1_Abstract of the PassivHaus in Arrúbal (La Rioja) .

External picture of the house, north facade.

1.1 Data of building

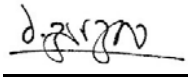
Year of construction:	2016	**Annual heating demand**	14 kWh /(m2a)
Exterior Wall U-value	0,142 W/(m²K)	**Primary Energy Renewable demande (PER)**	98 kWh /(m2a)
Basement floor U-value	0,123 W/(m²K)	**Generation of renewable energy (reference to ground área)**	11 kWh /(m2a)
Roof U-value	0,122 W/(m²K)	**Non-renewable primary Energy (PE)**	79 kWh /(m2a)
Frame window U-value	1 W/(m²K)	**Pressure test n50**	0,4 h-1
Window U-value	0,83 W/(m²K)	**Special features**	
Glazing U-value	0,64 W/(m²K)	It gets domestic hot water thanks to photovoltaic energy, and it uses surface geothermal energy so that it is even more energy-efficient.	
Heat recovery	84%		

1.2 Brief Description

The surface of the plot is 275.60 m2. It is located in Travesía de Gonzalo de Berceo in the town of Arrúbal (La Rioja, Spain). The house faces south-north with 18 degrees of deviation, so that the kitchen, living room and master bedroom look south whereas the other two bedrooms, the main entrance and the garage do north. It is built according to the Passivhaus standards, developed in a single volume on the ground floor. The facades have been designed using concrete slabs with outer finish in white and dark brown brick. A flat roof has been projected with 16x16cm wooden beams. These rest on the outer walls and on different load bearing walls located inside the house. Ceramic tile and brick + plaster have been used as interior finishes to have good thermal inertia into the building.

dwelling	**SUPERFICIE ÚTIL (m2)**
Garage	28,27
Hall	10,00
Passage area	5,16
Installations	3,91
Bath 1	4,35
Bath 2	4,19
Kitchen	10,37
Living room	25,51
Bedroom 1	16,83
Bedroom 2	11,99
Bedroom 3	11,43
TOTAL	**132,01**

1.3 Responsible Project participants

Architects	David Zorzano y Celia Zorzano
Implementation planning	David Zorzano y Celia Zorzano
Building systems	Construcciones Zorzano / Ecotelia Rioja
Structural engineering	Pedro Pablo Zorzano Gonzalo
Building physics	David Zorzano y Celia Zorzano
Passive House Project Planning	David Zorzano y Celia Zorzano
Construction management	Construcciones Zorzano
Certifying body	Energiehaus Edificios Pasivos
Certificaction-ID	14613_ENH_PH_20161117_MW
Passive House Database-ID	5183
Author of Project documentation	David Zorzano Gonzalo
Date	January 2017
Signature	

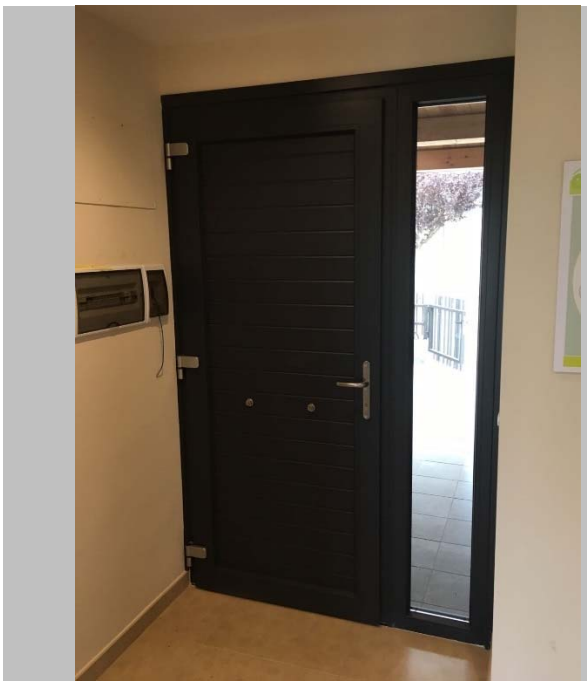
2_Views .

East facade.

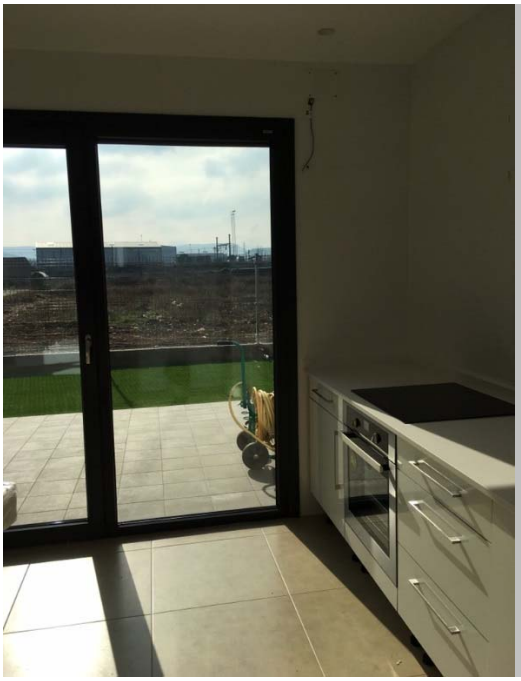
South facade, where you can see the awnings.

West facade.

North facade.

