, number of types of dwellings, whether it is a block building, a single-family house or an individual house. The information icon explains the correspondence of the different concepts between CERMA and Lider-Calener.

CERMA includes an assistant for the calculation of the minimum ventilation demand according to the CTE DB HS3. With this guide, the program proposes a minimum value according to the CTE regulations. The certifier accepts will accept is as valid or non-valid with an icon. If the certifier considers another value, it will be edited in the lower field and does not accept the value calculated by CERMA. To do this, the number of housing types in the building are introduced and then the number of rooms per dwelling. On the picture underneath, the program proposes a minimum value of 0,61 that the certifier can accept or not. The certifier does not accept it and it appears the value that it considers correct and that is superior since its value is 1.

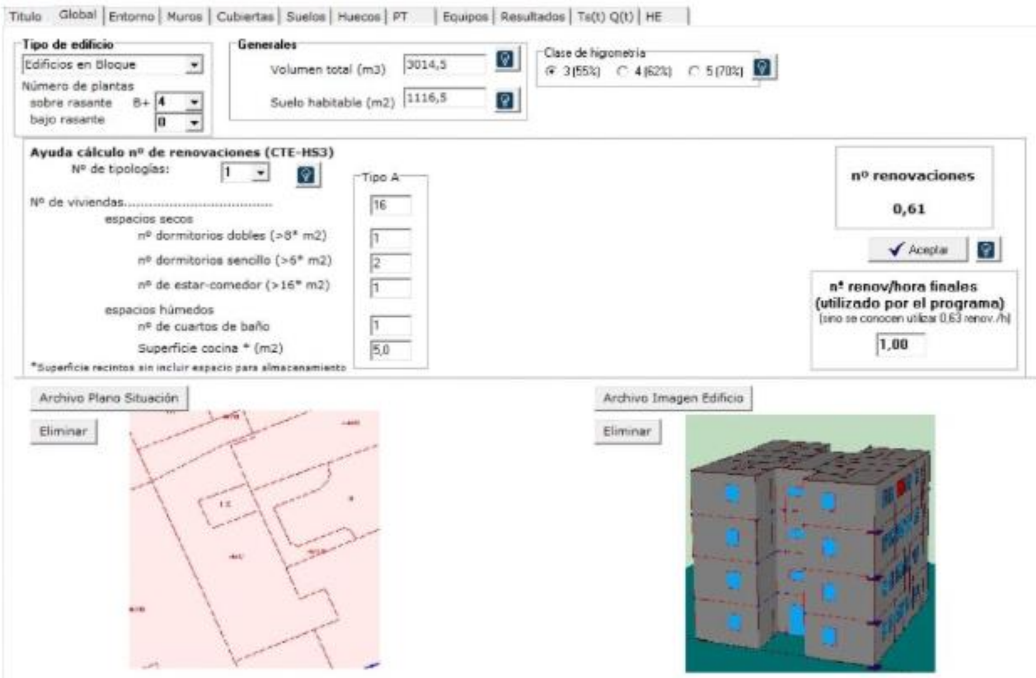


Figure 34: Minimum ventilation calculation in CERMA

7.3.3 Shadow calculation

CERMA also includes in the environmental panel, a wizard to calculate the shadow profile. It is very easy to put in the data to define the shadow profile of remote obstacles on the building to be certified. In the covers panel, a value of the shadow area of each cover is introduced. Due to the presence of elements of the building itself such as the elevator cassette of the building itself, the installed thermal solar panels, etc. finally in the panel of walls, to differentiate the shaded surface from which it receives radiation, the surface value in the first and second panels are introduced separately.

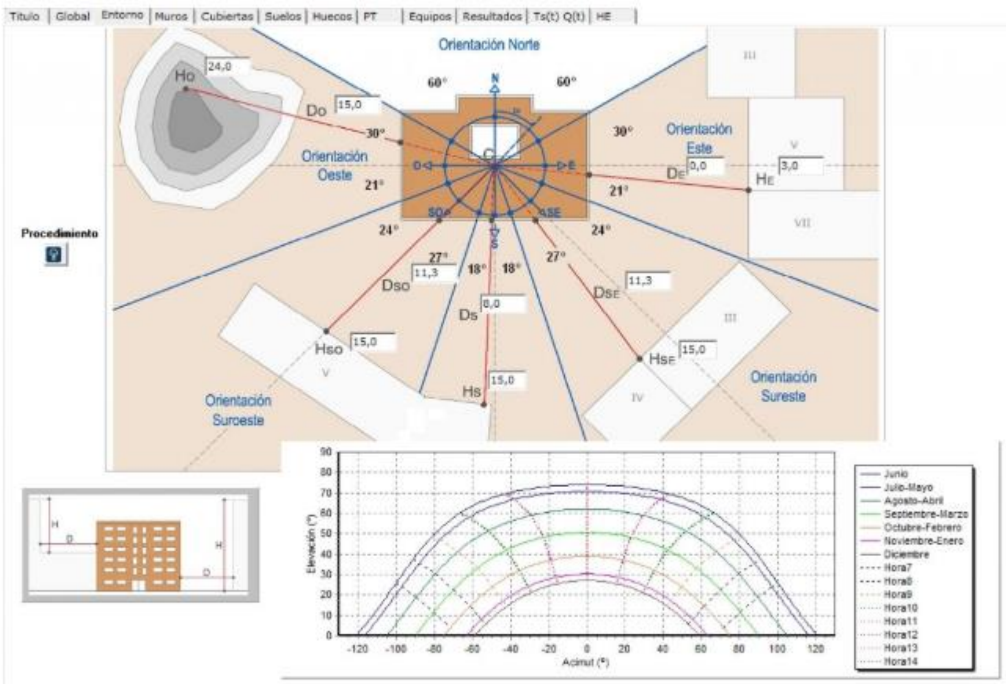


Figure 35: Shadow calculation in CERMA

7.3.4 Introducing walls

The program allows defining different types of walls, depending on the thermal envelop of the building or part of the building that we are certifying. We will not always have to use all the available types. This nuance is important considering whether it is about defining the thermal envelope of a complete building of dwellings or an individua dwelling within a block of dwellings.

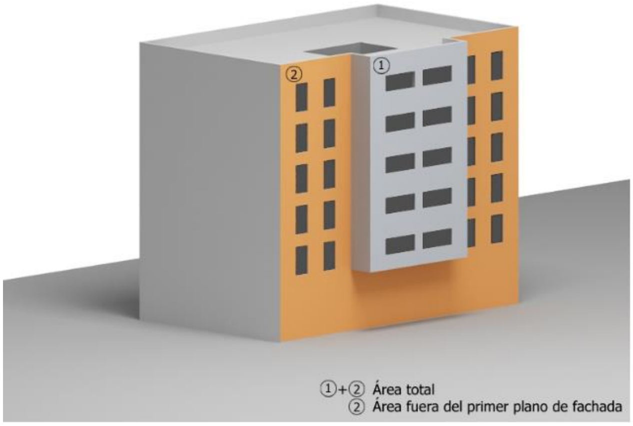


Figure 37: Walls in contact with the outdoor environment

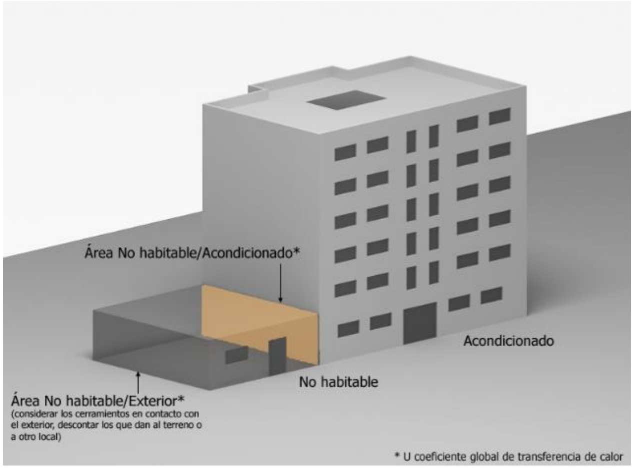


Figure 36: Wall in contact with non-habitable space: with garage, attic,....

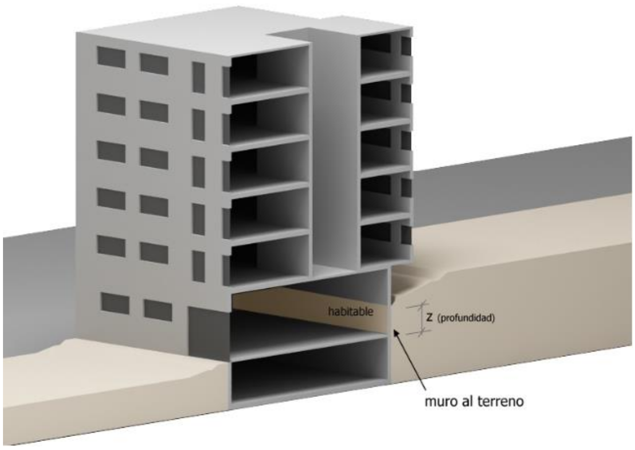


Figure 38: Walls in contact with the ground

Walls that are in contact with a unit of the same use: separation walls between dwellings of the same buildings. The value of the thermal transmittance of each wall can be determined by selecting the corresponding option in the database which has different options depending on the type composition.

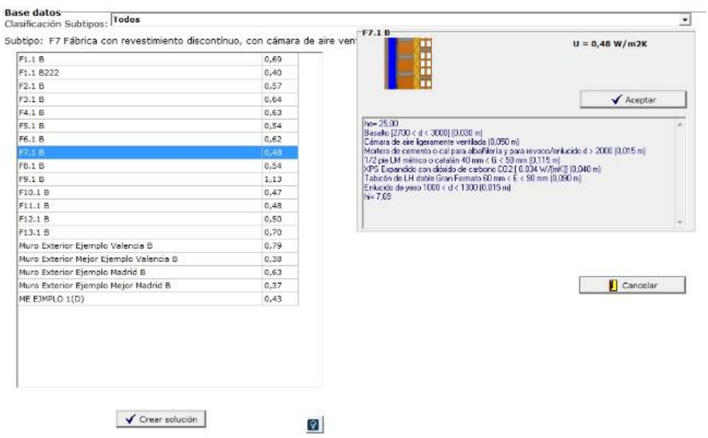


Figure 39: Walls in contact with a unit of the same use

7.3.5 Introducing roofs

You can find bot horizontal roofs and inclined roofs in this panel. Each type in its corresponding panel. The input of the data is similar to that of other elements of the envelope described in previous sections. It also allows to enter buried covers or covers in contact with a non-habitable space like attics.

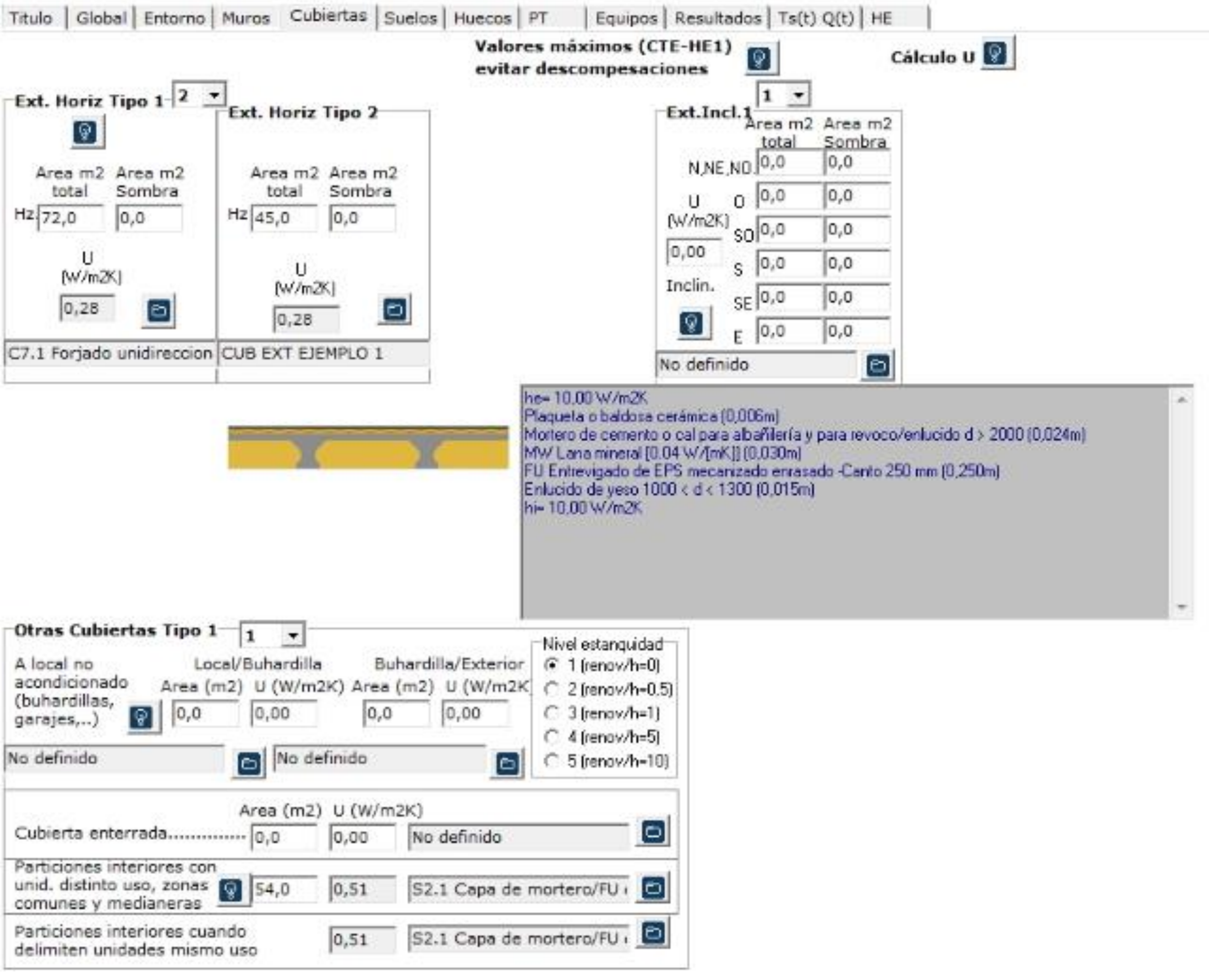


Figure 40: Introducing roofs in CERMA

Although the option exists in this panel, it seems more logical to perform the introduction of horizontal interior partitions in the following panel for the definition of soils. It makes more sense to introduce an internal partition between units of different use or with common areas or between units of the same use in the floor panel and not in the roof panel. As the section on walls, a database of type compositions is available, and a type of cover or customized horizontal element can also be generated.

