Passive House PASSIVPALAU
Project documentation

Detached house in Palau-solità i Plegamans, Spain

Designer in charge: Eva Jordan Guerrero, arq. http://www.arquitir.com
Col. Micheel Wassouf

This private house is located near Barcelona and was built with timber construction above concrete slab. It retains a small building and the pines existing. During the first year the family has saved 76% of their energy consumption in comparison with his older house placed at the same village.

See also www.passivehouse-database.org, Project ID: 4462

Special features : adaption standard Passivhaus to Mediterranean Climate

U-value of exterior wall	0.142 W/(m²K) 0.177 W/(m²K) 0.125 W/(m²K)	**PHPP Demand Annual heating**	**9 kWh/(m²a)**
U-value of the roof	0.116 W/(m²K)		
U-value of floor slab	0.391 W/(m²K)	**PHPP primary energy** 101Kwh/(m²a)	
U-value of the windows	1.20 W/(m²K)		
Heat recovery efficiency	77.2%	Pressurisation text n_{50}	0.24 h^{-1}

1. Context

The present project is a detached house located in the village of Palau-solità i Plegamans, near Barcelona, situated in the region of Vallès Occidental. Due the proximity to the Catalan capital, only 30km, and following the recommendation of the Passivhaus Institut, the building has been simulated with the official Barcelona climate, making the corrections due its height differences from the capital.

The project began in late 2012. The image in mind of the future house was a Mediterranean home with one level with its roller blinds as solar protection, fully opening windows, tiled roof and a wide outside space to grow their own orchard.

In this side, the Mediterranean solution of placing the windows in the inside face of the wall, in order to allow its full opening and also solar protection, with a large volume wooden roller blind incorporated on the lintel, has supposed a specific study and a thermal bridge and comfort calculation challenge.

The definitive construction system has been based in ventilated roofs and facades in order to refrigerate the building in summer.

2. Construction and photo-documentation

The detached house consists of a ground floor with a L-shape. The north side hosts the main entrance of the house and the living room, while the rest of the program lies in the east side (kitchen, two bathrooms and two bedrooms).

A structural wooden system with pine pillars and beams (Pinus radiata) was the chosen one to build up the house. The roof structure is sloped, corresponding to the roof slope. The foundation, after analyzing the characteristics of the ground after a geotechnical study, is based on a concrete slab with a thickness of 15 cm, over a layer of gravel and a waterproofing membrane.

Previous work consisted in cleaning the ground and executes the excavation of trenches for the foundation. The drainage system was also implemented. After verifying its correct operation, the arming of the struts and their concrete was done. This initial process was completed in a period of 20 days.

Construction of floor slab:

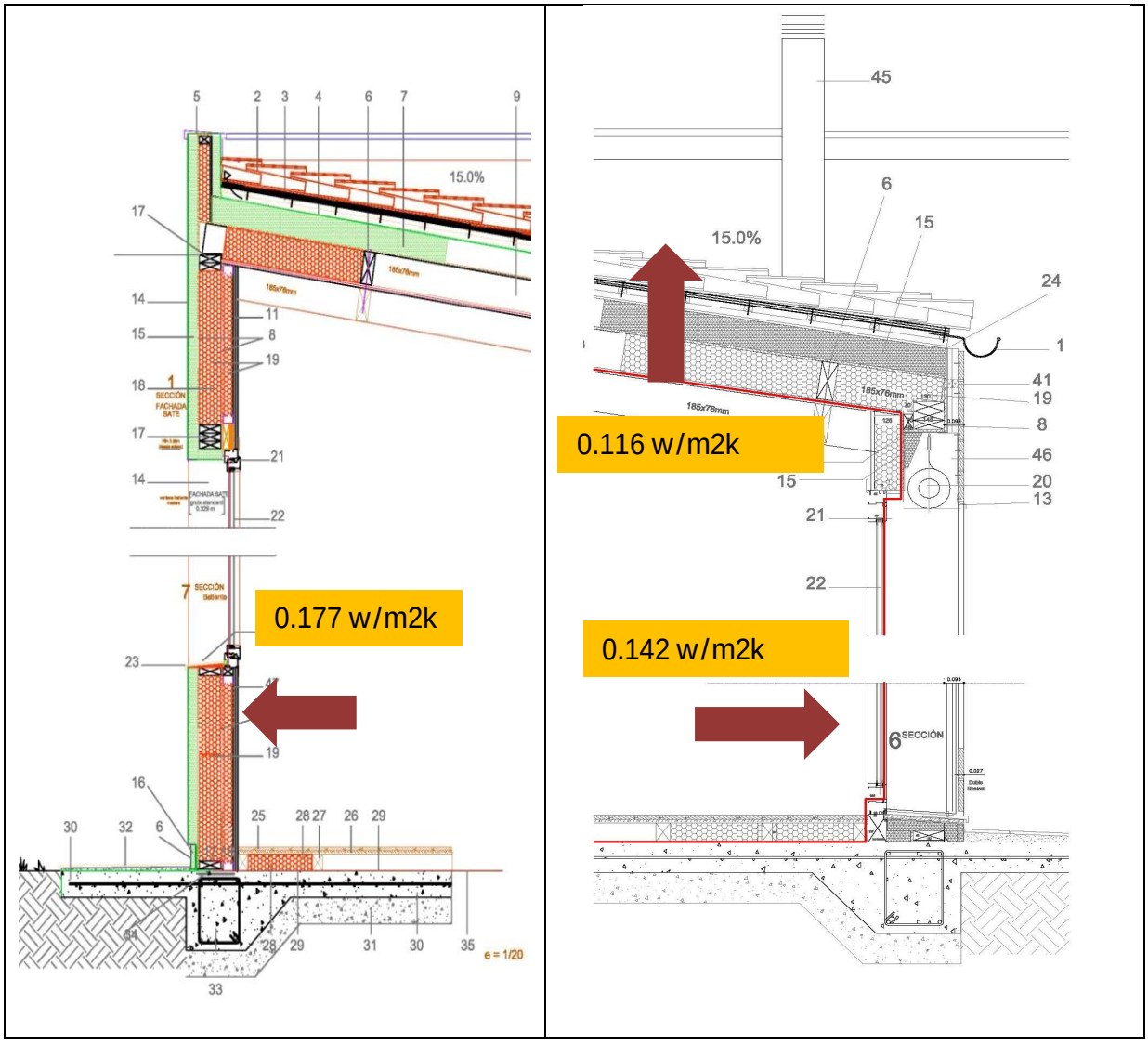
Slab *:* Grave layer and drainage system + Arming over the waterproof membrane + concrete 15cm+wood battens 94mm +cellulose 94mm/ WLG 039 + OSB3 panel+ parquet flooring. *U-value: 0.39w/m²k*

Special band connectors between the slab and the facades.

Construction of the exterior walls:

-EIFS facade (Exterior Insulation and Finishing System): thermal insulation Neopor. 60mm eps *0.032w/mk* +OSB3 panel+ wood structure + cellulose 145mm 0.039w/mk + OSB3 panel + 2x15mm PPF double plate plasterboard. *U-value: 0.177w/m²k*

-Ventilated facade: wooden slats on a double batten +impermeable membrane+ OSB3 panel+ wood structure + cellulose 145mm 0.039w/mk + OSB3 panel + 2x15mm PPF double plate plasterboard. *U-value: 0.142w/m²k*



The waterproofing of the ventilated façade is guaranteed by placing impermeable membrane, Rothoblaas TRASPIR 135, over the OSB. The thermal insulation of the walls, is done with cellulose from recycled newspaper, injected through prefabricated wooden panels.

u ulation Neopor 140mm 0.032w/mk + OSB3 panel + wood structure + cellulose 185mm 0.039w/mk+ OSB3 panel + double plate plasterboard. *U-value: 0.116w/m²k*

Sandwich roof: sandwich on battens 30mm + impermeable membrane + thermal insulation Neopor 140mm 0.032w/mk + OSB3 panel + wood structure + cellulose 185mm 0.039w/mk+ OSB3 panel + double plate plasterboard. *U-value: 0.116w/m^{2}k*

The points of special risk of water penetration have been covered by a layer of asphalt adhesive.