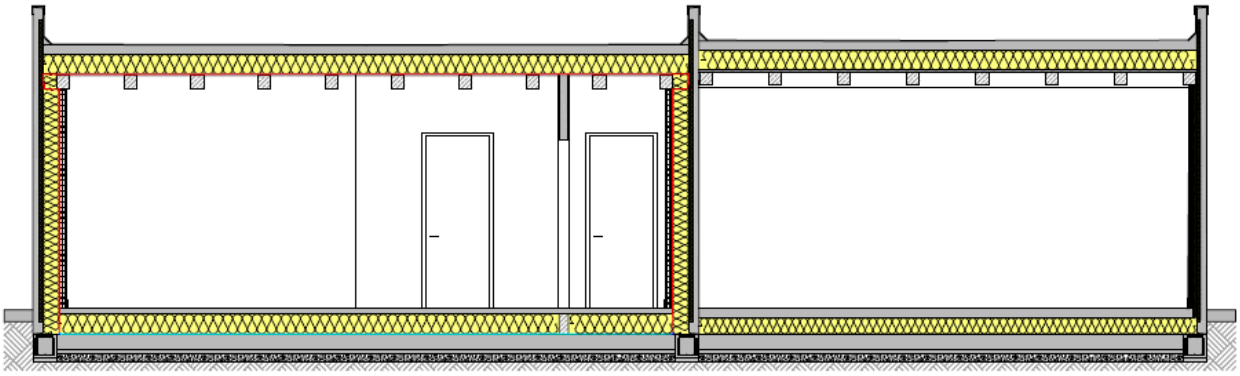



Main door and bathroom.

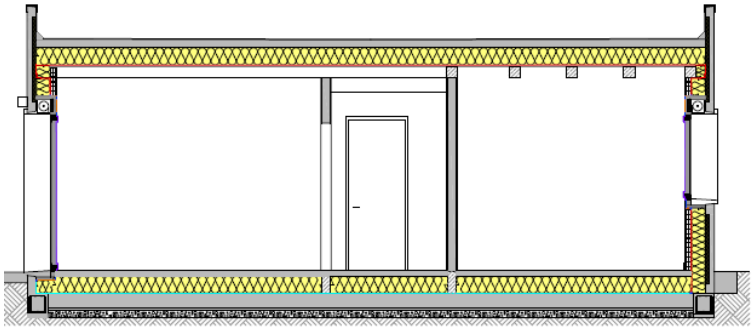


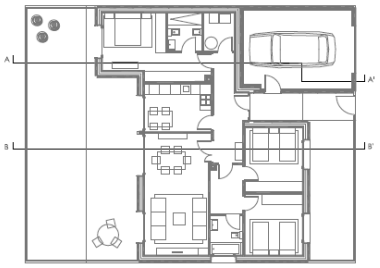

Kitchen and living room.

3_Sectional drawing .



Section housing and garage.





Section housing.

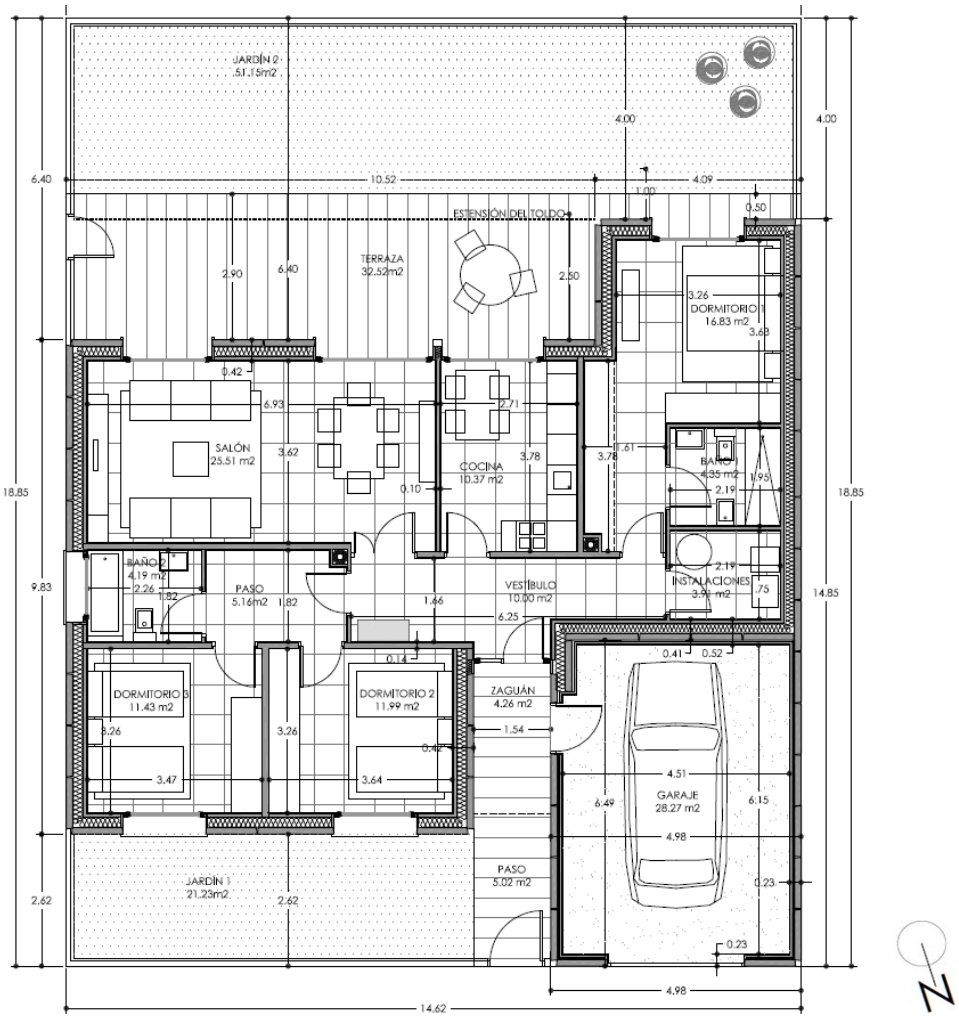
The section of the drawing shows clearly the layer of continuous insulation throughout the whole house (yellow), completely avoiding the existence of thermal bridges. 25cm of Neopor insulation have been placed on the floor and ceiling, whereas, 20cm of Neopor insulation have been placed on the walls, including the one in contact with the garage. Furthermore, the seal line (different colors) makes secure the protection against the infiltrations of the outside air. Special attention has been paid to external seals to prevent air from entering the insulation layer; all that improves its thermal capacity.

