Large urban terraced house, Eupen

1. OVERVIEW

PROJECT SUMMARY

- *Year of construction:* **1850**
- *Year of renovation:* **2006…**
- *Building typology:* *“**Large urban terraced building”***

CERTIFIED PASSIVE HOUSE

- *Space heating demand:* **10 kWh/m².a**
- *Airtightness value:* ***n_{50} 0,4 h^{-1}***
- *Compactness:* ***1,8***

SPECIAL FEATURES

- *Annex in timber frame construction, replacing the old fragmented annexes, resulting in an increase in floor space from 130m² to 180m²*
- *New roof construction*
- *Internal insulation*
- *Treatment of thermal bridges*
- *Mechanic ventilation with ground-coupled heat exchanger*

ARCHITECT

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One Stop Shop Demonstration Project

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2. ENERGY PERFORMANCES

Energy performance – before and after, space/water

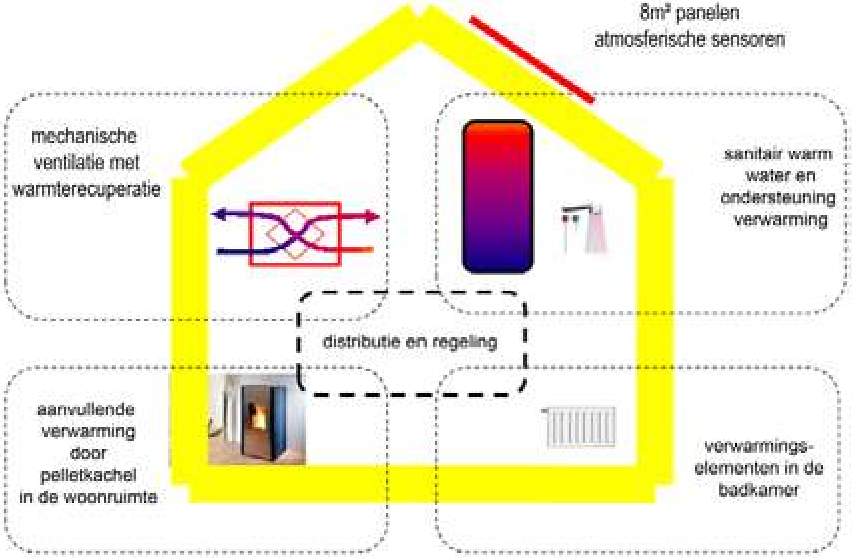
USE	kWh/m² year	kWh/year
Energy demand before renovation (space heating and DHW) Calculated with the Flemish EPB software	**275**	**35 750**
Energy demand after renovation (space heating only) Calculated with PHPP software	**12**	**2160**

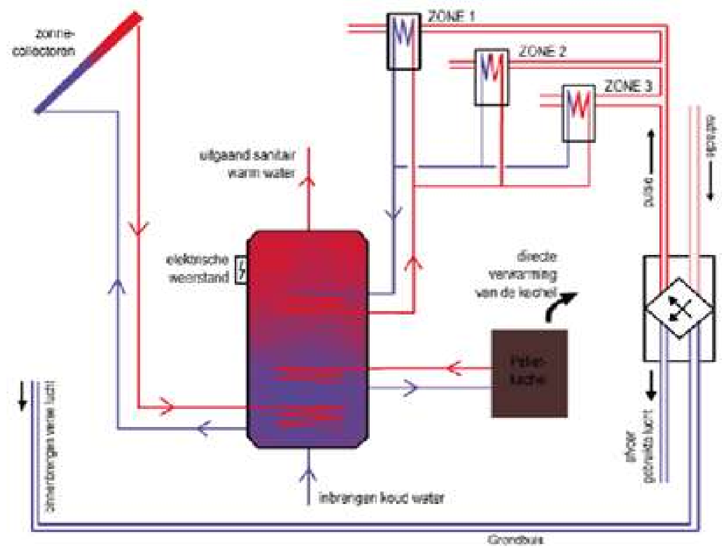
Renewable energy use

The hot water for space heating is supplied by the solar collectors with a surface of 8 m². These are also used for the producing domestic hot water. The solar system is dimensioned to achieve autonomy from March to October. When there is insufficient hot water available via the collector, the pellet stove in the living room is used as back-up.