Lifting of roof wooden structure: Sandwich cover + Tiled roof


Waterproof membrane on the wooden frame structure + Neopor thermal insulation




Construction inside:

The non-structural internal partitioning is performed by wooden room divider and plasterboard partitions. Decorative wooden roof structure and natural parquet flooring, and synthetic one for the bathrooms.

Windows and installation of the window:

It has been installed the Elegance 88 carpentry type, from the company Luis Ortiz SL, made of wood laminated pine, with a transmittance U_{frame} 1.25 W/m^{2}k (EN 12412-2), and double glazing with argon gas and thermal transmittance U_g 1.1o W/m^{2}K (EN-673) and solar factor g of 53% (EN-410). The spacer, Thermix TXN by Ensinger, has an estimated linear thermal transmittance of 0,039 W/m2k.

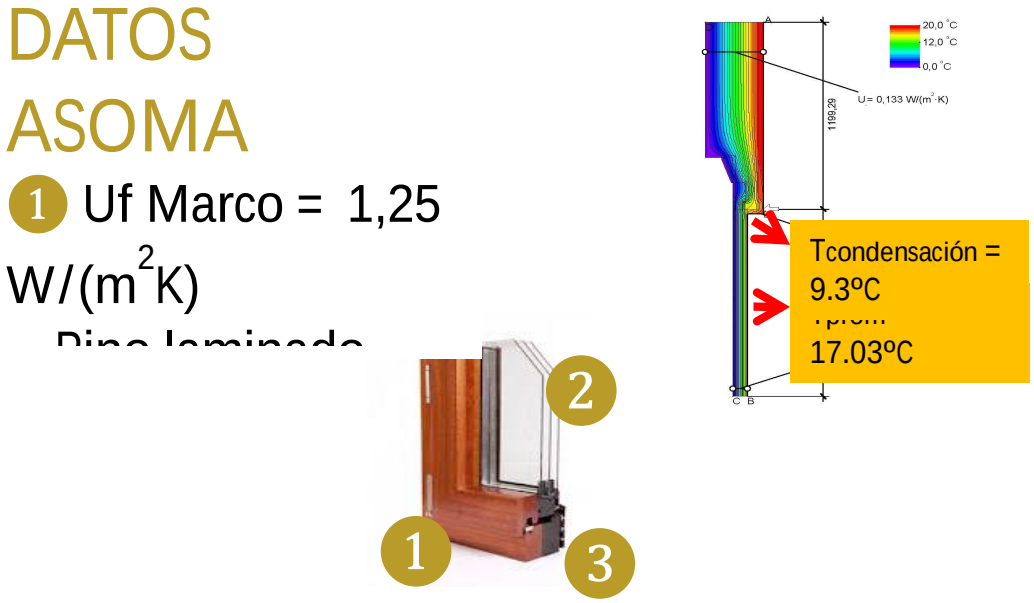
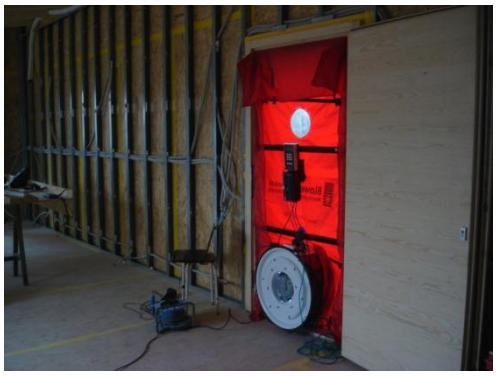