The cover has been made with a wooden structure that adds warmth to the rooms and also serves as a CO2 tank. In the 21st century's houses, in addition to seeking energy efficiency, we must build buildings with sustainable, reusable and other recyclable materials: we have used, not only, ecological paints A +, but also, wood.

A flat roof has been designed where 4 photovoltaic panels have been installed to take advantage of the solar radiation that exists in Spain, and to provide ecological and renewable energy in the sanitary hot water and in the general electricity of the house.

Due to the prefabrication of the outer walls, this house has been built very quickly and easily. The construction of a Passivhaus building requires a very controlled and clean execution, so the prefabricated elements help us to perform a good execution on the building site.

4_Floor plan .



The house is distributed in an orderly way on a plot almost quadrangular. The main entrance is sheltered by side walls and a small wooden deck which protect us against bad weather and rainy days.

The secondary bedrooms and the garage have been arranged in the north. The main bedroom, kitchen and living room are in the south area, this way you can open large gaps that will serve to capture as much solar radiation as possible. In this house, one winter day, due to the height of the windows the sun is able to get the opposite wall, getting the largest possible contribution of free and clean solar energy.

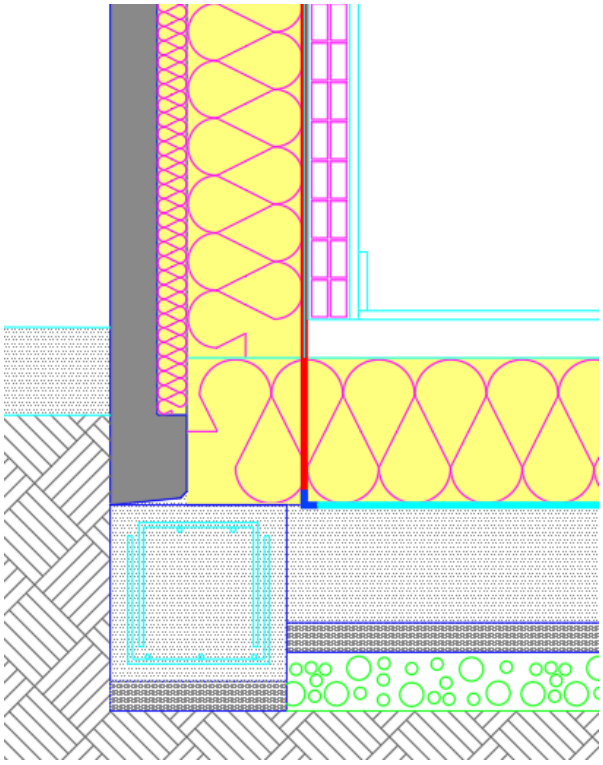
In the lobby area, a pellet stove has been placed so it gives us the necessary heat to reach a good degree of comfort on cloudy or cold winter days. This form of energy is ecological and renewable; moreover, the price of the pellets is very low and it brings a big saving to the families.

The garage has been left outside the thermal envelope as it is not air-conditioned and is not to live in.

It has 2 exterior gardens, the smallest one faces north and the second does south, where there is also a porch that it has been installed with a retractable awning owing a photocell to avoid overheating in summer.

5_Construction details of the envelope and PassivHaus techology .

5.1 Construction including insulation of the floor slab with connection points of exterior and interior walls.



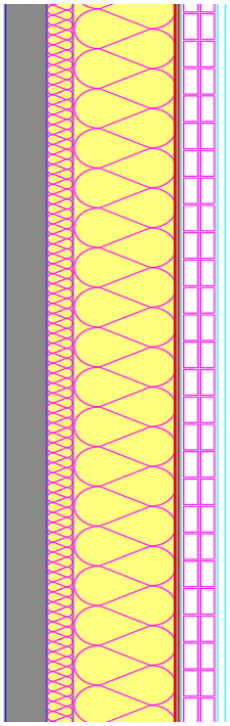
Floor construction section.

Photo of the floor.

To avoid thermal bridges completely, the outer walls are directly over the foundations. Inside the house, insulation has been placed over the concrete floor so that it can pass through the entire perimeter without any obstacles. Then the regularization mortar is placed where the inner brick wall finally lean upon.

FLOOR SLAB	
Ceramic tile	15mm
Mortar	70mm
Insulation Neopor	250mm
Reinforced concrete slab	200mm
U value: 0,123 W/(m2K)	

5.2 Construction including insulation of exterior walls.



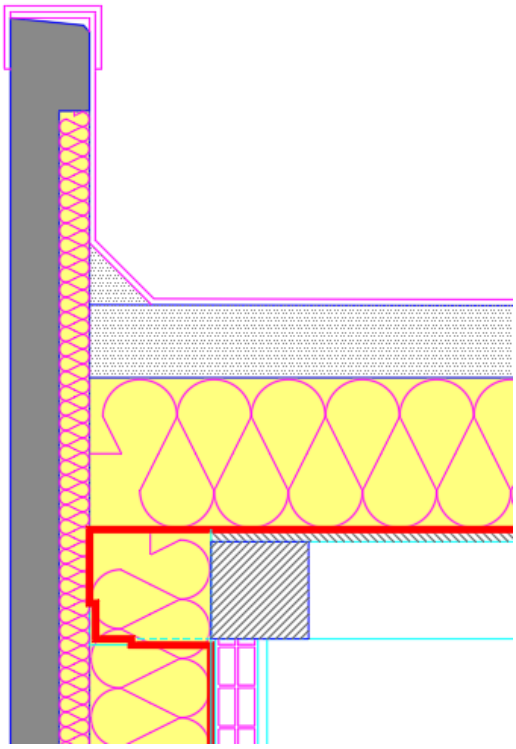
Construction wall section.