Thermal and electric consumption and costs

Through the use of LED lighting, the improved level of insulation and the use of low energy consumption equipment's, the overal consumption has decreased significantly.





Warm water production by solar power

3. CONTEXT AND BACKGROUND

BACKGROUND

- *Ownership status:* ***private***
- *Net surface area:* ***180 m²***
- *Occupation:* ***single family – 5 persons***

SUMMARY OF THE RENOVATION

- *Annex in timber frame construction, replacing the old fragmented annexes*
- *New roof construction*
- *Internal insulation*
- *Treatment of thermal bridges*
- *Mechanic ventilation with ground-coupled heat exchanger*
- *New passive door and windows. Tripple glazing window.*
- *External sun shading made with the solar collector.*
- *Solar collector (8 m²)*
- *Pellet stove as support for the hot water solar system in the coolest months.*

Solar collector as solar shading

New passive window installed in the surface of the new timber construction

4. DECISION MAKING PROCESSES

OBJECTIVES AND DETAILS

Why build with passive house standards?

The owners were looking for a terrain to build their dream house. After searching without a satisfactory result, they decided to buy this house in the centre of Eupen. The garden, with a nice south orientation, provides light and passive heat into the house and the view is also nice. The renovation was necessary because the house had just single glazing and was not insulated. But the most important reason were, healthy reasons.

They have a son with allergic asthma and the specialist said that the convectors, existing heating elements, were not recommended in his case. The dust and the pollen are factors that increase the risk of crisis, so they decided to install a mechanical ventilation, with efficient filters to avoid this problem.

Considering all these mandatory measures, the extra effort to achieve the passive house standards was so small, that they decided to go for it.

"The reasons to renovate with passive house standards were not in the first moment economical or environmental, it was a medical reason".

Façade before renovation

Façade after renovation

5. THERMAL ENVELOPE

Roof
construction
U-value: 5,5 W/m².K - Before
U-value: 0,11 W/m².K - After

Materials. (exterior to interior) / (existing – new):

Zinc roofing	-
Grid support for zinc	2,2 cm
Bituminized soft fiberboard	2,2 cm
Timber frame construction + cellulose insulation	36 cm
Vapor barrier	
Batten	4,8 cm
Plasterboard	1,25 cm
U = 0,11 W/m²K	**46,45 cm**

Doors and windows

Before: single glazing

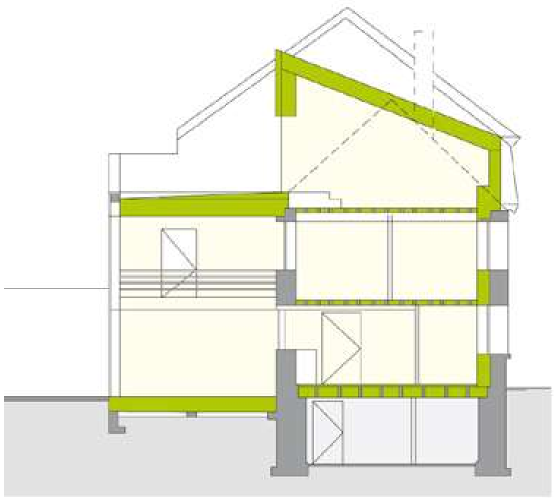
Average of windows and doors
U-value: 0,74 W/m².K - after

Glazing: *U-value: 0,60 W/m².K*

Windows and doors frame:
U-value: 0,72 W/m².K

Curtain wall profile: *U-value: 0,69 W/m².K*

Detail



Section

Detail of the front door opening with on the inside of the existing stone wall timber frame structure.