Photo: carpentry used. Inside and outside *view. U_{window}: 1.20 W/m^{2}K*

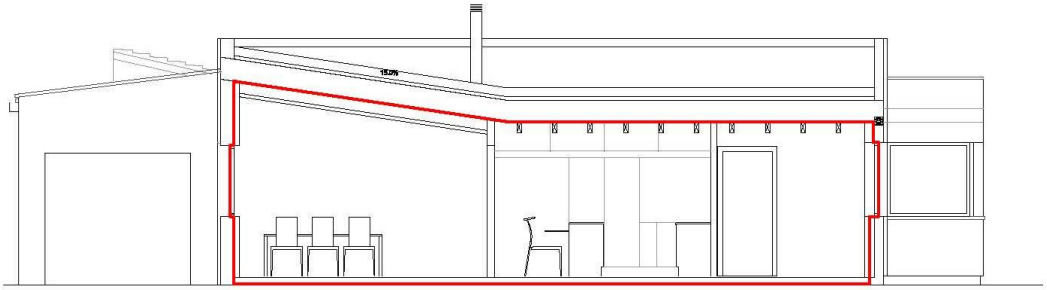
3. Blower Door Test



TEST A n50 = 0.24 1/h Date: 6/3/2014

TEST B: n50 = 0.24 1/h Date: 13/12/2014

Test made by Energiehaus scp M. Wassouf



The airtight building envelope is made by OSB panel on the floor, walls and roof. The panels are sealed together using special tapes to ensure tightness. They are also sealed encounters between floor slab, facades and roof.

The blower-door test had been carried out after PHI-recommendation with a result for the n50=0,24 1/h (overpressure 0,24 1/h and underpressure 0,25 1/h).

4. VMC Flow Calibration

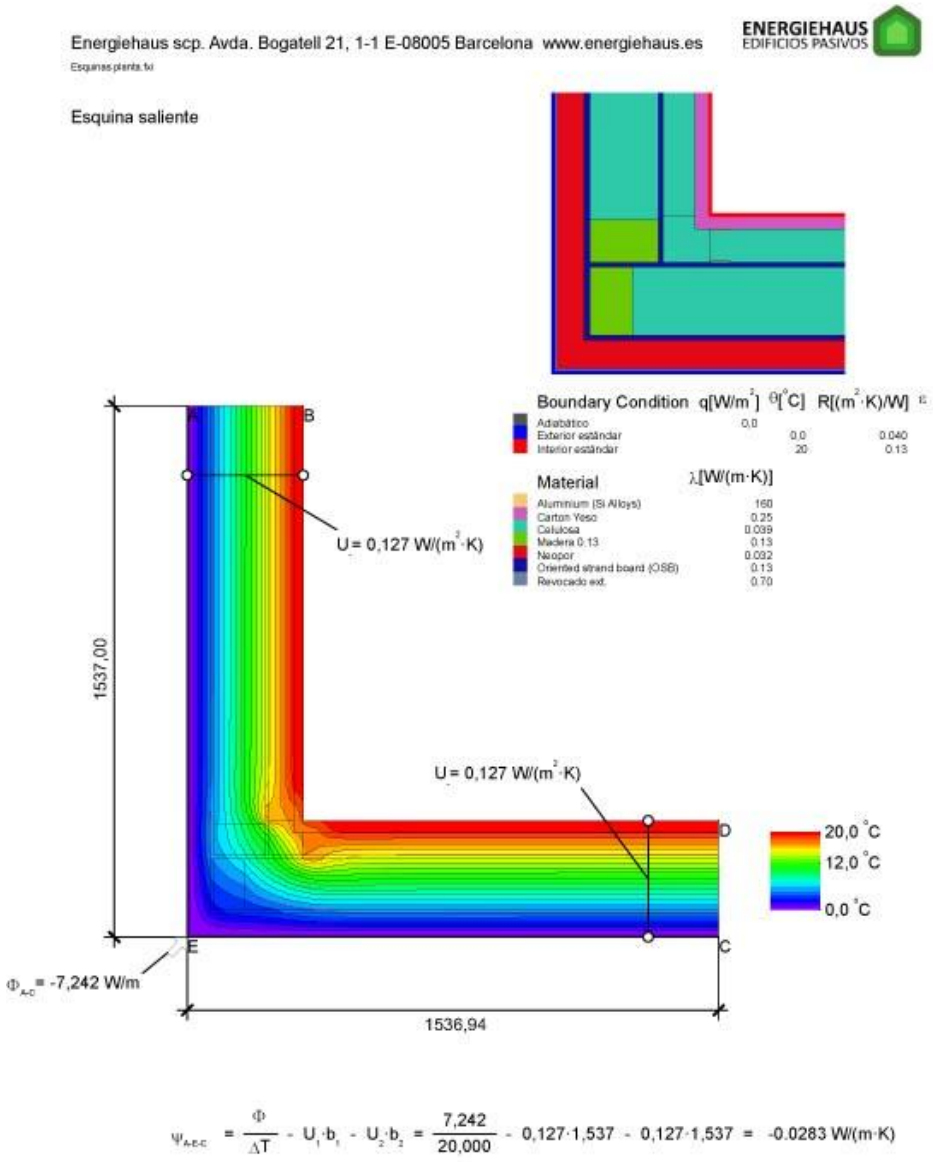
To ensure the comfort standards set by the Passivhaus Institut is important to check that the system of controlled mechanical ventilation is properly calibrated. The maximum range allowed between the supply and extract can not exceed 10%. This ensures not only the concepts of comfort, but high efficiency of heat recovery. Calibration was made with standard V1 position (standard PassivHaus).