Photos building the wall.

The façades are made with reinforced concrete slabs of 13cm thick and a facebrick finish anchored to the foundation using metallic pieces. Large size bricks of 52x67,5x7cm have been used for the interior wall of the house. The partitions have been made with large size bricks of 50x19x11,5 cm. Since there are no pillars because the structure rests on the outer wall we do not have thermal bridges.

EXTERIOR WALL	
Black plaster	15mm
Brick GF	50mm
Insulation Neopor	200mm
Isolation EPS	50mm
Concrete plate Zorzano	80mm
U value: 0,142 W/(m2K)	

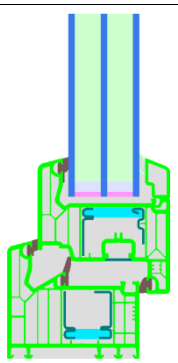
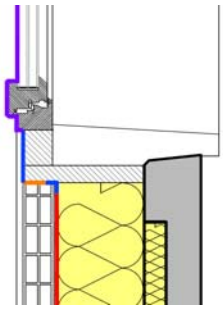
5.3 Construction including insulation of the roof.

	
Cover construction section.	Cover photo.

A flat roof has been designed using slopes of 2% made with regularization mortar and topped with self protected asphalt. Wood beams of 16x16cm have been used for the structure where a wooden platform rests so that it will be seen from the interior. The collection of rainfall is done by PVC sinks and internal PVC downspouts with a diameter of 90mm.The internal downspouts are thermally insulated.

ROOF	
Wooden platform	22mm
Insulation Neopor	250mm
Regularization mortar	90mm
Asphalt sheet	15mm
U value: 0,122 W/(m2K)	

5.4 Window sections including installation drawing.

	
Glazing composition 4/16GA/4/16GA/4, filled with inert gas	Installation drawing Assembled on wooden pre-frame

	
Air tightness treatment around the window cavity	External image

Glazing

Excellent glazing composition 4/16GA/4/16GA/4, filled with inert gas, it was used with g = 0.49 and Ug=0,64 W/(m²K).

Installation

The installation of the window was decided taking into consideration to avoid overheating, so it has been placed inside the wall.

The thermal bridges of the window installation were calculated in the building planning stage with the Flixo programme. The results were introduced into the PHPP to check the correct energy balance.

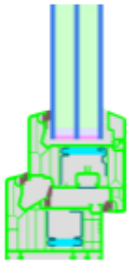
Outer protection to prevent overheating

Due to the location of the building, in Spain, and the degree of sunshine it has been necessary to design the window with blinds.

The blinds have been placed outside the thermal envelope. They are controlled through an electrical device, in that way, air infiltration is avoided.

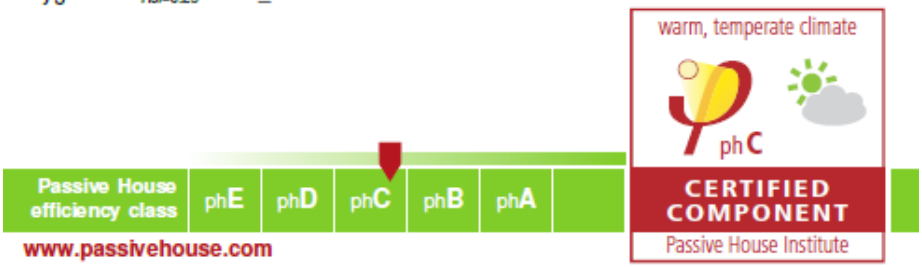
Window data		
window	PVC frame with thermally broken and insulated (0.035 W/(mK) reinforcements. Pane thickness: 44 mm (4/16/4/16/4), rebate depth: 28 mm, spacer: SWISSPACER Ultimate with polysulfide secondary seal.	Uw=0,83 W/(m²K) g=0,49 Ug=0,64 W/(m²K)

Category: **Window frame**
Manufacturer: **INRIALSA PVC S.A., Lardero, La Rioja, Spain**
Product name: **Window Ecoven Plus + by INRIALSA**



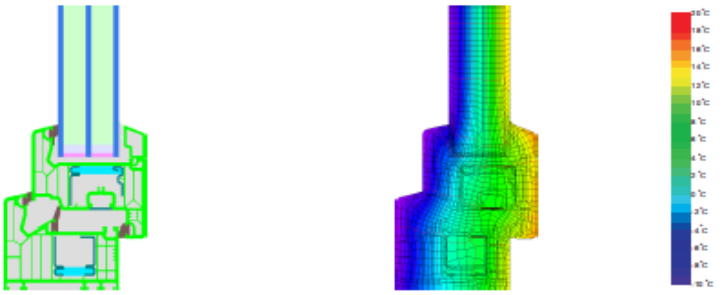
This certificate was awarded based on the following criteria for the warm, temperate climate zone

Comfort	U_W = 1.00	≤	1.00 W/(m² K)
	$U_{W,\,installed}$	≤	1.05 W/(m² K)
	mit U_g	=	0.90 W/(m² K)
Hygiene	$f_{Rsi-0.25}$	≥	0.65



Frame data.