Exterior wall – front façade
Construction
U-value: 3,14 W/m².K - Before
U-value: 0,14W/m².K - After

Materials. (exterior to interior) / (existing – new):

Exterior plaster	1,5 cm
Original stone facade	50 cm
timber frame construction + cellulose insulation	28 cm
vapor barrier	-
Wood fiber insulation board	6 cm
Interior plaster	2 cm
U = 0,14 W/m²K	**87,5 cm**

Basement plafond– Interior
Construction
U-value: 2,2 W/m².K - Before
U-value: 0,17W/m².K - After

Materials. (exterior to interior)):

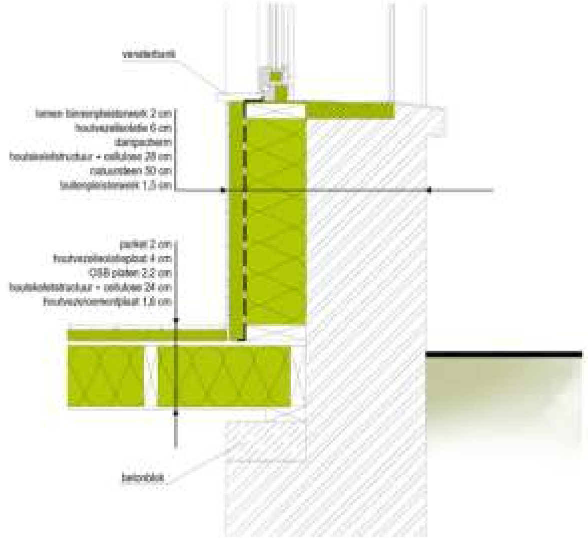
Existing floor	2 cm
Wood fiber insulation board	4 cm
OSB board	2,2 cm
Beams + cellulose insulation	24 cm
Wood fiber cement board	1,8 cm
U = 0,17 W/m²K	**34 cm**

Exterior wall

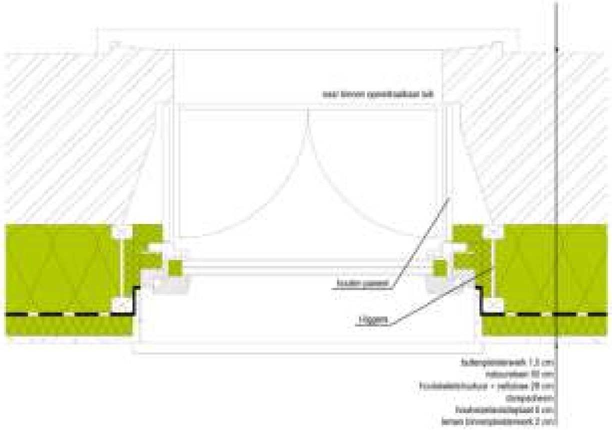
Thermal bridge avoidance:

Because of city regulations, insulating the façade on the exterior was impossible. Thus, a wooden I-beam construction was erected on the inside to be filled with cellulose. It cuts through all floor slabs, and even through the existing wooden support beams, ending next to the new roof construction. This allows for a continuous insulation and air tightness layer, as well as for a thermal bridge free connection to the floor slab.
The solution for the internal insulation in the basement was different. To solve the problem the wall insulated until a certain height to reduce the thermal bridge.. It was not enough to elimenate the thermal bridge but the temperature in the heated room is above the dew point which elimenate the risk of condensation.

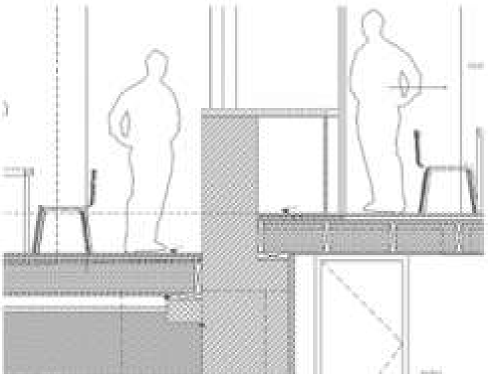
Box-in-box thermal envelope

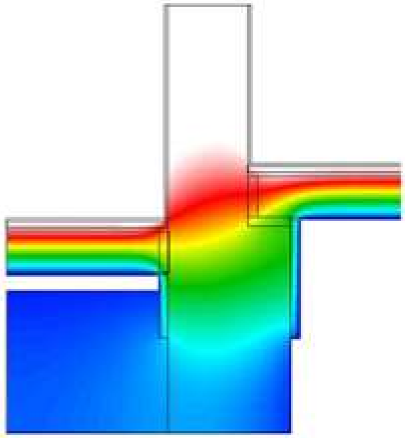


Connection of the interior insulation and floor, between the basement and first floor.