Calibration performed on date 03/13/2014 by technician Josep Castellà from Zehnder Group Iberica IC, SA CIF ESA-59069922, in the process of implementation of the ComfoAir 350 machine.

5.Comfort and Hygiene justification

Room	Area [m2]	Average Height [m]	Volume [m3]	Extract. [m3/h]	Supply [m3/h]
Living Room	45,8	2,95	135,11		18+23
Kitchen	13,2	2,75	36,3	-21-20	
Bedroom 1	13,6	2,6	35,36		17+21
Bedroom 2	9,8	2,75	26,95		18
Bathroom 1	3,5	2,6	9,1	-14	
Bathroom 2	5,8	2,6	15,08	-20	
Store	7,9	2,6	20,54	-22	
			TOTAL	-97	97

Due the fact that the house has no certified glassware and carpentry certified, and the Uw value is 1.25 W/m2K, (instead of 0.85 W/m2K for Uwinstl.), it has been necessary to justify the criteria of comfort and hygiene with a finite element tool (Flixino 7.0).



$$\Psi_{A\text{-}E\text{-}C} = \frac{\Phi}{\Delta T} - U_1 \cdot b_1 - U_2 \cdot b_2 = \frac{7,242}{20,000} - 0,127 \cdot 1,537 - 0,127 \cdot 1,537 = -0.0283\ W/(m \cdot K)$$

6. Summer comfort and thermal inertia

In the PHPP we have simulated the thermal inertia of 84 Wh / k and a square meter of reference. That means that one of the 6 walls of the building is considered "heavy". This assumption is justified because the slab is made of reinforced concrete.

The wooden facade are fitted with roller blinds. It has been taken a summer sun protection factor "z" according to DIN V 18599-2 for insulated double glazing and outside blind position z = (0.3 + 0.7) * 0.14 = 40%.