INRIALSA PVC S.A.
Avda. de Madrid Km 4, 26140 Lardero, La Rioja, Spain
☎ +34 941 449199 | ✉ jorge.orte@inrialsa.com | 🖱 http://www.inrialsa.com/ |



Calculation model | Isothermal

Description

PVC frame with thermally broken and insulated (0.035 W/(mK) reinforcements. Pane thickness: 44 mm (4/16/4/16/4), rebate depth: 28 mm, spacer: SWISSPACER Ultimate with polysulfide secondary seal.

Explanation

The window U-values were calculated for the test window size of 1.23 m × 1.48 m with U_g = 0.70 W/(m² K). If a higher quality glazing is used, the window U-values will improve as follows:

Glazing	U_g =	0.90	0.64	0.58	0.53	W/(m² K)
		↓	↓	↓	↓	
Window	U_W =	1.00	0.83	0.79	0.76	W/(m² K)

Descripcion frame.

Frame values	Frame width b_f mm	*U*-value frame U_f W/(m K)	*Ψ*-glass edge Ψ_g W/(m² K)	Temp. Factor $f_{Rsi=0.25}$ [-]
Top	124	1.03	0.024	0.71
Left	124	1.03	0.024	0.71
Right	124	1.03	0.024	0.71
Bottom	124	1.03	0.024	0.71
Flying mullion	176	1.04	0.022	0.71
Spacer: SWISSPACER Ultimate			Secondary seal: Polysulfide	

Frame U values.

Marcos de ventana

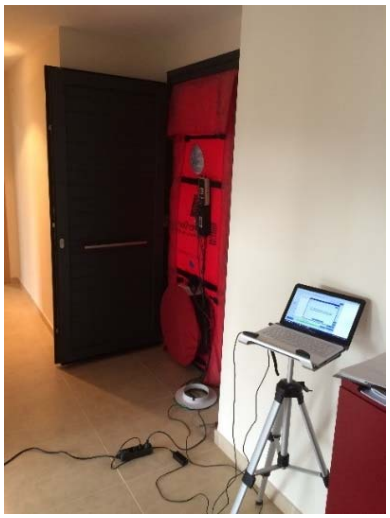
ID	Descripción	Valor U_f Izquierda	Valor U_f Derecha	Valor U_f Abajo	Valor U_f Arriba	Ancho del marco Izquierda	Ancho del marco Derecha	Ancho del marco Abajo	Ancho del marco Arriba
		W/(m²K)	W/(m²K)	W/(m²K)	W/(m²K)	m	m	m	m
01ud	V1	1,03	1,04	1,03	1,03	0,124	0,088	0,124	0,124
02ud	V2	1,04	1,03	1,03	1,03	0,088	0,124	0,124	0,124
03ud	V3	1,03	1,04	1,03	1,03	0,124	0,088	0,124	0,124
04ud	V4	1,04	1,03	1,03	1,03	0,088	0,124	0,124	0,124
05ud	V5	1,03	1,04	1,03	1,03	0,124	0,088	0,124	0,124
06ud	V6	1,04	1,03	1,03	1,03	0,088	0,124	0,124	0,124
07ud	V7	1,03	1,04	1,03	1,03	0,073	0,088	0,073	0,073
08ud	V8	1,04	1,03	1,03	1,03	0,088	0,124	0,124	0,124
09ud	V9	1,03	1,04	1,03	1,03	0,073	0,088	0,073	0,073
10ud	V10	1,04	1,03	1,03	1,03	0,088	0,124	0,124	0,124
11ud	V11	1,03	1,03	1,03	1,03	0,073	0,073	0,073	0,073
12ud	V12	1,03	1,03	1,03	1,03	0,124	0,124	0,124	0,124
13ud	P1	1,03	1,04	1,03	1,03	0,073	0,088	0,073	0,073

Marcos

Puente térmico en borde de vidrio: $\Psi_{Borde\ vidrio}$ izquierda	$\Psi_{Borde\ vidrio}$ derecha	$\Psi_{Borde\ vidrio}$ abajo	$\Psi_{Borde\ vidrio}$ arriba	Puente térmico de instalación: $\Psi_{Instalación}$ izquierda	$\Psi_{Instalación}$ derecha	$\Psi_{Instalación}$ abajo	$\Psi_{Instalación}$ arriba
W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)	W/(mK)
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,079	0,195	0,220
0,070	0,070	0,070	0,070	0,079	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,220
0,070	0,070	0,070	0,070	0,152	0,152	0,195	0,152

Data in PHPP

6_Description of the airtight envelope; documentation of the pressure test result .

<table>
<tr><td>  </td><td>  </td></tr>
<tr><td>Airtight sheet in the interior.</td><td>Airtight sheet on the cover.</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Airtight sheet in the entrance door.</td><td>Second test blower door.</td></tr>
</table>

To obtain a Passivhaus home it is necessary to target a value of less than 0.6 h-1 for the 50 Pa pressure test air.
In this house, it has been used a vapor barrier (intello) to get the sealing in the roof and the walls. On the ground, the sealing is reached with a very liquid concrete. The joint of the different parts which conform the vapour barrier is made by means of adhesive tapes of high resistance (tescon). Wooden frames have been used for the placement of the windows. The joint of the window and the vapour barrier is made with high strength adhesive tapes (tescon).

Two airtightness tests were carried out during the construction and once the house was finished. The company SERCONEVI S.L. performed the different tests. The first test gave a result of 0.43 h-1 and the second test gave a result of 0.38 h-1 for the 50 Pa pressure.