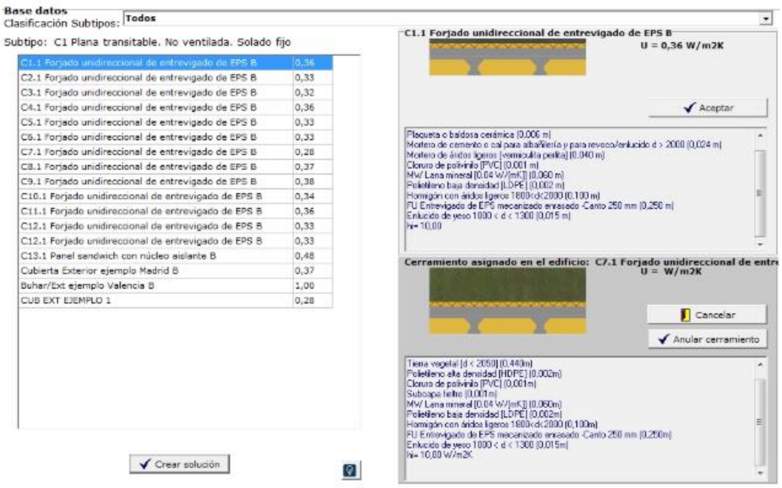


Figure 41: Database of roofs

7.3.6 Introduction of floors

CERMA allows the introduction of floors in contact with the ground, as indicated in the lower image. By introducing the roof surface in contact with the ground, its perimeter and depth in addition tot the characteristics of the thermal insulation that it includes.

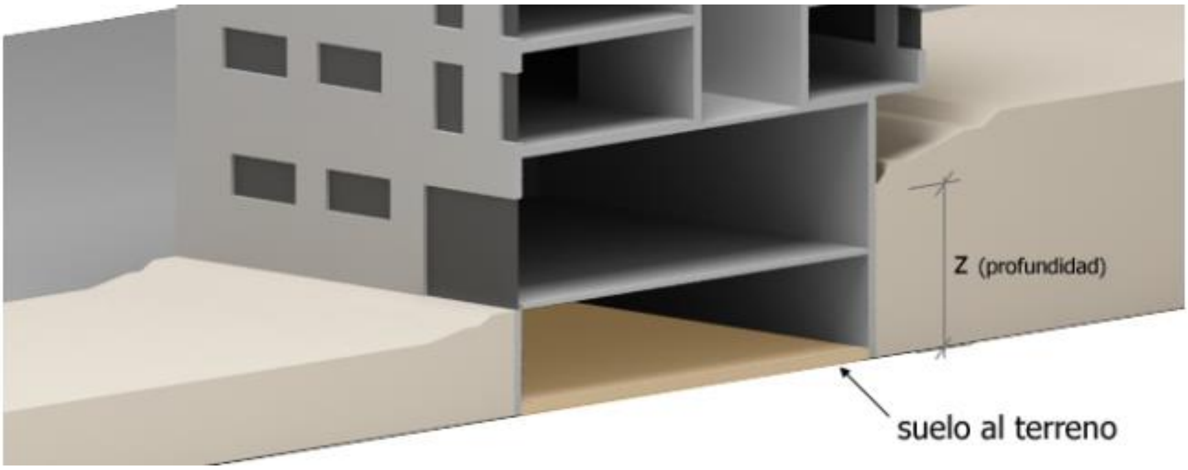


Figure 42: Floors in contact with the ground

As in previous panels, the certifier can make a definition of the composition of the floor in 2 ways. Choosing a typology already defined in the database or ha can create a new floor in a personalised way. Finally, this panel allows the definition of another type of floor: floors in contact with spaces not habitable or not conditioned, in contact with the outside air or with a sanitary chamber. As already mentioned in the roofs section. It is in this panel where it seems more logical to define floors in contact with other units if the same use, different use and/or common areas.

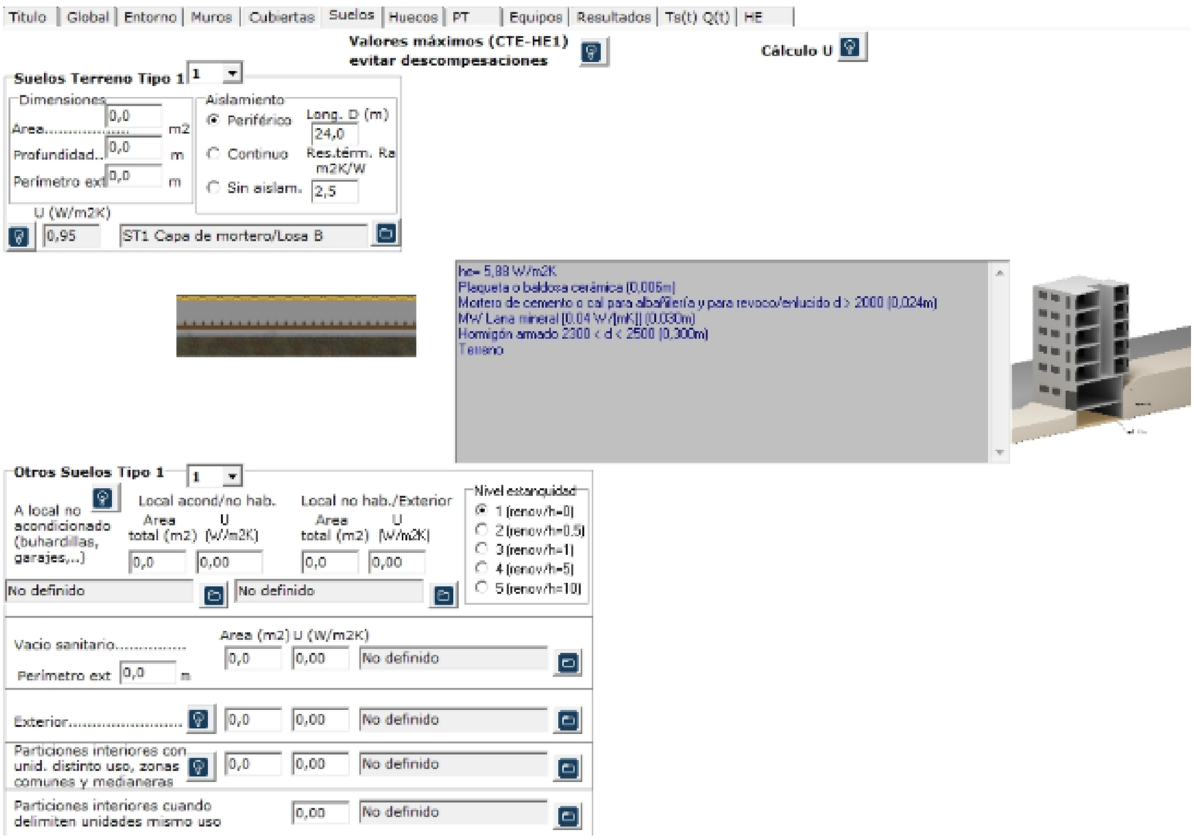


Figure 43: Creating a new floor composition

7.3.7 Introduction of openings in the building

In this panel, the openings of the building are defined, this is the group name for: windows, doors, skylights that are in direct contact with the outdoor environment. For this, different groups are created depending on the orientation and the characteristics of the gaps: dimensions and setback, whether they have cantilever or not and their dimensions with respect to the gap, type of glass and frame, solar factor and frame fraction, permeability whether it has a blind or not or does it has fixed elements that project the shade. The certifier can also edit the reduction value of the solar factor and the reduction of the heat transfer coefficient U, due to the placement of the shade devices, blind or curtains.

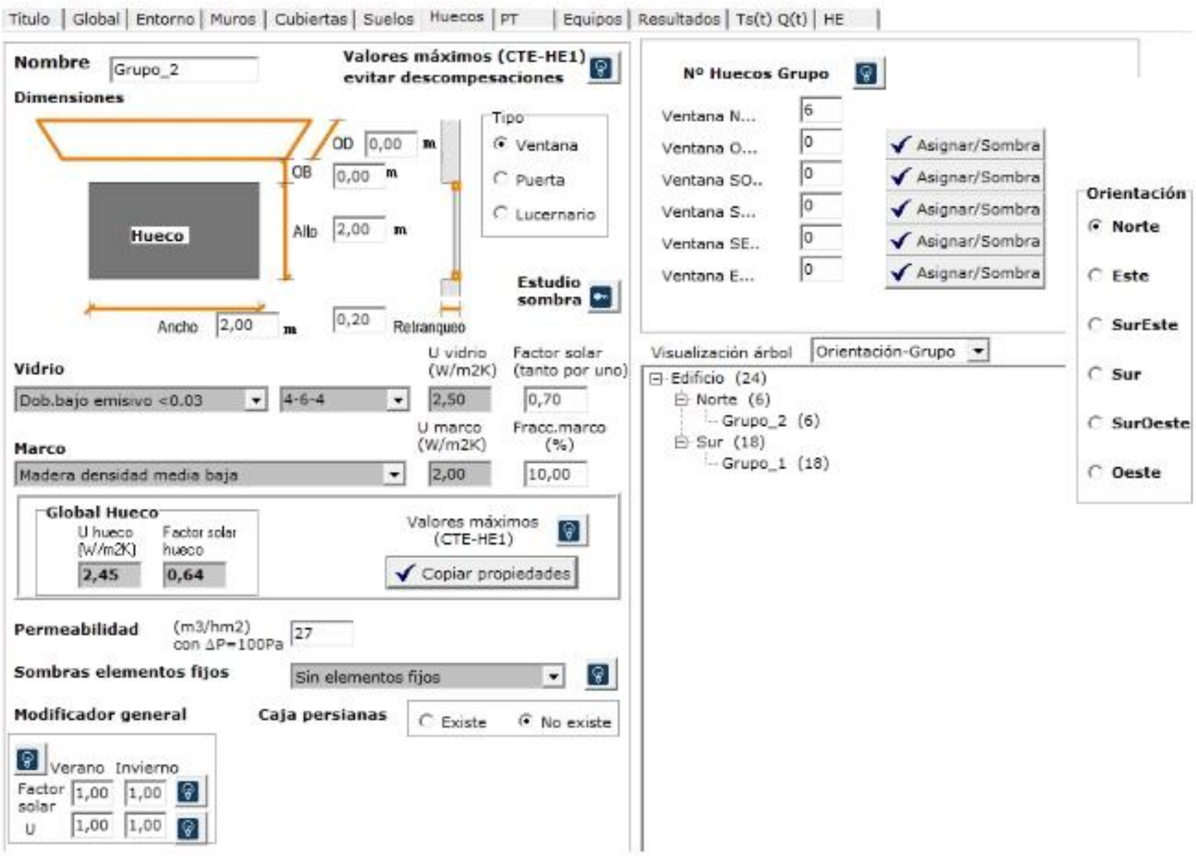


Figure 44: Introduction of gaps in CERMA

The study of the shadow on the gaps are done by introducing on one side the elements of the building that generate shade and on the other side by defining remote obstacles. First the offset value and the geometrical characteristics of the cantilever are introduced with respect to the gap. From here after clicking on the shadow study, a first graph of the percentage of shadow over the gap can be generated throughout the hours of the day and for the 12 months of the year as shown on next picture.