Regarding the summer ventilation, a daytime ventilation with the VMC switched on and bypass off has been simulated. The hygienic flow in summer is 1.5 times the winter flow = 0.55 / h. In the night, controlled ventilation will be off and the user will open the windows of H2 and Living. The strategy is to open one of the leaves of window FO3.1, and open partially the window FS2.1 of the Living-room. According PHPP (sheet SummVent), that equals to a natural night ventilation of 1.57 / h renovations.

With this hypothesis, the theoretical overheating in summer above 25°C is 24.8%. To compensate this overheating, an air cooling machine is installed inside the housing, which allows to dehumidify the (latent component).

7.Heating

The property has a point of heating in the Living-room: a wood stove (Jotul F163), with a nominal heat output of 5 KW, according to EN-13240.

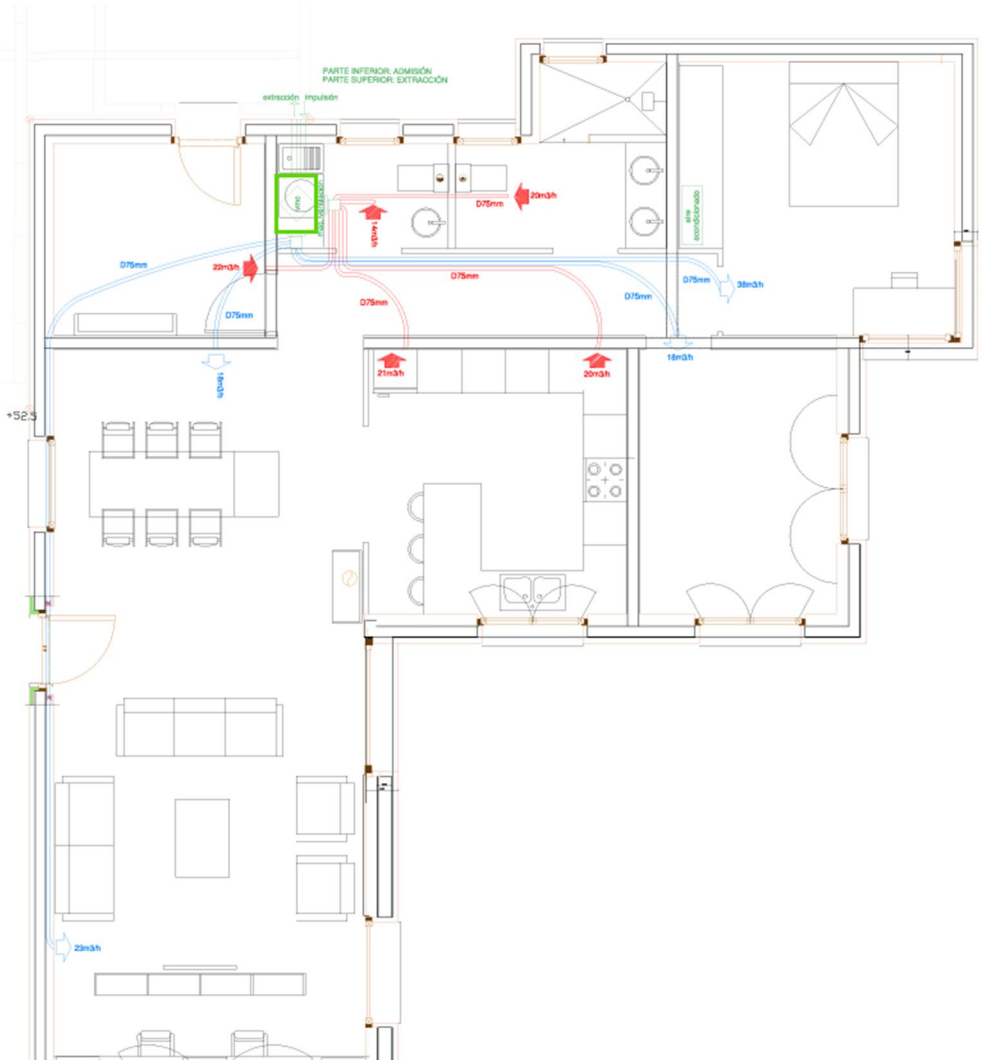
Stove in the Living-room.