Declaración de prestaciones

DoP-Nr.: 4026639011237-003183

① INTELLO PLUS

② 10093
(Numero del lote véase impreso en la lámina)

Dampfbrems- und Luftdichtungsbahn

④ MOLL bauökologische Produkte GmbH
Rheintalstraße 35 - 43
68723 Schwetzingen

Sistema 3

El organismo notificado "Gesellschaft für Materialforschung und Prüfungsanstalt für Bauwesen mbH" - NB 0800 - ha realizado el ensayo principal de los propiedades de éste material según Sistema 3.

⑨ Prestaciones declaradas según DIN EN 13984 - Typ B

Propiedad	Norma	Valor
Longitud¹		20 m
Anchura²		1,5 m
Peso por superficie	UNE EN 1849-2:2001	110 ±5 g/m²
Grosor	UNE EN 1849-2:2001	0,20 ±0,05 mm
Valor-sd	UNE EN 1931 :2001	7,50 ±0,25 m
Comportamiento al fuego	UNE EN 13501-1:2010	E
Máx. fuerza a tracción long./trans.	UNE EN 13859-1:2005	350 N/5 cm / 290 N/5 cm
Dilatación long./trans.	UNE EN 13859-1:2005	15 % / 15 %
Resistencia al desgarre long./trans.	UNE EN 13859-1:2005	240 N / 200 N
Durabilidad, tras envejecimiento artificial	UNE EN 1296:2001 / UNE EN 1931:2001	

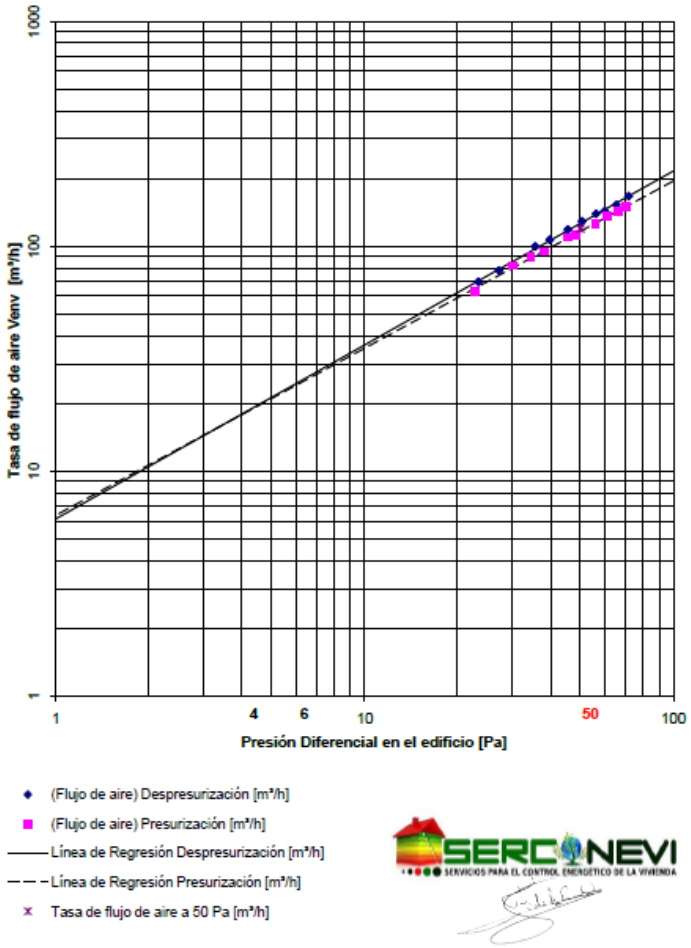
Tolerancias de medidas: ¹: +0.5 m; ²: +0.005 m

La prestación del producto según los números 1 y 2 equivale a la prestación declarada según numero 9. Responsable de la declaración de prestaciones es únicamente el fabricante según numero 4. Firmado por el fabricante y en nombre del fabricante por.

Lothar Moll, Gerente — Michael Förster, Director técnico

Schwetzingen, 02/04/2014

Airtight sheet data.



Graphic showing the infiltration and exfiltration curve of the Blower Door Test results.

EDIFICIO OBJETO:

Vivienda Unfamiliar

C/Gonzalo Berceo
Arrubal

Fecha del Test: 09/05/2016

Tasa de Renovación de Aire a 50 Pascales (n50)

METODO	A
MORMATIVA	Según norma EN 13829
	Test sobre edificio en uso

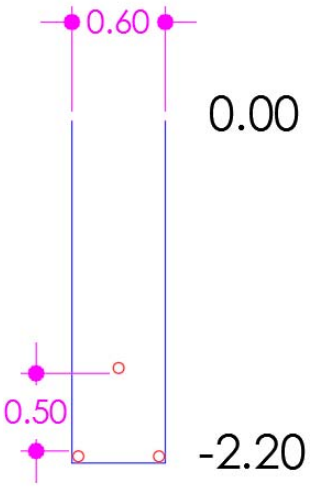
n50	**1/H**	=	**0,38**	0,38

Blower Door Test results.

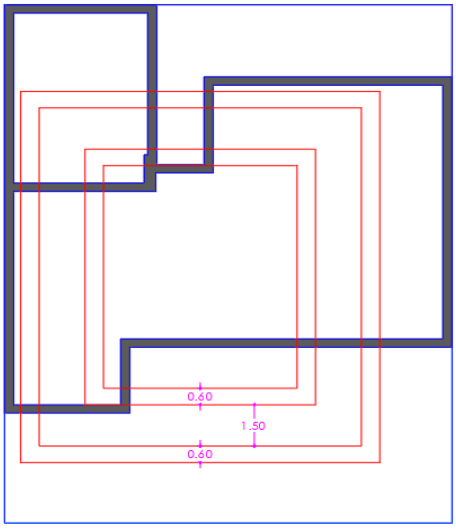
7_Planning of ventilation ductwork .

Pipes for superficial geothermal.

Outside pipes.

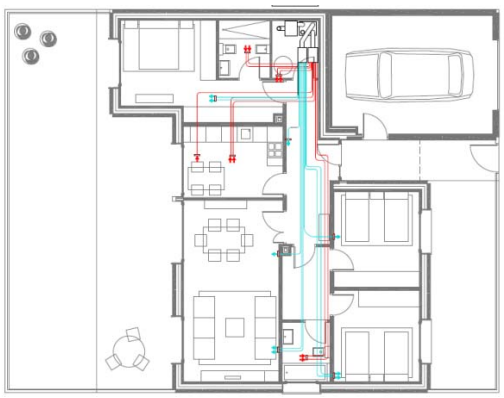


Placement of geotermal in section.



Geothermal distribution plant.

To improve the efficiency of the air-to-air heat exchanger, a superficial geothermal installation of 300 meters long has been placed 2.2 meters under the ground. These pipes are connected to an air-water exchanger before the air-to-air heat exchanger. In winter days, only the geothermal facility is able to raise the external air from 0ºC up to 14ºC. Surperficial geothermal installation for Passivhaus are very useful and cheap because of the low energy demand of the buildings.

	
Heat recovery.	Air distribution ducts.
	
Ejection mouth.	Plan of distribution.

In this house, the ventilation works as follows: the outdoor air, after being tempered in the superficial geothermal installation, passes to the air-to-air heat exchanger (zehnder comforair350 with a recovery rate of over 80% and electrical efficiency 0,29 Wh/m^3) and from there, it is distributed to the common spaces (living room, bedrooms and lobby). Once it has circulated around the house, the air with odors and humidity is collected by the wet rooms (bathrooms, kitchen and utility room).
The ventilation is working 24 hours a day at different speeds, in this way we make the indoor environment so healthy and comfortable.
The sum of the geothermal and the heat exchanger gets the outside air, which is at 0 ° C, to enter the dwelling at 19 ° C. on a winter day.

Aparatos de ventilación con recuperación de calor

	Especificaciones recomendadas para comenzar con la planificación: Protección frente a la congelación: Sí; Recuperación de humedad:	75 %		0,45
ID	Descripción	Rendimiento del recuperador de calor	Valor de recuperación de energía	Eficiencia eléctrica
	Área definida por el usuario	%	%	Wh/m³
01ud	Zehnder - ComfoAir350, ComfoD350, WHR930	84%	0%	0,29
02ud				

Información adicional del aparato							
Rango de aplicación		Presión exterior por sección	Ajustes Δp	Protección frente a congelación	Protección contra el ruido		
m³/h	m³/h	Pa	Pa		35 dB(A)	Aire de impulsión dB(A)	Aire de extracción dB(A)
71	293	100	incl.	sí	/	63,8	50,2

Data in PHPP.

8_Heat supply .

	
Pellet stove.	Hot air grille.

The stove has been placed approximately in the geometric center of the construction, in order to distribute the warm air in a more effective and uniform way. To obtain this distribution of hot air, we have chosen a stove with two independent fans that lead the air to the rooms. One of the fans does it frontally, releasing the air in the main distributor towards kitchen and living room. The second fan expells the air through two insulated tubes to avoid heat losses, one goes to the main bedroom and, the other goes to the distributor from where you access the other two bedrooms and bathroom.

	
Photovoltaic panels.	Photovoltaic panels.

In the roof, 4 photovoltaic modules (1455 kWh / y) have been installed that are connected to a water tank to obtain domestic sanitary hot water. In the future, a converter will be available to use the surplus energy for the rest of the house (light, appliances, computers…)

9_PHPP calculations .

Edificio:	CASA PILOTO PASSIVHAUS ZORZANO	
Calle:	Travesía Gonzalo de Berceo	
CP / Ciudad:	26151	Arrúbal
Provincia/País:	LA RIOJA	ES-España
Tipo de edificio:	Vivienda unifamiliar	
Datos climáticos:	ES0018b-Logroño	
Zona climática:	4: Cálido-templado Altitud de la localización:	356 m

Valores específicos referenciados a la superficie de referencia energética

					Criterio	Criterios alternativos	¿Cumplido?[1]
	Superficie de referencia energética	m²	103,7				
Calefacción	Demanda de calefacción	kWh/(m²a)	14,4	≤	15	-	Sí
	Carga de calefacción	W/m²	12,7	≤	-	10	
Refrigeración	Demanda refrigera. & deshum.	kWh/(m²a)	-	≤	-	-	-
	Carga de refrigeración	W/m²	-	≤	-	-	
	Frecuencia de sobrecalentamiento (> 25 °C)	%	2	≤	10		Sí
	Frecuencia excesivamente alta humedad (> 12 g/kg)	%	0	≤	20		Sí
Hermeticidad	Resultado ensayo presión n_{50}	1/h	0,4	≤	0,6		Sí
Energía Primaria no renovable (EP)	Demanda EP	kWh/(m²a)	78,6	≤	100		Sí
Energía Primaria Renovable (PER)	Demanda PER	kWh/(m²a)	98	≤	-	-	-
	Generación de Energía Renovable	kWh/(m²a)	11	≥	-	-	

[1] Celda vacía: Falta dato; "-": No requerimiento

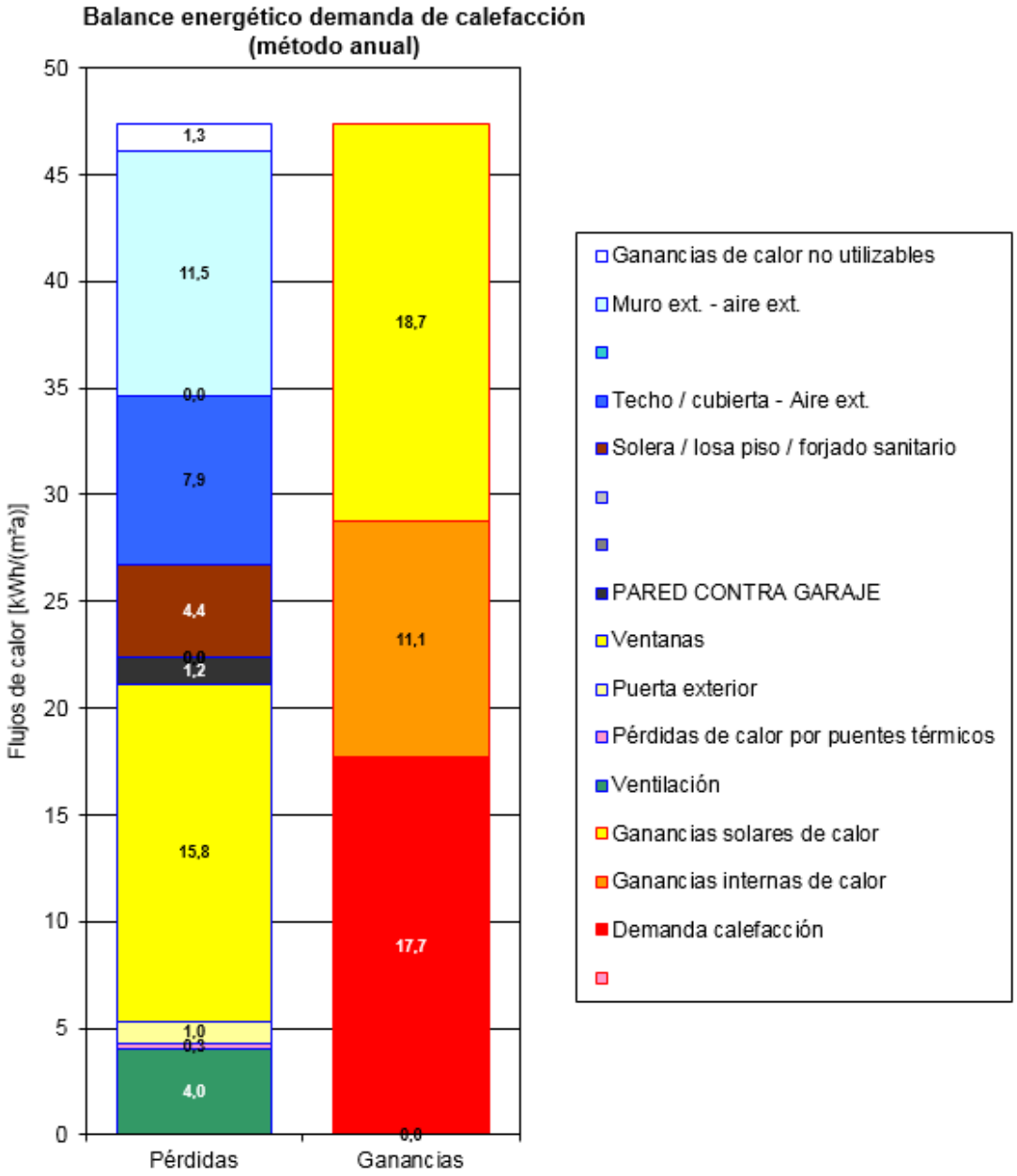
Confirmo que los valores aquí presentados han sido determinados siguiendo la metodología de PHPP y están basados en los valores característicos del edificio. Los cálculos de PHPP están adjuntos a esta comprobación.

¿Casa Pasiva Classic? Sí

Función:	Nombre:	Apellido:	Firma:
2-Certificador	Micheel	Wassouf	m.Wa
	ID Certificado	Fecha emisión:	Ciudad:
		31/10/16	Barcelona

This building has been awarded the certified Passive House seal by Energiehaus Arquitectos.

Certified Passive House
Passive House Institute



The heating demand was calculated using the PHPP. Windows are the area where the house has a greater loss of heat as well as the exterior wall. The most important heat gain is the sun entering through the windows, after that, the pellet stove and, finally, the internal gains.

10_Construction costs .

This house was built during a heavy construction crisis in Spain, therefore, the budget has been very tight. The cost of construction has been 88,900 euros, so that the square meter of construction has cost 550 euros. This very competitive cost was achieved because of several factors:
1) Materials for passive houses were bought in Spain, consequently, there were no import costs. For example, the windows of the building are from a company in La Rioja, the isolation comes from Burgos ... this proximity produces an adjustment in costs.
2) The use of a lightweight prefabricated concrete designed to build passive housing has reduced construction times significantly. The building was built in 4 months.

11_Information about the building services .

Architectura	David Zorzano Gonzalo /Celia Zorzano Gonzalo
Street	Avd. Del Ebro, Parcela 4B Pol. El Sequero
PC/City	26150 / Agoncillo
Province /Country	La Rioja / Spain

Construction	Construcciones Zorzazno, Pedro Pablo Zorzano Gonzalo
Street	Avd. Del Ebro, Parcela 4B Pol. El Sequero
PC/City	26150 / Agoncillo
Province /Country	La Rioja / Spain

Installations	Ecotelia
Street	Calle Valsalado nº6 Nave-J
PC/City	26006 / Logroño
Province /Country	La Rioja / Spain

12_Measured results .

Currently, the house is being monitored by University of La Rioja. The temperature span between the different rooms never exceeds 1,5^{o}C and the total expenditure of pellets to maintain the house the whole year has been of 180 euros in an average temperature of 21^{o}C.