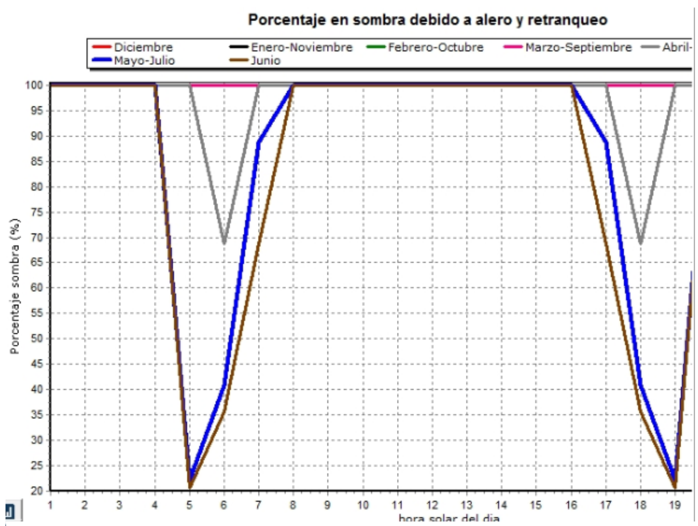


Figure 45: Graphical representation of the shadow calculation

To study the shadows due to the presence of remote obstacles, you can click on 'assign shadows' in each group of gaps, depending on the orientation of the holes. The data entry methods are similar to the definition of shadow on the building to be certified. Commented in the environment panel. The image below shows us that the shadow to be defined may be due to nearby buildings or to the presence of wall of an interior courtyard of the building that casts shadow over the gaps.

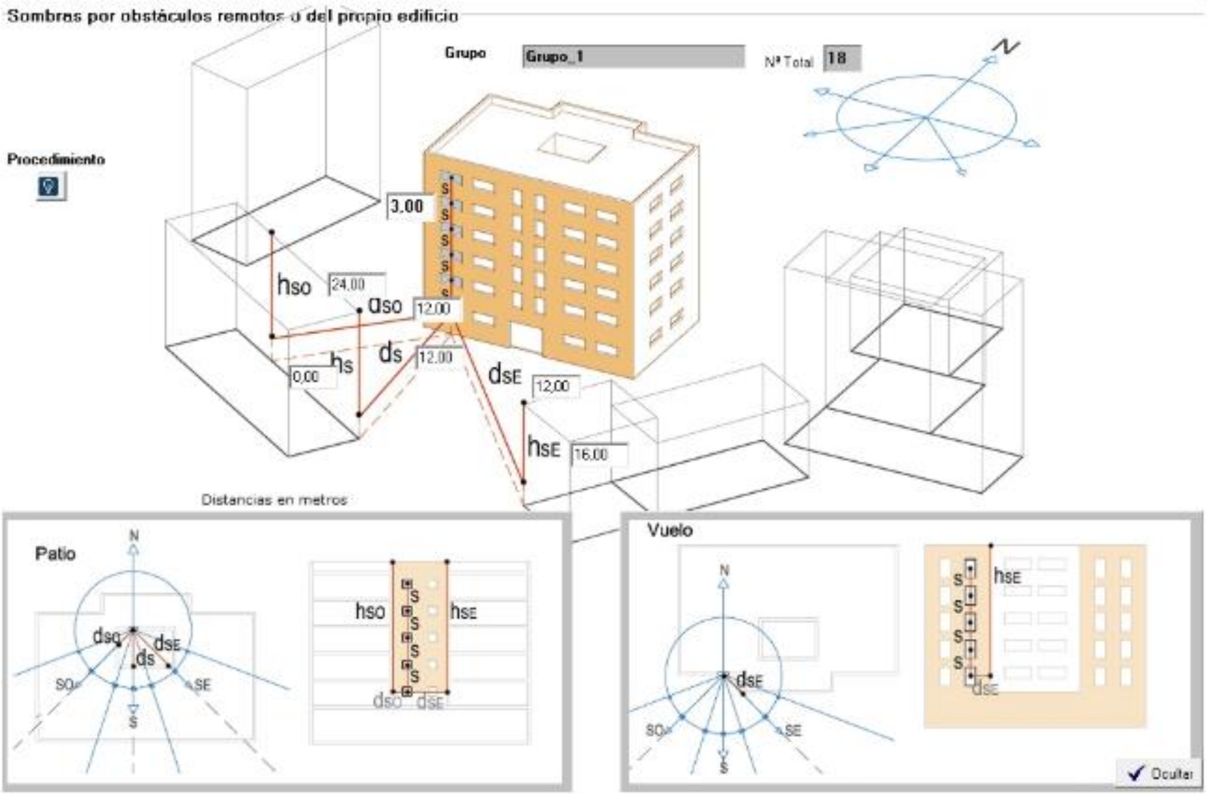


Figure 46: Obstacles which causes shadow over gaps

7.3.8 Introduction of thermal bridges

The introduction of the thermal bridges in CERMA can be done in three different ways:

- Depending on the construction characteristics
- Editing the values that the technician has previously calculated
- Use default values of Leader

The program also proposes two options for the introduction of the lengths of the thermal bridges either estimated by the program or provided by the technician who will have measured the exact lengths of the building or part of the building that is certified. In the lower image, the default option of leader of the thermal bridges and estimated values of the lengths of the thermal bridges has been selected. This is the option where there is less data to edit.

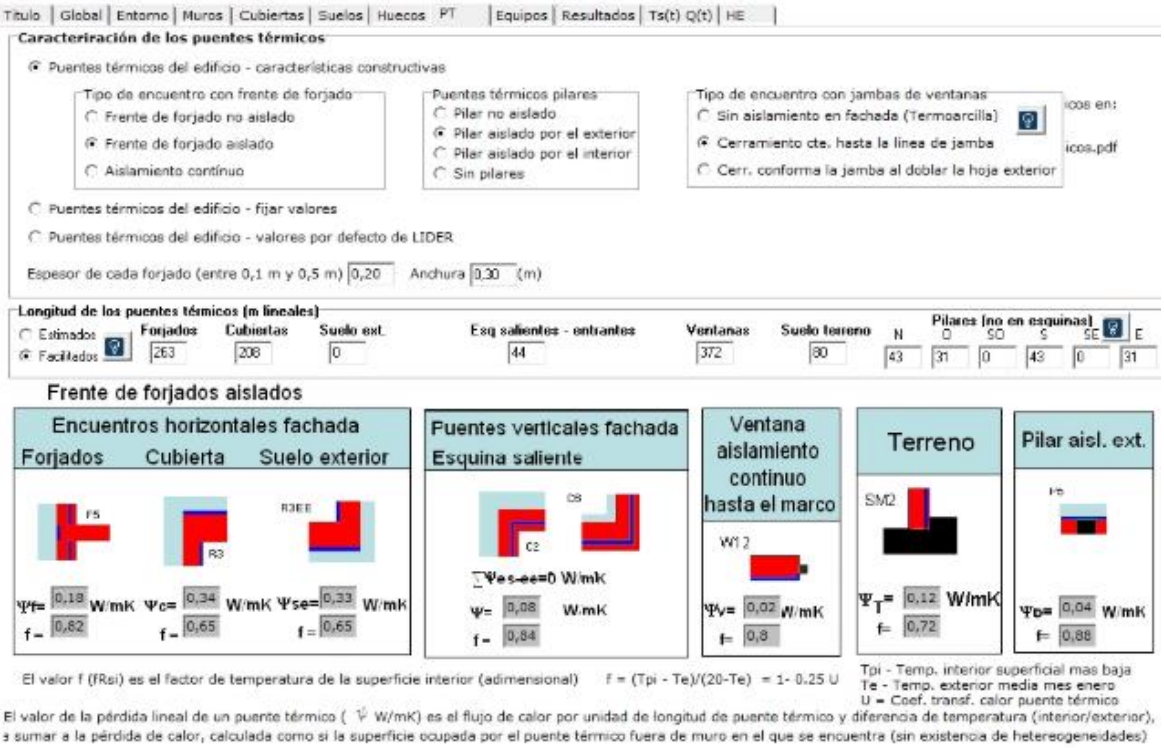


Figure 47: Introduction of the thermal bridges depending on the construction characteristics

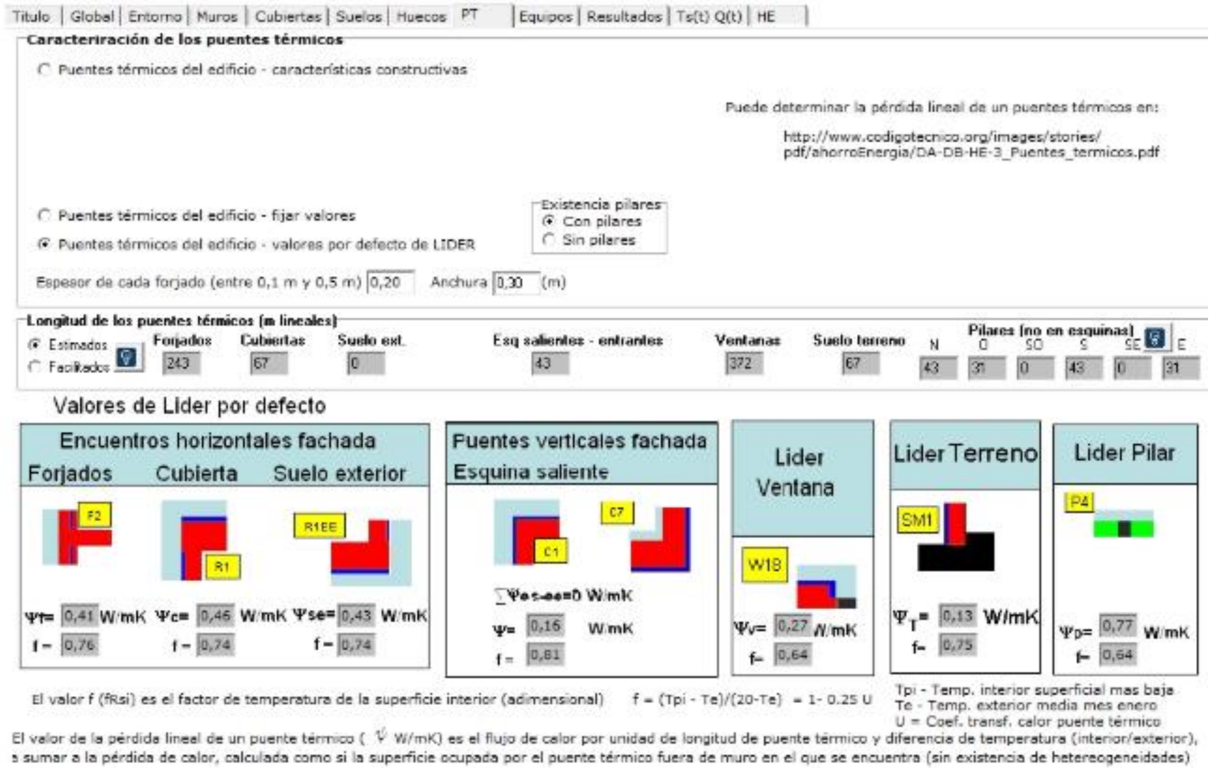


Figure 48: Introducing the thermal bridges using the default values of Leader

8 Conclusion

Belgium, Spain and other member states have been improving in the field of the energy performance of buildings. Regulations have been made and been adjusted over the years. In this story every member state adjusted their local regulations regarding the energy performance of buildings, so they participate in a good way for the goal in a better and green world. Beside all the work that has already been delivered by every country, there is still a lot of work to do. We are not there yet. Defining and the complete introduction of nearly zero energy buildings in our lives sounds still strange while the deadlines are coming closer and closer. The current deadline for this is set in 2021 and for public buildings these regulations are already in force.

Sharing the path that a country has followed over the years with the other member states of the European Union in the field of the improvement of the energy performance, calculation methods, building towards nearly energy zero buildings and more can improve the evolution of a less developed country significant.

Every country has his own climate which has a big influence on the level where we improve the regulations for energy efficient buildings. Depending on the climate different U values will be made and these can different enormous from each other. The regulations in Belgium are here very strict while these in Spain are less.

The climate can be directly connected with the energy sources that can be implemented into the houses which provide renewable energy. In Spain the solar energy is on top while we in Belgium must use other renewable energy installations like heatpumps. The most important aspect is that the use of fossil fuels is decreasing, and the use of renewable energy systems is going upwards. This will have a significant effect on the environment by reducing the CO_2 level strongly. Here the value of active houses in our society comes more clear. Instead that the country supplies the houses with energy, each house should work independently.

There is still a lot of work for both countries to work towards the goal for nearly zero energy buildings. Each state will follow its own path with the same destination and goal. Although Spain still must make clear on how they will achieve this goal. The current legislation in Belgium is already much closer to the standards of the NZEB houses than Spain. The standards that Belgium has are much more strict than the ones in Spain.