8. Winter ventilation

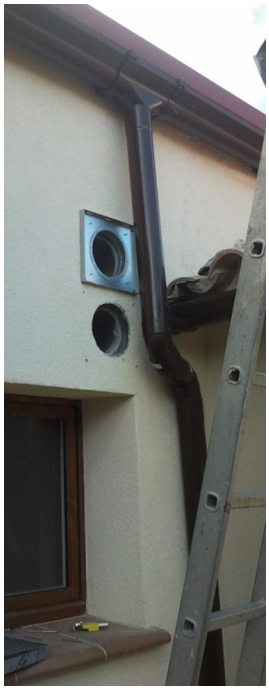
In order to control the ventilation, I has been installed the Comfoair 350 W machine, from Zehnder, inside the house (in the small bathroom), with direct input and output air conducts. This system ensures high energy efficiency for heat recovery. The nominal output of the machine is 84% and the nominal power consumption is 0.29 Wh/m3.

The effective heat recovery value, taking into account the conductivity of the air conduct supply / extract and its length, it is reduced to 77.2%.

Intake air from the backyard, located close to the machine. The distributor carries air to the rooms, living room and collects air in kitchen, pantry and bathrooms. The air ducts are hidden in the walls cameras and ceilings. Metallic’s grids are located on the walls, at the top for removal aire and at the bottom for extraction air.



Ventilation system: Red conducts: extraction / Blue conducts: supply
VMC located inside the Bathroom, (green rectangle).PVC Ventilation conducts through dropped ceiling.



9. PHPP Main Results

Valores característicos del edificio con relación a la superficie de referencia energética y año						
	Superficie de referencia energética	105,9	m²	**Requerimientos**		**¿Cumplido?***
Calefacción	Demanda de calefacción	**9**	**kWh/(m²a)**	15	kWh/(m²a)	**sí**
	Carga de calefacción	**9**	**W/m²**	10	W/m²	**sí**
Refrigeración	Demanda total refrigeración	**17**	**kWh/(m²a)**	18	kWh/(m²a)	**sí**
	Carga de refrigeración	**10**	**W/m²**	-		**-**
	Frecuencia de sobrecalentamiento (> 25 °C)		%	-		**-**
Energía primaria	Calef., ref., deshum., ACS, elect. auxiliar, ilum., aparatos eléct.	**117**	**kWh/(m²a)**	120	kWh/(m²a)	**sí**
	ACS, calefacción y electricidad auxiliar	75	kWh/(m²a)	-		**-**
	Ahorro de EP a través de electricidad solar		kWh/(m²a)	-		**-**
Hermeticidad	Resultado ensayo de presión n_{50}	**0,2**	**1/h**	0,6	1/h	**sí**

* Campo vacío: faltan datos; '-': sin requerimiento

Passivhaus?	**sí**

10. Construction costs

The cost of construction of the house is around 1200 € / m2 (taxes, project architect and foundation not included).

11. Information about de team:

Architect: Eva Jordan Collaborator: M. Wassouf, Technical Architect: Joan Vilanova as Structural Calculation consultants: BG Blazquez – Guanter, Builder: Papik Cases Passives.