Connection of interior insulation and new joinery.





Thermal bridge simulation of the existing thermal bridge at basement wall.

Airtightness

The biggest problem to reach the required airtightness was the existing front façade and the common wall. To solve the problem of the airtightness of the common wall a layer of plaster was added. Thus was the airtightness guaranteed and the inertia of wall intact.

By sawing off the floor connection with the front facade, it was possible to place a continious airtight layer (with exception of the joinery). The foils were carefully placed by the owner. Elsewhere in the building was also paid attention to air leakage The result fulfills the requirement of the maximum allowable infiltration rate of 0,6^{h-1} for passive house constructions..

During the tests, there were still some openings available, e.g. the passage of the electricity. After several corrections, and after 10 blowerdoor tests, the result reached a n_{50} value of 0,4^{h-1} .

1

2

3

1 Airtightness connected with the new windows.

2 Airtightness layer behind the sawed beam.

3 Hermetic taping from the timber frame to the facade

6. BUILDING SERVICES

HEATING SYSTEM

The main heating is provided by the decentralized ventilation system, with an electrical heating after the pulsation channel, per area. The fresh air is pre-heated by a ground-coupled heat exchanger. The building is split up in 3 thermal areas, to be able to regulate better the temperature. Additional heating is done by radiators in the bathroom to let the towels dry.
A pellet stove has been installed in the living room.

VENTILATION

A balanced ventilation system with heat recovery was installed (type D, R=78%).

HOT WATER PRODUCTION

A Solar collector of 8m² provides heat for both domestic hot water and space heating. This was a requirement to get the label "Zero Energy House" and then be able to apply for a green credit.

Winter strategies

- *The solar gains are maximized in winter by the orientation of the windows. The big windows are orientated to the south, with a nice view on the garden.*
- *The common wall has a high thermal inertia that helps to avoid sharp fluctuations in temperature.*
- *Ventilation system type D coupled to electrical heating after the pulsation channel, is the main heater of the house.*
- *Extra heating with a pellet stove has been placed in the living room. Radiators has been installed in the bathroom's.*

Summer strategies

- *Solar panels as solar shading on the second floor.*
- *Natural ventilation in the day and mechanical ventilation in the night.*

Ventilation system "D" with heat recovery (R=78%)

Pellet stove in the living room

7. ENVIRONMENTAL PERFORMANCE

WATER MANAGEMENT

The owners recuperate the rain water in a rain water tank of 750 liters. It has a filter before entering to the tank made by plants. The collected water is used for the toilet and the washing machine.

RECYCLING/ REUSE

The existing structure and materials were reused as much as possible.

ECOLOGICAL MATERIALS

Cellulose insulation in roof, walls and floors.

CERTIFICATION/ LABELS/ AWARDS

This house is certified by PHP as a 'passive house'. They have also achieved the "Zero Energy House" standard. With this standard they were able to ask for a green credit.

8. USER EXPERIENCES

The improvements in the insulation, ventilation and heating, guaranteed a healthy environment for their asthmatic son and also an extra comfort for him and the rest of the family.

USER TESTIMONIAL

«The medium temperature is 20 C in winter and 28 C in the summer. It is warm, but most of the time cooler than outside. We have noticed that the solar shading is necessary for the big windows on the south. This will be our next step."

Result after renovation

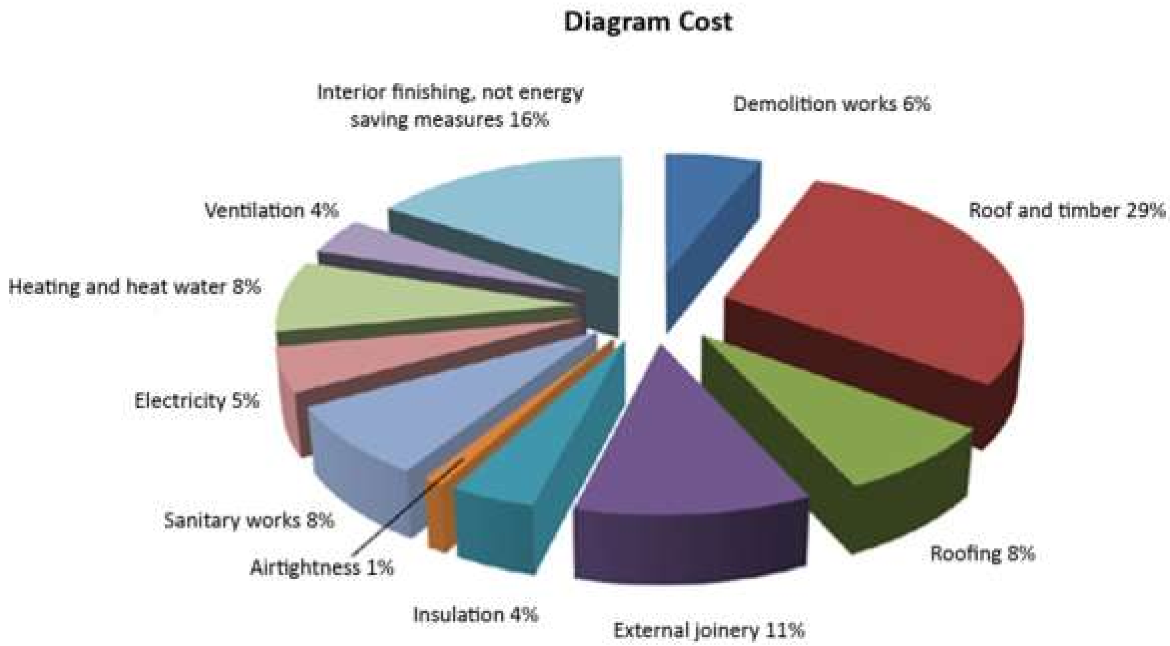
Back façade before renovation

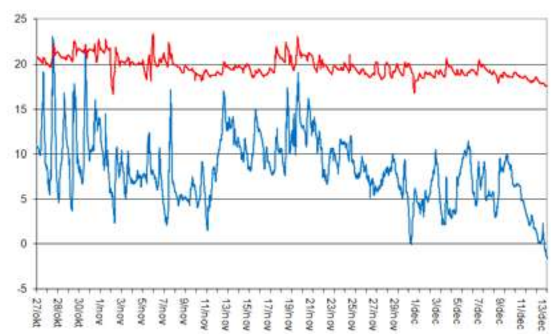
Image during the renovation

Water tank filter

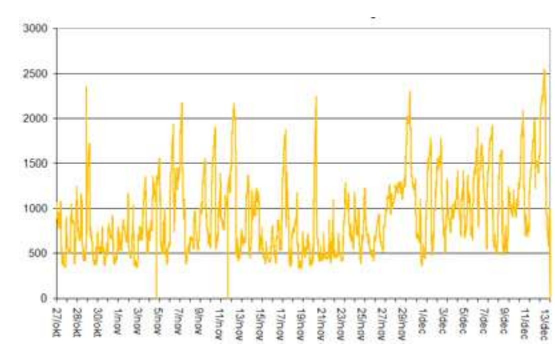
9. COST INFORMATION
RENOVATION COSTS

	€ (euro)
Insulation, airtightness, ventilation and heating system, excluding cost of timber work	27,500
Not energetic aspect: new kitchen, bathroom, floor finishing, demolition roof finishing	78,000
Collector system of rain water	9,100
Earth-to-air heat exchanger	2,800
Solar panels	8,000
Pellet heating system	1,000
Total investment cost (excluding taxes)	**171,240**
Total price per m² (180m²)	**951,00**
Cost of energy demand before renovation	**2,149,00 / year**
Cost of energy demand after renovation	**150,00 / year**





Monitoring of temperature



Monitoring of CO2 concentration