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10 Annexes

10.1 EPB-report

10.2 CERMA-report

10.3 Building plans

10.3.1 Ground floor

10.3.2 First floor

10.3.3 Attic floor

10.3.4 Section AA’

Energieprestatie en binnenklimaat van gebouwen

EPB-Rapport

Administratieve gegevens van het project

Naam van het project	**De_Sloovere_Maxim_Plan-07_Model-B**		
Straat	**Uitwijkweg**	Nummer	
Gemeente	**Oostkamp**	Postcode	**8020**
Referentie kadaster	**Oostkamp-D-0986/00A004**		

Weergave van het rapport

Weergavevolgorde van het rapport

Resultaten alle EPB-eenheden per eis

Weergegeven EPB-eenheden in het rapport

- [x] Gebouw "Plan-07-model-B"
    - [x] EPB-eenheid "De_Sloovere_Maxim_individuele_oefening"

Lijst van de betrokken personen

Aangifteplichtige/Eigenaar

Aangifteplichtige ook eigenaar

Naam **De Sloovere** Voornaam **Maxim**

Firma naam

Straat **Uitwijkweg** Nummer **5** Bus **5**

Postcode **8020** Gemeente **Hertsberge** Landcode **België**

Telefoon **0492850254**

EPB-verslaggever

Naam **De Sloovere** Voornaam **Maxim**

Firma naam

N° PEB **EP21109**

Straat Nummer Bus

Postcode Gemeente Landcode **België**

Telefoon

Samenvatting van de eisen per gebouw

Gebouw "Plan-07-model-B" (naam van het gebouw)

Aard van de werken: Nieuwbouw (of hiermee gelijkgesteld)

Beschermd volume: 649,12 m³

Volume "EPB-eenheden buiten het K-volume"

EPB-eenheid "De_Sloovere_Maxim_individuele_oefening"

Bestemming van de EPB-eenheid: Wonen

Oppervlakte: 242,40 m²

Eisen op het niveau van de EPB-eenheid:

Umax / Rmin	K-peil	S-peil	E-peil	Etech	NE	Oververh.	Ventilatie	HE
		13.0	19.0					
zie fiche 1 voor meer info.			zie fiche 3 voor meer info.			zie fiche 3 voor meer info.	zie fiche 4 voor meer info.	zie fiche 5 voor meer info.

Methode bouwknopen: Optie B : methode van de EPB-aanvaarde knopen

Deze EPB-eenheid voldoet aan de eisen voor een BEN-gebouw.

BEN staat voor bijna-energieneutraal. Bouwen volgens de BEN-principes wordt vanaf 2021 de standaard voor nieuwe gebouwen in Vlaanderen. BEN-bouwen is vandaag al de slimste keuze, meer informatie via www.energiesparen.be/BEN.

Fiche 1: Eisen U/R-waarden

Gebouw "Plan-07-model-B" (naam van het gebouw)

Aard van de werken: Nieuwbouw (of hiermee gelijkgesteld)

Volume "EPB-eenheden buiten het K-volume"

EPB-eenheid "De_Sloovere_Maxim_individuele_oefening"

1.1. TRANSPARANTE SCHEIDINGSCONSTRUCTIES

Uw (gemiddelde) 1,01 ✓

Naam	Type	U	Ug	R	b.Ui	a.Ueq	b.Ueq	Eis
RAAM1_NG_G_praktijk	Venster	0,86	0,60	-	-	-	-	✓
RAAM2_NG_G_R_	Venster	1,00	0,60	-	-	-	-	✓
RAAM3_NG_G_R2	Venster	1,00	0,60	-	-	-	-	✓
RAAM4_Voordeur	Venster	1,32	0,60	-	-	-	-	✓
RAAM5_OG_G	Venster	1,20	0,60	-	-	-	-	✓
RAAM6_ZG_G_Keuken	Venster	0,97	0,60	-	-	-	-	✓
RAAM7_ZG_G_Keuken	Venster	1,00	0,60	-	-	-	-	✓
RAAM8_ZG_G_Leefruimt	Venster	0,87	0,60	-	-	-	-	✓
RAAM9_WG_G_Leefruimt	Venster	1,00	0,60	-	-	-	-	✓
RAAM10_WG_G_Leefrui	Venster	1,00	0,60	-	-	-	-	✓
RAAM11_NG_V_SLPK2_	Venster	1,10	0,60	-	-	-	-	✓
RAAM12_NG_V_SLPK2_	Venster	1,10	0,60	-	-	-	-	✓
RAAM13_NG_V_Boven	Venster	0,97	0,60	-	-	-	-	✓
RAAM14_OG_V_SLPK4_	Venster	1,10	0,60	-	-	-	-	✓
RAAM15_OG_V_SLPK4_	Venster	1,10	0,60	-	-	-	-	✓
RAAM16_WG_V_SLPK1	Venster	1,10	0,60	-	-	-	-	✓

1.2.1 Daken en plafonds

Naam	Type	U	Ug	R	b.Ui	a.Ueq	b.Ueq	Eis
Daksamenstelling_Verdie	Dak	0,11	-	-	-	-	-	✓

1.2.2. Muren niet in contact met de grond, met uitzondering van de muren bedoeld in 1.2.4.

Naam	Type	U	Ug	R	b.Ui	a.Ueq	b.Ueq	Eis
Muursamenstelling_Gelijk	Muur	0,10	-	-	-	-	-	✓
Muursamenstelling_Verdi	Muur	0,10	-	-	-	-	-	✓
Muursamenstelling_Badka	Muur	0,10	-	-	-	-	-	✓

1.2.5. Vloeren in contact met de buitenomgeving

Naam	Type	U	Ug	R	b.Ui	a.Ueq	b.Ueq	Eis
Vloersamenstelling	Vloer/plafond	0,10	-	-	-	-	-	✓

1.3. DEUREN EN POORTEN (met inbegrip van kader)

Naam	Type	U	Ug	R	b.Ui	a.Ueq	b.Ueq	Eis
Voordeur	Deur	1,30	-	-	-	-	-	✓

Fiche 3: Eisen E-peil en oververhitting (met jaarlijks totaal per post)

Gebouw "Plan-07-model-B" (naam van het gebouw)

Aard van de werken: Nieuwbouw (of hiermee gelijkgesteld)

EPB-eenheid: De_Sloovere_Maxim_individuele_oefening

Bestemming van de EPB-eenheid: Wonen

Oververhitting	Indicator	Kans
ES1_Gelijkvloer	2 895,34	34,46%
ES2_Verdieping	829,66	0,00%
ES3_Badkamer_	363,87	0,00%

Samenvatting van de resultaten van de EPB-eenheid

Posten	Jaarlijks totaal
Primair energieverbruik verwarming (en bevochtiging als EPU/EPN) (MJ)	11 790,62
Primair energieverbruik koeling (MJ)	1 152,74
Primair energieverbruik SWW (MJ)	8 440,09
Primaire energiebesparing door PV (MJ)	-25 341,16
Primair energieverbruik hulpenergie (MJ)	28 800,51
Primaire energiebesparing door WKK (MJ)	-0,00
Karakteristiek primair energieverbruik (MJ)	24 842,80

S-Peil berekeningen

Posten	Jaarlijks totaal
S-peil gerelateerde transmissieverliezen (MJ)	22 090,29
S-peil gerelateerde ventilatieverliezen (MJ)	460,25
Zonnewinsten (MJ)	-14 767,61
S-peil gerelateerde netto-energiebehoefte verwarming (MJ)	14 899,30
S-peil gerelateerde transmissieverliezen koeling (MJ)	33 557,60
S-peil gerelateerde ventilatieverliezen koeling (MJ)	699,17
Zonnewinsten koeling (MJ)	-10 749,77
S-peil gerelateerde netto-energiebehoefte koeling (MJ)	1 485,73
Totale S-peil gerelateerde netto-energiebehoefte	16 385,03

Primair energieverbruik verwarming (en bevochtiging als EPU/EPN)

Posten	Jaarlijks totaal
Transmissieverliezen (MJ)	22 090,29
Ventilatieverliezen (MJ)	6 810,41
Interne winsten (MJ)	-20 653,25
Zonnewinsten (MJ)	-14 767,61
Netto energiebehoefte verwarming (MJ)	9 840,43
Bruto energiebehoefte verwarming (MJ)	11 005,32
Energie voor verwarming geproduceerd door thermische zonne-E (MJ)	-0,00
Bruto energiebehoefte gedekt door verwarmingssysteem (MJ)	11 005,32
Eindenergieverbruik verwarming - preferent (MJ)	11 789,98
Eindenergieverbruik verwarming - niet preferent (MJ)	0,00
Eindenergieverbruik verwarming (MJ)	11 789,98

Posten	Jaarlijks totaal
Primair energieverbruik verwarming (en bevochtiging als EPU/EPN) (MJ)	11 790,62

Primair energieverbruik koeling

Posten	Jaarlijks totaal
Transmissieverliezen koeling (MJ)	33 557,60
Ventilatieverliezen koeling (MJ)	28 114,43
Interne winsten koeling (MJ)	-20 653,25
Zonnewinsten koeling (MJ)	-10 749,77
Netto energiebehoefte koeling (MJ)	1 037,46
Eindenergieverbruik koeling (kWh)	128,08
Primair energieverbruik koeling (MJ)	1 152,74

Primair energieverbruik SWW

Posten	Jaarlijks totaal
Netto energiebehoefte SWW (MJ)	6 487,21
Bruto energiebehoefte SWW (MJ)	7 174,07
Energie voor SWW geproduceerd door thermische zonne-E (MJ)	-0,00
Bruto energiebehoefte gedekt door SWW systeem (MJ)	7 174,07
Eindenergieverbruik SWW preferent (MJ)	8 440,09
Eindenergieverbruik SWW-niet-preferent (MJ)	0,00
Eindenergieverbruik SWW (MJ)	8 440,09
Primair energieverbruik SWW (MJ)	8 440,09

Primair energieverbruik hulpenergie

Posten	Jaarlijks totaal
Ventilatoren (kWh)	3 101,04
Circulatiepompen (kWh)	6,39
Opwekkers (kWh)	92,63
Circulatiepompen thermische zonne-energie (kWh)	0,00
Free-chilling	0,00
Voorkoeling (kWh)	0,00
Primair energieverbruik hulpenergie (MJ)	28 800,51

Primaire energiebesparing door PV

Posten	Jaarlijks totaal
Eindenergieopwekking elektriciteit (kWh)	0,00
Primaire energiebesparing door PV (MJ)	-25 341,16

Primaire energiebesparing door WKK

Posten	Jaarlijks totaal
Eindenergieopwekking elektriciteit (kWh)	0,00
Primaire energiebesparing door WKK (MJ)	-0,00

CO2-uitstoot

Posten	Jaarlijks totaal
Uitstoot door verwarming (kg)	594,27
Uitstoot door SWW (kg)	425,38
Uitstoot door koeling (kg)	0,00
Uitstoot door hulpenergie (kg)	2 062,12
Vermeden uitstoot door PV (kg)	-1 814,43
Vermeden uitstoot door WKK (kg)	-0,00
Totale CO2 uitstoot (kg)	1 267,34

Fiche 4: Eisen ventilatie

Gebouw "Plan-07-model-B" (naam van het gebouw)

Aard van de werken: Nieuwbouw (of hiermee gelijkgesteld)

K-volume: EPB-eenheden buiten het K-volume

EPB-eenheid: De_Sloovere_Maxim_individuele_oefening

Bestemming van de EPB-eenheid: Wonen

Eisen gerespecteerd: ✓

Ventilatiesysteem: Ventilatiezone_1

Type systeem: D - Mechanische toevoer, mechanische afvoer

Met warmteterugwinning: ☐

	Ruimten	Opp. [m²]	Toevoer [m³/h]	Doorstroom [m³/h]	Afvoer [m³/h]	Openingen	Eis
D	Leefruimte (Woonkamer (of analoge ruimten))	28.68	105,00	29880,00	0,00	1 MTO, 1 DO	✓
D	Slaapkamer 1 (Slaap-, studeer-, speelkamer (of analoge ruimte))	13.6	50,00	25,20	0,00	1 MTO, 1 DO	✓
D	Slaapkamer 2 (Slaap-, studeer-, speelkamer (of analoge ruimte))	14.7	53,00	8384,40	0,00	1 MTO, 2 DO	✓
D	Slaapkamer 3 (Slaap-, studeer-, speelkamer (of analoge ruimte))	12.99	47,00	25,20	0,00	1 MTO, 1 DO	✓
D	Slaapkamer 4 (Slaap-, studeer-, speelkamer (of analoge ruimte))	11.4	50,00	25,20	0,00	1 MTO, 1 DO	✓
D	Homecinema (Slaap-, studeer-, speelkamer (of analoge ruimte))	57.2	72,00	11167,20	100,00	1 MTO, 2 DO, 1 MAO	✓
C	Inkom (Gang, trapzaal, hal (of analoge ruimte))		0,00	50,40	0,00	2 DO	
C	Nachthal (Gang, trapzaal, hal (of analoge ruimte))		0,00	2959,20	0,00	7 DO	
V	Open keuken (Open keuken)		0,00	29930,40	100,00	3 DO, 1 MAO	✓
V	Toilet (WC)		0,00	25,20	25,00	1 DO, 1 MAO	✓
V	Douchekamer (Badkamer, was-, droogplaats)	3.37	0,00	25,20	75,00	1 DO, 1 MAO	✓
V	Badkamer (Badkamer, was-, droogplaats)	5.7	0,00	25,20	75,00	1 DO, 1 MAO	✓
	Totaal		449,00		475,00		

	Ruimten	Opp. [m²]	Buitenlucht		Herbruikte lucht		Doorstroomlucht		Openingen	Eis
			Toevoer [m³/h]	Afvoer [m³/h]	Toevoer [m³/h]	Afvoer [m³/h]	Toevoer [m³/h]	Afvoer [m³/h]		
C 1	Praktijk (Niet-residentiële ruimte)	20.26	72.0	100.0	0.0	0.0	25.2	0.0	1 MTO, 1 DO, 1 MAO	✓

Fiche 5: Eisen hernieuwbare energie

Gebouw "Plan-07-model-B" (naam van het gebouw)

Aard van de werken: Nieuwbouw (of hiermee gelijkgesteld)

K-volume: EPB-eenheden buiten het K-volume

EPB-eenheid: De_Sloovere_Maxim_individuele_oefening

Eisen gerespecteerd: ✔

System	Aanwezig ?	Voldoet aan de eisen?	Hoeveelheid hernieuwbare energie voor woningen		Hoeveelheid hernieuwbare energie voor kantoren, scholen appartementen	
			Bereikte hoeveelheid	Vereiste hoeveelheid	(kWh)	(kWh/m²)
Zonne-thermisch energiesysteem	✘	-	nvt	nvt	-	-
Photovoltaïsch zonne-energiesysteem	✔	✔	nvt	nvt	7.039,21	29,04
Biomassakachel, biomassaketel of WKK op biomassa	✘	-	nvt	nvt	-	-
Warmtepomp	✘	-	nvt	nvt	-	-
Stadsverwarming of stadskoeling	✘	-	nvt	nvt	-	-
Participatie	✔	✔	nvt	nvt	3.636,00	15,00
Overzicht	✔	✔	✔	nvt	10.675,21	44,04

Bijlage 1: Gedetailleerde berekeningen per maand

Gebouw "Plan-07-model-B" (naam van het gebouw)

EPB-eenheid: De_Sloovere_Maxim_individuele_oefening

Bestemming van de EPB-eenheid: Wonen

Samenvatting van de resultaten van de EPB-eenheid

	Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	Totaal
Primair energieverbruik verwarming (en bevochtiging als EPU/EPN) (MJ)	3 051,7	2 192,5	1 349,3	278,0	2,0	0,0	0,0	0,0	0,0	159,2	1 714,7	3 043,2	**11 790,6**
Primair energieverbruik koeling (MJ)	0,0	0,0	0,0	21,6	113,9	248,9	355,7	299,9	101,0	11,8	0,0	0,0	**1 152,7**
Primair energieverbruik SWW (MJ)	716,8	647,5	716,8	693,7	716,8	693,7	716,8	716,8	693,7	716,8	693,7	716,8	**8 440,1**
Primaire energiebesparing door PV (MJ)	-707,7	-1 143,8	-1 943,5	-2 646,5	-3 367,1	-3 392,4	-3 339,4	-3 131,8	-2 518,4	-1 702,1	-888,7	-559,7	**-25 341,2**
Primair energieverbruik hulpenergie (MJ)	2 461,3	2 218,2	2 447,9	2 362,2	2 438,9	2 360,2	2 438,9	2 438,9	2 360,2	2 439,9	2 372,6	2 461,5	**28 800,5**
Primaire energiebesparing door WKK (MJ)	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	**-0,0**
Karakteristiek primair energieverbruik (MJ)	5 522,1	3 914,4	2 570,6	709,0	-95,5	-89,7	172,1	323,8	636,5	1 625,6	3 892,3	5 661,7	**24 842,8**

S-Peil berekeningen

	Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	Totaal
S-peil gerelateerde transmissieverliezen (MJ)	3 603,6	3 100,9	2 946,2	2 073,5	1 144,4	424,1	97,4	97,4	659,8	1 655,7	2 756,9	3 530,5	**22 090,3**
S-peil gerelateerde ventilatieverliezen (MJ)	75,1	64,6	61,4	43,2	23,8	8,8	2,0	2,0	13,7	34,5	57,4	73,6	**460,2**
Zonnewinsten (MJ)	-423,6	-669,8	-1 130,1	-1 515,5	-1 963,8	-2 012,9	-1 983,8	-1 801,7	-1 420,0	-983,9	-526,5	-335,9	**-14 767,6**
S-peil gerelateerde netto-energiebehoefte verwarming (MJ)	3 255,0	2 495,9	1 887,1	781,5	97,1	4,6	1,0	1,0	42,8	777,2	2 287,9	3 268,2	**14 899,3**
S-peil gerelateerde transmissieverliezen koeling (MJ)	4 577,5	3 980,6	3 920,1	3 016,1	2 118,3	1 366,7	1 071,3	1 071,3	1 602,3	2 629,6	3 699,4	4 504,5	**33 557,6**
S-peil gerelateerde ventilatieverliezen koeling (MJ)	95,4	82,9	81,7	62,8	44,1	28,5	22,3	22,3	33,4	54,8	77,1	93,8	**699,2**
Zonnewinsten koeling (MJ)	-312,8	-455,0	-772,0	-1 099,2	-1 460,3	-1 498,1	-1 554,7	-1 338,7	-973,7	-625,2	-390,3	-269,8	**-10 749,8**
S-peil gerelateerde netto-energiebehoefte koeling (MJ)	0,0	0,0	0,0	4,2	106,6	357,5	565,6	404,6	47,3	0,0	0,0	0,0	**1 485,7**
Totale S-peil gerelateerde netto-energiebehoefte	3 255,0	2 495,9	1 887,1	785,7	203,6	362,1	566,6	405,6	90,1	777,2	2 287,9	3 268,2	**16 385,0**

Primair energieverbruik verwarming (en bevochtiging als EPU/EPN)

	Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	Totaal
Transmissieverliezen (MJ)	3 603,6	3 100,9	2 946,2	2 073,5	1 144,4	424,1	97,4	97,4	659,8	1 655,7	2 756,9	3 530,5	**22 090,3**
Ventilatieverliezen (MJ)	1 111,0	956,0	908,3	639,3	352,8	130,8	30,0	30,0	203,4	510,4	849,9	1 088,5	**6 810,4**

Interne winsten (MJ)												
-1 754,1	-1 584,4	-1 754,1	-1 697,5	-1 754,1	-1 697,5	-1 754,1	-1 754,1	-1 697,5	-1 754,1	-1 697,5	-1 754,1	**-20 653,3**
Zonnewinsten (MJ)												
-423,6	-669,8	-1 130,1	-1 515,5	-1 963,8	-2 012,9	-1 983,8	-1 801,7	-1 420,0	-983,9	-526,5	-335,9	**-14 767,6**
Netto energiebehoefte verwarming (MJ)												
2 546,2	1 833,1	1 130,4	233,0	1,7	0,0	0,0	0,0	0,0	132,3	1 427,1	2 536,6	**9 840,4**
Bruto energiebehoefte verwarming (MJ)												
2 851,2	2 048,4	1 258,8	258,2	1,8	0,0	0,0	0,0	0,0	147,6	1 597,2	2 842,1	**11 005,3**
Energie voor verwarming geproduceerd door thermische zonne-E (MJ)												
-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	**-0,0**
Bruto energiebehoefte gedekt door verwarmingssysteem (MJ)												
2 851,2	2 048,4	1 258,8	258,2	1,8	0,0	0,0	0,0	0,0	147,6	1 597,2	2 842,1	**11 005,3**
Eindenergieverbruik verwarming - preferent (MJ)												
3 051,5	2 192,3	1 349,3	278,0	2,0	0,0	0,0	0,0	0,0	159,2	1 714,7	3 043,0	**11 790,0**
Eindenergieverbruik verwarming - niet preferent (MJ)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Eindenergieverbruik verwarming (MJ)												
3 051,5	2 192,3	1 349,3	278,0	2,0	0,0	0,0	0,0	0,0	159,2	1 714,7	3 043,0	**11 790,0**
Primair energieverbruik verwarming (en bevochtiging als EPU/EPN) (MJ)												
3 051,7	2 192,5	1 349,3	278,0	2,0	0,0	0,0	0,0	0,0	159,2	1 714,7	3 043,2	**11 790,6**

Primair energieverbruik koeling

Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	**Totaal**
Transmissieverliezen koeling (MJ)												
4 577,5	3 980,6	3 920,1	3 016,1	2 118,3	1 366,7	1 071,3	1 071,3	1 602,3	2 629,6	3 699,4	4 504,5	**33 557,6**
Ventilatieverliezen koeling (MJ)												
3 835,0	3 334,9	3 284,2	2 526,8	1 774,7	1 145,0	897,6	897,6	1 342,4	2 203,1	3 099,3	3 773,8	**28 114,4**
Interne winsten koeling (MJ)												
-1 754,1	-1 584,4	-1 754,1	-1 697,5	-1 754,1	-1 697,5	-1 754,1	-1 754,1	-1 697,5	-1 754,1	-1 697,5	-1 754,1	**-20 653,3**
Zonnewinsten koeling (MJ)												
-312,8	-455,0	-772,0	-1 099,2	-1 460,3	-1 498,1	-1 554,7	-1 338,7	-973,7	-625,2	-390,3	-269,8	**-10 749,8**
Netto energiebehoefte koeling (MJ)												
0,0	0,0	0,0	19,4	102,5	224,0	320,2	269,9	90,9	10,6	0,0	0,0	**1 037,5**
Eindenergieverbruik koeling (kWh)												
0,0	0,0	0,0	2,4	12,7	27,7	39,5	33,3	11,2	1,3	0,0	0,0	**128,1**
Primair energieverbruik koeling (MJ)												
0,0	0,0	0,0	21,6	113,9	248,9	355,7	299,9	101,0	11,8	0,0	0,0	**1 152,7**

Primair energieverbruik SWW

Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	**Totaal**
Netto energiebehoefte SWW (MJ)												
551,0	497,6	551,0	533,2	551,0	533,2	551,0	551,0	533,2	551,0	533,2	551,0	**6 487,2**
Bruto energiebehoefte SWW (MJ)												
609,3	550,3	609,3	589,6	609,3	589,6	609,3	609,3	589,6	609,3	589,6	609,3	**7 174,1**
Energie voor SWW geproduceerd door thermische zonne-E (MJ)												
-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	**-0,0**
Bruto energiebehoefte gedekt door SWW systeem (MJ)												
609,3	550,3	609,3	589,6	609,3	589,6	609,3	609,3	589,6	609,3	589,6	609,3	**7 174,1**
Eindenergieverbruik SWW preferent (MJ)												
716,8	647,5	716,8	693,7	716,8	693,7	716,8	716,8	693,7	716,8	693,7	716,8	**8 440,1**

Eindenergieverbruik SWW-niet-preferent (MJ)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Eindenergieverbruik SWW (MJ)												
716,8	647,5	716,8	693,7	716,8	693,7	716,8	716,8	693,7	716,8	693,7	716,8	**8 440,1**
Primair energieverbruik SWW (MJ)												
716,8	647,5	716,8	693,7	716,8	693,7	716,8	716,8	693,7	716,8	693,7	716,8	**8 440,1**

Primair energieverbruik hulpenergie

Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	**Totaal**
Ventilatoren (kWh)												
263,4	237,9	263,4	254,9	263,4	254,9	263,4	263,4	254,9	263,4	254,9	263,4	**3 101,0**
Circulatiepompen (kWh)												
1,7	1,1	0,7	0,2	0,0	0,0	0,0	0,0	0,0	0,1	0,9	1,7	**6,4**
Opwekkers (kWh)												
8,4	7,4	8,0	7,4	7,6	7,4	7,6	7,6	7,4	7,7	7,8	8,4	**92,6**
Circulatiepompen thermische zonne-energie (kWh)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Free-chilling												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Voorkoeling (kWh)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Primair energieverbruik hulpenergie (MJ)												
2 461,3	2 218,2	2 447,9	2 362,2	2 438,9	2 360,2	2 438,9	2 438,9	2 360,2	2 439,9	2 372,6	2 461,5	**28 800,5**

Primaire energiebesparing door PV

Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	**Totaal**
Eindenergieopwekking elektriciteit (kWh)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Primaire energiebesparing door PV (MJ)												
-707,7	-1 143,8	-1 943,5	-2 646,5	-3 367,1	-3 392,4	-3 339,4	-3 131,8	-2 518,4	-1 702,1	-888,7	-559,7	**-25 341,2**

Primaire energiebesparing door WKK

Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	**Totaal**
Eindenergieopwekking elektriciteit (kWh)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Primaire energiebesparing door WKK (MJ)												
-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	**-0,0**

CO2-uitstoot

Jan	Feb	Maart	April	Mei	Juni	Juli	Aug	Sept	Okt	Nov	Dec	**Totaal**
Uitstoot door verwarming (kg)												
153,8	110,5	68,0	14,0	0,1	0,0	0,0	0,0	0,0	8,0	86,4	153,4	**594,3**
Uitstoot door SWW (kg)												
36,1	32,6	36,1	35,0	36,1	35,0	36,1	36,1	35,0	36,1	35,0	36,1	**425,4**
Uitstoot door koeling (kg)												
0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	**0,0**
Uitstoot door hulpenergie (kg)												
176,2	158,8	175,3	169,1	174,6	169,0	174,6	174,6	169,0	174,7	169,9	176,2	**2 062,1**
Vermeden uitstoot door PV (kg)												
-50,7	-81,9	-139,2	-189,5	-241,1	-242,9	-239,1	-224,2	-180,3	-121,9	-63,6	-40,1	**-1 814,4**

Vermeden uitstoot door WKK (kg)												
-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	-0,0	**-0,0**
Totale CO2 uitstoot (kg)												
315,5	220,1	140,3	28,6	-30,2	-38,9	-28,3	-13,5	23,6	97,0	227,6	325,7	**1 267,3**

Bijlage 2: Samenstelling van de scheidingsconstructies

Opmerking: de U-waarde in de tabellen met muren en vloeren staat voor:
- aUeq: als de omgeving de grond is
- bUeq: als de omgeving een kelder of een kruipruimte is
- bUi: als de omgeving een aangrenzende onverwarmde ruimte is

Type scheidingsconstructie: Muur

Lagen

#	Type laag	Type materiaal	Dikte [m]	R [m²K/W]
1	Metselwerk	Stenen van gebakken aarde (Elementen van metselwerk) - λU: 1.19 Verbinding: Cementmortel (Gipsen, mortels en bepleisteringen) - λU: 1.5	0,090	0,070
2	Laag	Sterk geventileerde luchtlaag (Luchtlaag)	-	0,000
3	Laag	Recticel Insulation / Eurowall - λU: 0.022	0,100	4,545
4	Laag	Recticel Insulation / Eurowall - λU: 0.022	0,100	4,545
5	Metselwerk	Wienerberger / Porotherm Thermobrick 14 cm - λU: 0.26 Verbinding: Cementmortel (Gipsen, mortels en bepleisteringen) - λU: 0.93	0,138	0,376
6	Laag	Gipsbepleistering (Gipsen, mortels en bepleisteringen) - λU: 0.52	0,015	0,029

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	U [W/m²K]	R [m²K/W]	Eis
Muursamenstelling_Gelijkvloer	93,60	Buitenomgeving	0,10		✓

Type scheidingsconstructie: Muur

Lagen

#	Type laag	Type materiaal	Dikte [m]	R [m²K/W]
1	Metselwerk	Stenen van gebakken aarde (Elementen van metselwerk) - λU: 1.19 Verbinding: Cementmortel (Gipsen, mortels en bepleisteringen) - λU: 1.5	0,090	0,070
2	Laag	Sterk geventileerde luchtlaag (Luchtlaag)	-	0,000
3	Laag	- λU: 0.022	0,100	4,545
4	Laag	- λU: 0.022	0,100	4,545
5	Metselwerk	- λU: 0.26 Verbinding: Cementmortel (Gipsen, mortels en bepleisteringen) - λU: 0.93	0,138	0,376
6	Laag	Gipsbepleistering (Gipsen, mortels en bepleisteringen) - λU: 0.52	0,015	0,029

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	U [W/m²K]	R [m²K/W]	Eis
Muursamenstelling_Verdiepin	126,37	Buitenomgeving	0,10		✓

Type scheidingsconstructie: Muur

Lagen

#	Type laag	Type materiaal	Dikte [m]	R [m²K/W]
1	Metselwerk	Stenen van gebakken aarde (Elementen van metselwerk) - λU: 1.19 Verbinding: Cementmortel (Gipsen, mortels en bepleisteringen) - λU: 1.5	0,900	0,705
2	Laag	Sterk geventileerde luchtlaag (Luchtlaag)	-	0,000
3	Laag	- λU: 0.022	0,100	4,545
4	Laag	- λU: 0.022	0,100	4,545
5	Metselwerk	- λU: 0.26 Verbinding: Cementmortel (Gipsen, mortels en bepleisteringen) - λU: 0.93	0,138	0,376
6	Laag	Gipsbepleistering (Gipsen, mortels en bepleisteringen) - λU: 0.52	0,015	0,029

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	U [W/m²K]	R [m²K/W]	Eis
Muursamenstelling_Badkamer	6,83	Buitenomgeving	0,10		✓

Type scheidingsconstructie: Venster

Type venster : Enkelvoudig venster

U-waarde beglazing: 0,60 W/m²k

g-waarde 0,53

Groep: Kunststof

Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)

U-waarde ventilatierooster: Geen ventilatierooster

U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM1_NG_G_praktijk	3,00	Buitenomgeving	180,00	0,86	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53
Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM2_NG_G_R_	1,47	Buitenomgeving	180,00	1,00	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53
Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM3_NG_G_R2	1,47	Buitenomgeving	180,00	1,00	0,60	✓

Type scheidingsconstructie:	Venster	
Type venster :	Enkelvoudig venster	
U-waarde beglazing:	0,60	W/m²k
g-waarde	0,53	
Groep:	Kunststof	
Uf-waarde raamprofiel:	1,60	W/m²k (Berekende waarde)
U-waarde ventilatierooster:	Geen ventilatierooster	
U-waarde vulpaneel:	Geen vulpaneel	

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM4_Voordeur	1,04	Buitenomgeving	180,00	1,32	0,60	✓

Type scheidingsconstructie:	Venster	
Type venster :	Enkelvoudig venster	
U-waarde beglazing:	0,60	W/m²k
g-waarde	0,53	
Groep:	Kunststof	
Uf-waarde raamprofiel:	1,60	W/m²k (Berekende waarde)
U-waarde ventilatierooster:	Geen ventilatierooster	
U-waarde vulpaneel:	Geen vulpaneel	

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM5_OG_G	1,89	Buitenomgeving	-90,00	1,20	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53
Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM6_ZG_G_Keuken	1,20	Buitenomgeving	0,00	0,97	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53
Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM7_ZG_G_Keuken	1,47	Buitenomgeving	0,00	1,00	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53
Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM8_ZG_G_Leefruimte	2,52	Buitenomgeving	0,00	0,87	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53
Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM9_WG_G_Leefruimte_R	1,47	Buitenomgeving	90,00	1,00	0,60	✓

Type scheidingsconstructie: Venster

Type venster : Enkelvoudig venster

U-waarde beglazing: 0,60 W/m²k

g-waarde 0,53

Groep: Kunststof

Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)

U-waarde ventilatierooster: Geen ventilatierooster

U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM10_WG_G_Leefruimte_	1,47	Buitenomgeving	90,00	1,00	0,60	✓

Type scheidingsconstructie: Venster

Type venster : Enkelvoudig venster

U-waarde beglazing: 0,60 W/m²k

g-waarde 0,53

Groep: Kunststof

Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)

U-waarde ventilatierooster: Geen ventilatierooster

U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM11_NG_V_SLPK2_R	0,63	Buitenomgeving	180,00	1,10	0,60	✓

Type scheidingsconstructie: Venster

Type venster : Enkelvoudig venster

U-waarde beglazing: 0,60 W/m²k

g-waarde 0,53

Groep: Kunststof

Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)

U-waarde ventilatierooster: Geen ventilatierooster

U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM12_NG_V_SLPK2_L	0,63	Buitenomgeving	180,00	1,10	0,60	✔

Type scheidingsconstructie: Venster

Type venster : Enkelvoudig venster

U-waarde beglazing: 0,60 W/m²k

g-waarde 0,53

Groep: Kunststof

Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)

U-waarde ventilatierooster: Geen ventilatierooster

U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM13_NG_V_Boven deur	3,30	Buitenomgeving	180,00	0,97	0,60	✔

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53

Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM14_OG_V_SLPK4_R	0,63	Buitenomgeving	-90,00	1,10	0,60	✓

Type scheidingsconstructie: Venster
Type venster : Enkelvoudig venster
U-waarde beglazing: 0,60 W/m²k
g-waarde 0,53

Groep: Kunststof
Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)
U-waarde ventilatierooster: Geen ventilatierooster
U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM15_OG_V_SLPK4_L	0,63	Buitenomgeving	-90,00	1,10	0,60	✓

Type scheidingsconstructie: Venster

Type venster : Enkelvoudig venster

U-waarde beglazing: 0,60 W/m²k

g-waarde 0,53

Groep: Kunststof

Uf-waarde raamprofiel: 1,60 W/m²k (Berekende waarde)

U-waarde ventilatierooster: Geen ventilatierooster

U-waarde vulpaneel: Geen vulpaneel

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Ug [m²K/W]	Eis
RAAM16_WG_V_SLPK1	0,63	Buitenomgeving	-90,00	1,10	0,60	✓

Type scheidingsconstructie: Vloer/plafond

Lagen

#	Type laag	Type materiaal	Dikte [m]	R [m²K/W]
1	Laag	Zwaar normaal gewapend beton (Steenachtige bouwdelen zonder voegen) - λU: 2.2	0,200	0,091
2	Laag	Ludiso / Ludiso Thermomix - λU: 0.043	0,070	1,628
3	Laag	URSA / URSA XPS N-W-E (0,070 - 0,120) - λU: 0.036	0,100	2,778
4	Laag	URSA / URSA XPS N-W-E (0,070 - 0,120) - λU: 0.036	0,100	2,778
5	Laag	URSA / URSA XPS N-W-E (0,070 - 0,120) - λU: 0.036	0,100	2,778
6	Laag	Zwaar normaal ongewapend beton (Steenachtige bouwdelen zonder voegen) - λU: 1.3	0,080	0,062

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	U [W/m²K]	R [m²K/W]	Eis
Vloersamenstelling	95,20	Buitenomgeving	0,10		✓

Type scheidingsconstructie: Dak

Lagen

#	Type laag	Type materiaal	Dikte [m]	R [m²K/W]
1	Laag	Platen van met nat. min. vezels versterkt cement (Verscheidene materialen) - λU: 0.5	0,015	0,030
2	Samengest	3% van OSB-plaat (oriented strand board) (Hout en houtderivaten) - λU: 0.13 97% van Rockwool / RockRoof Sidefix - λU: 0.04	0,080	1,874
3	Laag	Rockwool / RockRoof Sidefix - λU: 0.04	0,200	5,000
4	Laag	Rockwool / RockRoof Sidefix - λU: 0.04	0,080	2,000
5	Laag	Gips met lichte granulaten (Gipsen, mortels en bepleisteringen) - λU: 0.22	0,020	0,091
6	Laag	Gipsbepleistering (Gipsen, mortels en bepleisteringen) - λU: 0.52	0,015	0,029

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	U [W/m²K]	R [m²K/W]	Eis
Daksamenstelling_Verdiep	116,20	Buitenomgeving	0,11		✓

Type scheidingsconstructie: Deur

Directe invoer U-waarde : 1,30 W/m²K

Lijst met scheidingsconstructies

Naam	Oppervlakte [m²]	Omgeving	Oriëntatie [°]	U [W/m²K]	Eis
Voordeur	2,57	Buitenomgeving	-	1,30	✓

Bijlage 3: Aanwezigheid van systemen

Systemen van de EPB-eenheid : De_Sloovere_Maxim_individuele_oefening

Verwarmingsinstallatie <Condenserende gaswandketel>

Soort verwarming	Centrale Verwarming (1 ES)
Directe invoer van het opslagrendement	Neen
Warmteopslag in buffervat	?
Systeemrendement verwarming	87,00 %

Warmteopwekkingstoestel <Condenserende_Gasketel>

Merk	Viessmann
Product-ID	Vitodens 200-W B2HA
Soort toestel	Condenserende waterketel
Energiedrager	Aardgas
Rendement	93,17 %

Verwarmingsinstallatie <Lage_temp._radiatoren>

Soort verwarming	Centrale Verwarming (1 ES)
Directe invoer van het opslagrendement	Neen
Warmteopslag in buffervat	?
Systeemrendement verwarming	94,66 %

Warmteopwekkingstoestel <Condenserende_Gasketel>

Merk	Viessmann
Product-ID	Vitodens 200-W B2HA
Soort toestel	Condenserende waterketel
Energiedrager	Aardgas
Rendement	93,17 %

Verwarmingsinstallatie <Elektrische_weerstandsverwarming>

Soort verwarming	Lokale verwarming
Systeemrendement verwarming	91,00 %

Warmteopwekkingstoestel <Elektrische_radiator_badkamer>

Merk	Radson
Product-ID	Flores CE FLEDC0512EL

Soort toestel	Elektrisch stralingstoestel of convector zonder elektronische regeling
Rendement	16250,00 %

Ventilatiesysteem <Ventilatiesyst1>

Ventilatiesysteem	D - Mechanische toevoer, mechanische afvoer
Er is vraaggestuurde ventilatie	Ja
Reductiefactor	1,00

Luchtdichtheid (waarde V50)

De meetwaarde van het lekdebiet is gekend	Ja
Lekdebiet bij 50 Pa per eenheid oppervlakte	0,30 $m^3/(h.m^2)$

Sanitair warm water <InstSWW1>

Soort SWW	Lokaal SWW (in 1 ES)
Circulatieleiding aanwezig	Neen

Warmteopwekkingstoestel <Condenserende_Gasketel>

Merk	Viessmann
Product-ID	Vitodens 200-W B2HA
Soort toestel	Verbrandingstoestel voor SWW
Rendement	85,00 %

Thermisch zonne-energie systeem

Onbestaand

Fotovoltaïsch systeem <Zonnepanelen>

Piekvermogen	3300,00

Vernieuwende technieken

Onbestaand

CERTIFICADO DE EFICIENCIA ENERGÉTICA DE EDIFICIOS

IDENTIFICACIÓN DEL EDIFICIO O DE LA PARTE QUE SE CERTIFICA:

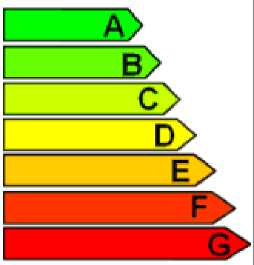
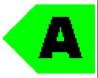
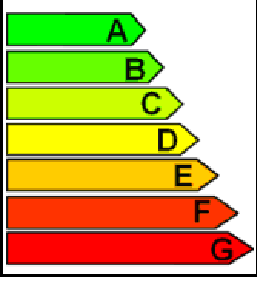
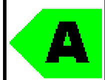
Nombre del edificio	Example building Maxim De Sloovere		
Dirección	Francesco cubells		
Municipio	Valencia	**Código postal**	46011
Provincia	Valencia/València	**Comunidad Autónoma**	Comunidad Valenciana
Zona climática	B3	**Año construcción**	1
Normativa vigente (construcción/rehabilitación)			
Referencia/s catastral/es	B32123456		

Tipo de edificio o parte del edificio que se certifica:	
☒ Edificio de nueva construcción	☐ Edificio Existente
☒ Vivienda ☒ Unifamiliar ☐ Bloque ☐ Bloque completo ☐ Vivienda individual	☐ Terciario ☐ Edificio completo ☐ Local

DATOS TÉCNICOS DEL CERTIFICADOR:

Nombre y apellidos	De Sloovere Maxim	**NIF/NIE**	96102125
Razón social	Projecto 1	**NIF**	74302359
Domicilio	Francesco cubells		
Municipio	Valencia	**Código Postal**	46011
Provincia	Valencia/València	**Comunidad Autónoma**	Comunidad Valenciana
E-mail:	maximdesloovere@me.com	**Teléfono**	492850254
Titulación habilitante según normativa vigente	Arquitecto		
Procedimiento reconocido de calificación energética utilizado y versión:	CERMA v_4.2		

CALIFICACIÓN ENERGÉTICA OBTENIDA:

CONSUMO DE ENERGÍA PRIMARIA NO RENOVABLE [kWh/m²·año]			**EMISIONES DE DIÓXIDO DE CARBONO [kgCO₂/m²·año]**		
		10,32			4,80

El técnico certificador abajo firmante certifica que ha realizado la calificación energética del edificio o de la parte que se certifica de acuerdo con el procedimiento establecido por la normativa vigente y que son ciertos los datos que figuran en el presente documento, y sus anexos:

Fecha:22/05/2019

Firma del técnico certificador:

Anexo I. *Descripción de las características energéticas del edificio.*
Anexo II. *Calificación energética del edificio.*
Anexo III. *Recomendaciones para la mejora de la eficiencia energética.*
Anexo IV. *Pruebas, comprobaciones e inspecciones realizadas por el técnico certificador.*

Registro del Órgano Territorial Competente:

ANEXO I
DESCRIPCIÓN DE LAS CARACTERÍSTICAS ENERGÉTICAS DEL EDIFICIO

En este apartado se describen las características energéticas del edificio, envolvente térmica, instalaciones, condiciones de funcionamiento y ocupación y demás datos utilizados para obtener la calificación energética del edificio.

1. SUPERIFICIE, IMAGEN Y SITUACIÓN

Superficie habitable [m²]	242,4

Imagen del edificio	Plano de situación

2. ENVOLVENTE TÉRMICA

Cerramientos opacos

Nombre	Tipo	Superficie [m²]	Transmitancia [W/ m²·K]	Modo de obtención
No definido	Cubierta Incl Exterior	116,2	0,13	Definido por el usuario
No definido	Muro Exterior	241,4	0,1	Definido por el usuario
No definido	Suelo al terreno	95,2	0,1	Definido por el usuario

Huecos y lucernarios

Nombre	Tipo	Superficie [m²]	Transmitancia [W/ m²·K]	Factor solar	Modo de obtención. Transmitancia	Modo de obtención. Factor solar
Grupo 1	Puertas	2,64	2,50	0,63	Función de su composición	Definido por usuario
Grupo 2	Ventanas	8,82	0,70	0,48	Definido por usuario	Definido por usuario
Grupo 3	Ventanas	3,15	0,70	0,48	Definido por usuario	Definido por usuario
Grupo 4	Ventanas	3	0,70	0,48	Definido por usuario	Definido por usuario
Grupo 5	Ventanas	3,15	0,70	0,48	Definido por usuario	Definido por usuario
Grupo 6	Ventanas	2,52	0,70	0,48	Definido por usuario	Definido por usuario
Grupo 7	Ventanas	1,2	0,70	0,48	Definido por usuario	Definido por usuario

3. **INSTALACIONES TÉRMICAS**

Generadores de calefacción

Nombre	Tipo	Potencia nominal [kW]	Rendimiento [%]	Energía	Modo de obtención
TOTALES		0			

Generadores de refrigeración

Nombre	Tipo	Potencia nominal [kW]	Rendimiento [%]	Energía	Modo de obtención
TOTALES		0			

Instalaciones de Agua Caliente Sanitaria

Demanda diaria de ACS a 60ºC (litros/día)	140

Nombre	Tipo	Potencia nominal [kW]	Rendimiento [%]	Tipo de energía	Modo de obtención

4. **INSTALACIONES DE ILUMINACIÓN**

(no aplicable)

5. **CONDICIONES DE FUNCIONAMIENTO**

(no aplicable)

6. **ENERGÍAS**

Térmica

Nombre	Consumo de Energía Final, cubierto en función del servicio asociado [%]			Demanda de ACS cubierta [%]
	Calefacción	Refrigeración	ACS	
Paneles solares	0,00	0,00	0,00	0,00
Caldera de biomasa	0,00	0,00	0,00	0,00
TOTAL	0,00	0,00	0,00	0,00

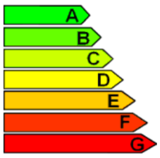
Eléctrica

Nombre	Energía eléctrica generada y autoconsumida [kWh/año]
Panel fotovoltaico	2448,00
TOTAL	2448,00

ANEXO II
CALIFICACIÓN ENERGÉTICA DEL EDIFICIO

Zona climática	B3	Uso	Residencial

1. CALIFICACIÓN ENERGÉTICA DEL EDIFICIO EN EMISIONES

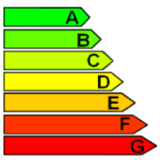
INDICADOR GLOBAL			INDICADORES PARCIALES			
	A	4,80	CALEFACCIÓN		ACS	
			Emisiones calefacción [kgCO$_2$/m^2·año]	A	*Emisiones ACS [kgCO$_2$/m^2·año]*	D
			0,00		3,05	
			REFRIGERACIÓN		ILUMINACIÓN	
Emisiones globales [kgCO$_2$/m^{2}año][1]			*Emisiones refrigeración [kgCO$_2$/m^2·año]*	A		
			1,75			

La calificación global del edificio se expresa en términos de dióxido de carbono liberado a la atmósfera como consecuencia del consumo energético del mismo.

	kgCO$_2$/m^2·año	kgCO$_2$/año
Emisiones CO$_2$ por consumo eléctrico	0,00	0,00
Emisiones CO$_2$ por otros combustibles	4,80	1163,90

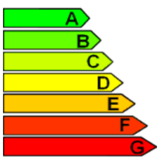
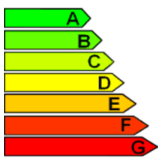
2. CALIFICACIÓN ENERGÉTICA DEL EDIFICIO EN CONSUMO DE ENERGÍA PRIMARIA NO RENOVABLE

Por energía primaria no renovable se entiende la energía consumida por el edificio procedente de fuentes no renovables que no ha sufrido ningún proceso de conversión o transformación.

INDICADOR GLOBAL			INDICADORES PARCIALES			
	A	10,32	CALEFACCIÓN		ACS	
			Energía primaria calefacción [kWh/m^{2}año]	A	*Energía primaria ACS [kWh/m^{2}año]*	A
			0,00		0,00	
			REFRIGERACIÓN		ILUMINACIÓN	
Consumo global de energía primaria no renovable [kWh/m^{2}año][1]			*Energía primaria refrigeración[kWh/m^{2}año]*	B		
			10,32			

3. CALIFICACIÓN PARCIAL DE LA DEMANDA ENERGÉTICA DE CALEFACCIÓN Y REFRIGERACIÓN

La demanda energética de calefacción y refrigeración es la energía necesaria para mantener las condiciones internas de confort del edificio.

DEMANDA DE CALEFACCIÓN			DEMANDA DE REFRIGERACIÓN		
	A	0,00		B	10,57
Demanda global de calefacción [kWh/m^{2}año]			*Demanda global de refrigeración [kWh/m^{2}año]*		

[1] El indicador global es resultado de la suma de los indicadores parciales más el valor del indicador para consumos auxiliares, si los hubiera (sólo ed. terciarios, ventilación, bombeo, etc…). La energía eléctrica autoconsumida se descuenta únicamente del indicador global, no así de los valores parciales.

ANEXO III
RECOMENDACIONES PARA LA MEJORA DE LA EFICIENCIA ENERGÉTICA

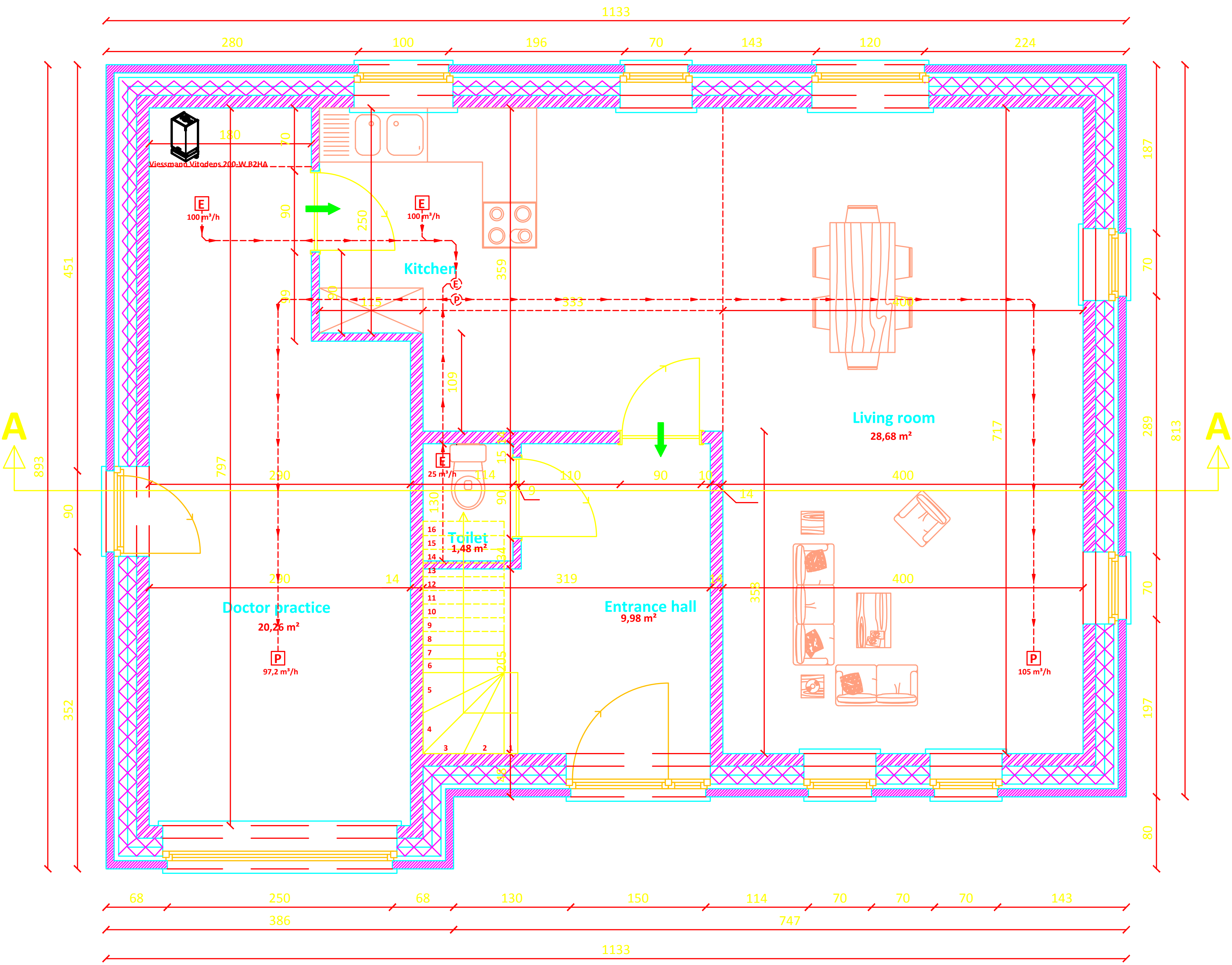
ANEXO IV
PRUEBAS, COMPROBACIONES E INSPECCIONES REALIZADAS POR EL TÉCNICO CERTIFICADOR

Se describen a continuación las pruebas, comprobaciones e inspecciones llevadas a cabo por el técnico certificador durante el proceso de toma de datos y de calificación de la eficiencia energética del edificio, con la finalidad de establecer la conformidad de la información de partida contenida en el certificado de eficiencia energética.

Fecha de realización de la visita del técnico certificador	Visita1. Fecha: 22/05/2019

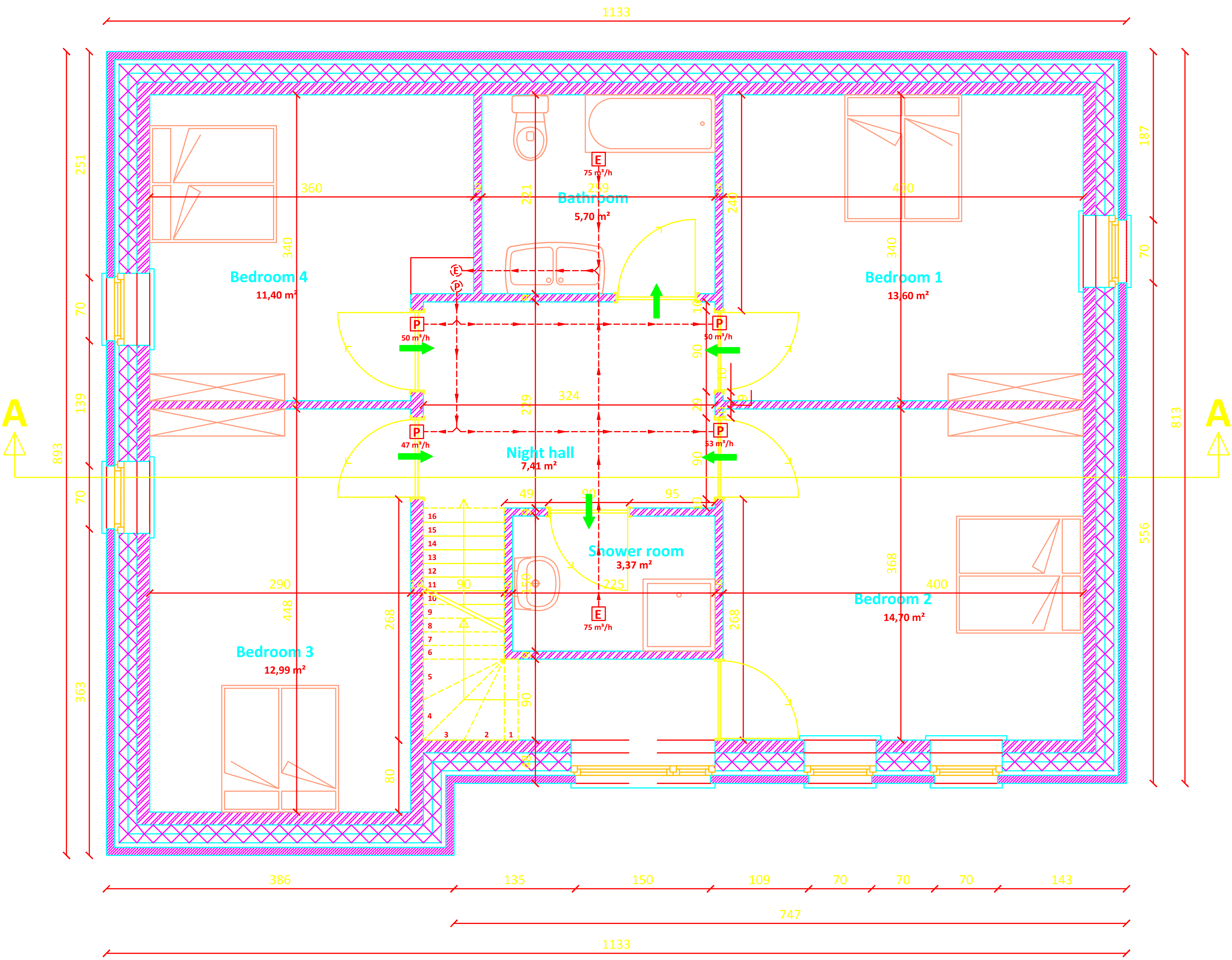
Fecha de realización de la visita del técnico certificador	

Fecha de realización de la visita del técnico certificador	



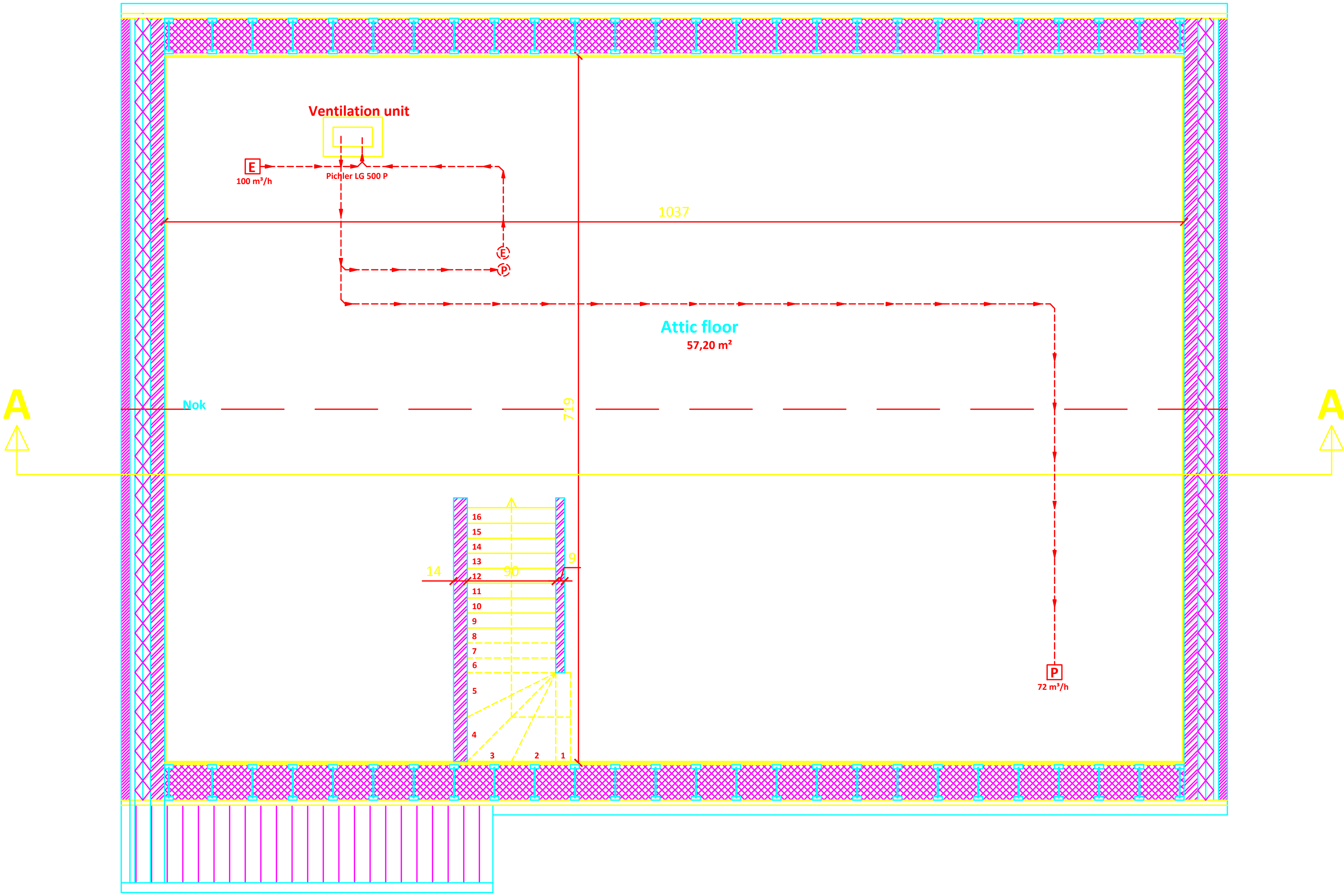
Groundfloor

	Description Floorplan 1	
	De Sloovere Maxim	Ground floor
	Thesis	
15/04/19	2018-2019	SCHAAL : 1/50



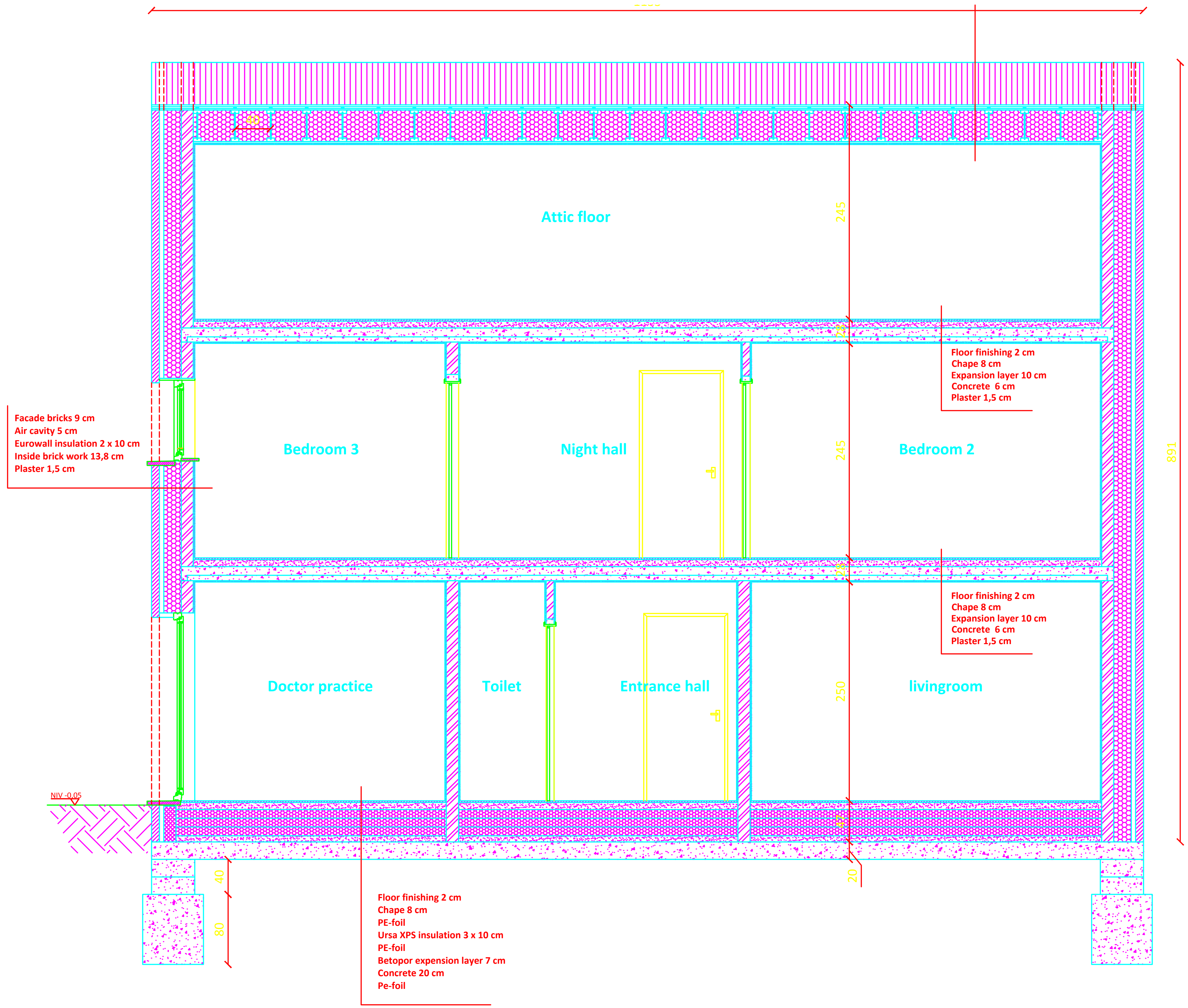
First floor

	Description Floorplan 3	
	De Sloovere Maxim	First floor
	Thesis	
15/04/19	2018-2019	SCHAAL : 1/50



Attic floor

	Description Floorplan 2		
	De Sloovere Maxim	Attic floor	
	Thesis		
15/04/19	2018-2019		SCHAAL : 1/50



Section A-A'

Description Section 1		
De Sloovere Maxim	Section A-A'	
Thesis		
15/04/19	2018-2019	SCHAAL : 1/50