12. User's Experiences:

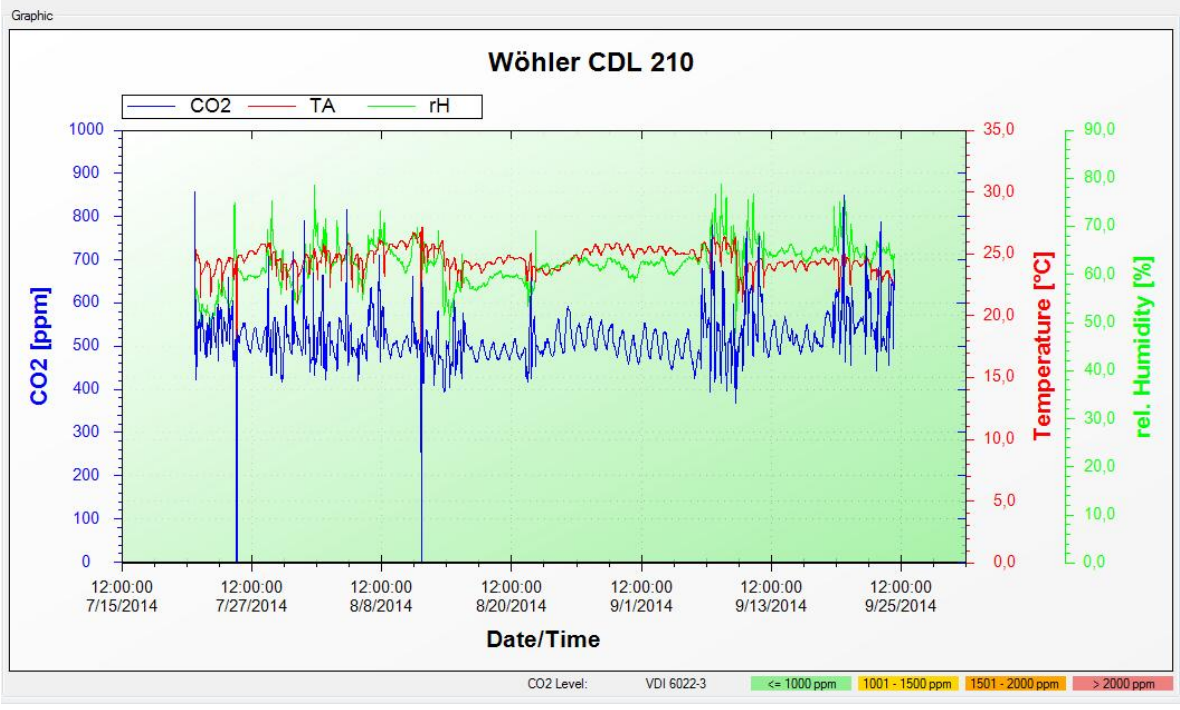
Devices in a PassivHaus: The first is the recirculation extractor. Tightness pursued by Passivhaus not allow a conventional hood in the kitchen, would be a considerable loss of warm air and cold air intake. The extractor works with activated carbon filters and returns the air at the same kitchen. After a year normal use, we cook much, the result is quite satisfactory.

The second device and heart of the system is the machine for mechanical ventilation with heat recovery. Unlike most northern climates, in summer the house is not closed, so the work of the heat exchanger can be evaluated after winter. Summer nights the bypass has been insufficient with the windows closed, therefore in warmer months natural cross ventilation at night and morning is necessary.

The third device is the water heater. Perhaps the most common solution would be a thermos with solar collectors, but compared to aerotermia (a heat pump air-water) we decided on this due to its simplicity and maintenance.

The average of consumption during a year for two people and electric devices has been approximately 4.41 kW / day. The energy consumption in our previous home, built in 1997, was about 18.36 kW / day. Energy savings in invoices (electricity and gas) comparing previous house and PassivPalau have been 76% during the first year.

During the colder months, December until March, we have lit the stove only 54 days for less than two hours.



13. Publications:

-Passiv Palau : Arquitectura y Madera Journal.

- Roca Gallery Barcelona. October 2014.

-Exposition Construction 21 Barcelona. May 2015.

-Exposition Sabadell Catalonia. May 2015.

-Exposition Escola Elisava Barcelona. October 2015.

-Exposition Colegio Aparejadores Gerona. October 2015.

-PassivPalau: Casa pasiva mediterránea. Smart Building Journal. November 2015.

14. Photos: