

PASSIVE HOUSE OBJECT DOCUMENTATION

Rua do Mar House B, single family house, Ílhavo Portugal

(Passive House project database: ID 2403)



2.1 PROJECT OVERVIEW

Project designer: João Marcelino, Homegrid (www.homegrid.pt)

The “Rua do Mar” House B integrates a development plan (two single family houses) which led to the first Passive House buildings in Portugal. It is located in Ílhavo, in the center-north coast of Portugal, which climate is in a transition range from the Oceanic Climate to the Mediterranean Climate. This project is one of the first two Certified Passive House in Portugal as well as the “Rua do Mar” House A.

Special features:

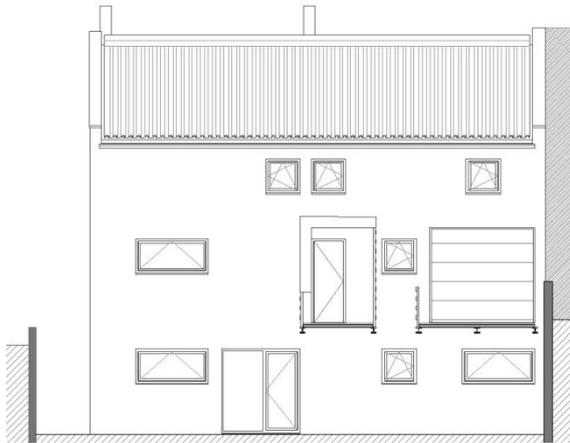
Solar thermal panels for domestic hot water; rainwater harvesting for irrigation and toilets flush; fruit and horticultural production; “very good environmental performance level” certified by LiderA (Portuguese voluntary system for assessment of sustainable construction) with A⁺ rating.

U-value exterior wall:	0,262 W/(m²K)	PHPP annual heating demand:	
U-value basement slab:	0,421 W/(m²K)		8 kWh/(m²a)
U-value roof:	0,234 W/(m²K)	PHPP annual cooling demand:	
U-value roof (terrace):	0,512 W/(m²K)		0 kWh/(m²a)
U-value window:	1,44 W/(m²K)	PHPP primary energy demand:	
Heat recovery:	75%		63 kWh/(m²a)
		Pressure test n ₅₀ :	0,45 h⁻¹

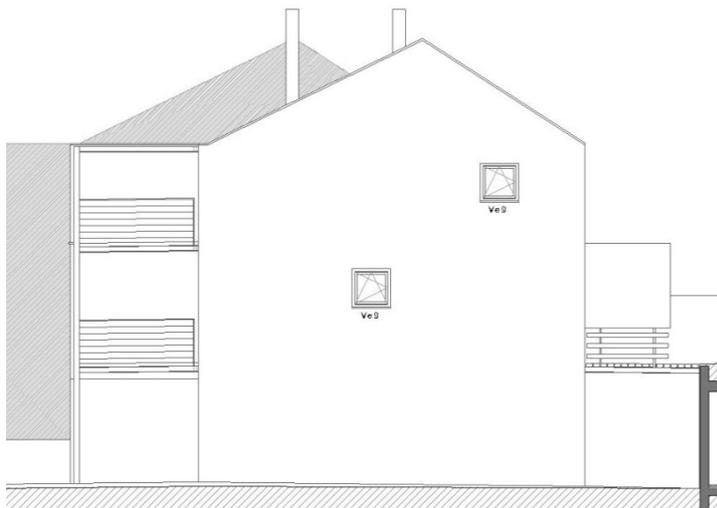
2.2 PROJECT DESCRIPTION

The House B is a 4-bedroom, 210 m², three-storey single family home. It is part of a two single-family houses development located in Ílhavo. The design began in 2008 and its goal was that the house had a good energy performance, A⁺ according to Portuguese regulation. The construction of both dwellings began on the 19th May and on the 28th May 2011, during the 15th International Passive House Conference in Innsbruck, it was decided to adapt both houses to the Passive House concept. Homegrid extended the concept beyond the energy issue, defining solutions to both water and food sector. It was developed the **wefi-BUILDING** concept - WATER ENERGY FOOD ALMOST INDEPENDENT BUILDING - and it was applied to the House B.

2.3 ELEVATIONS

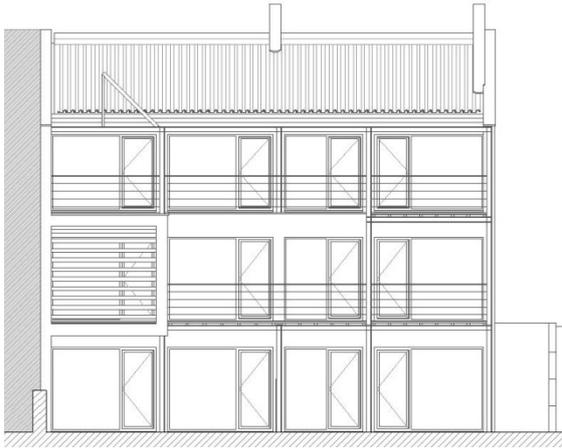


East elevation

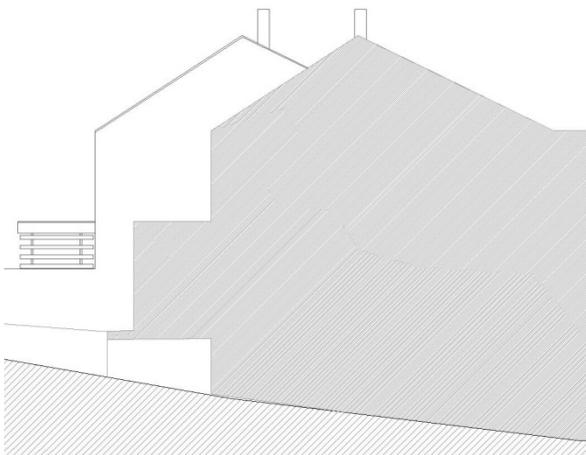


South elevation





West elevation



North elevation



2.4 INTERIORS

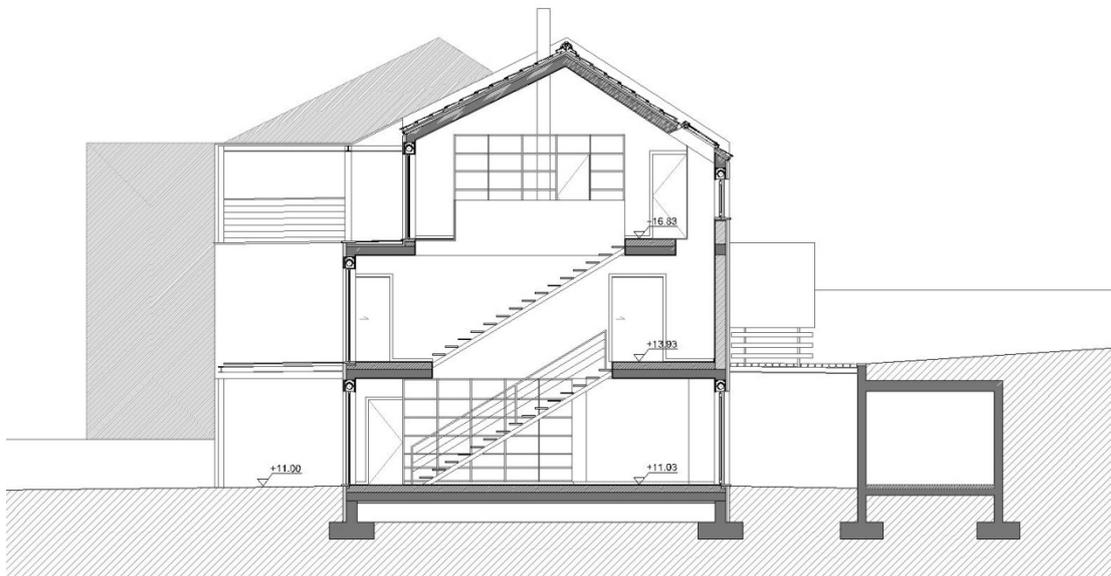


3rd floor

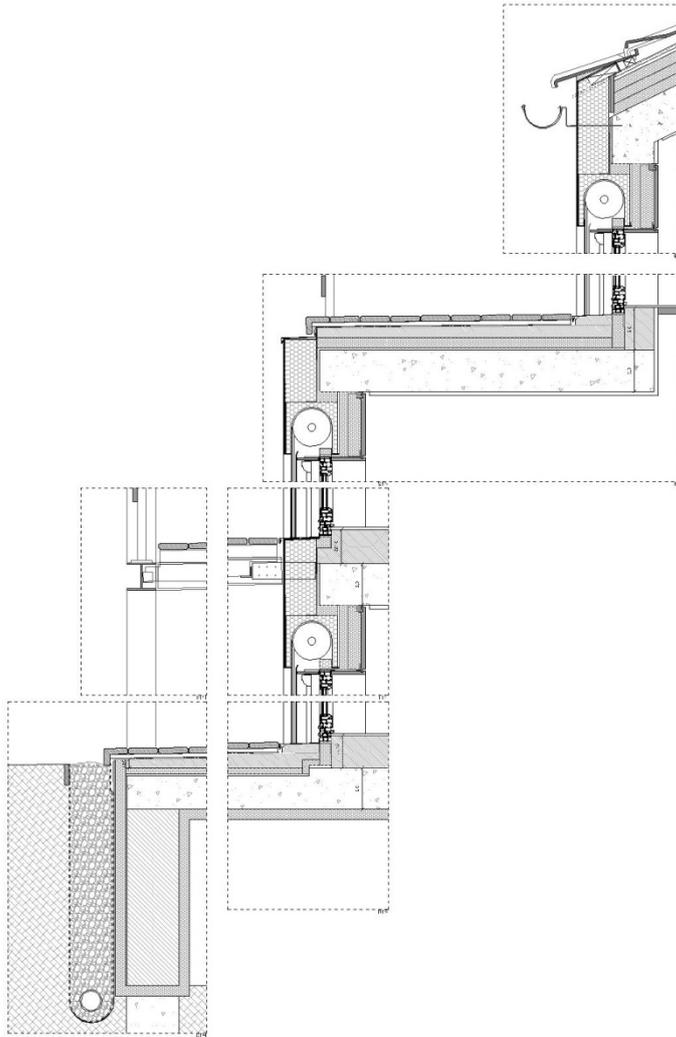


1st floor – stairs

2.5 CROSS SECTION

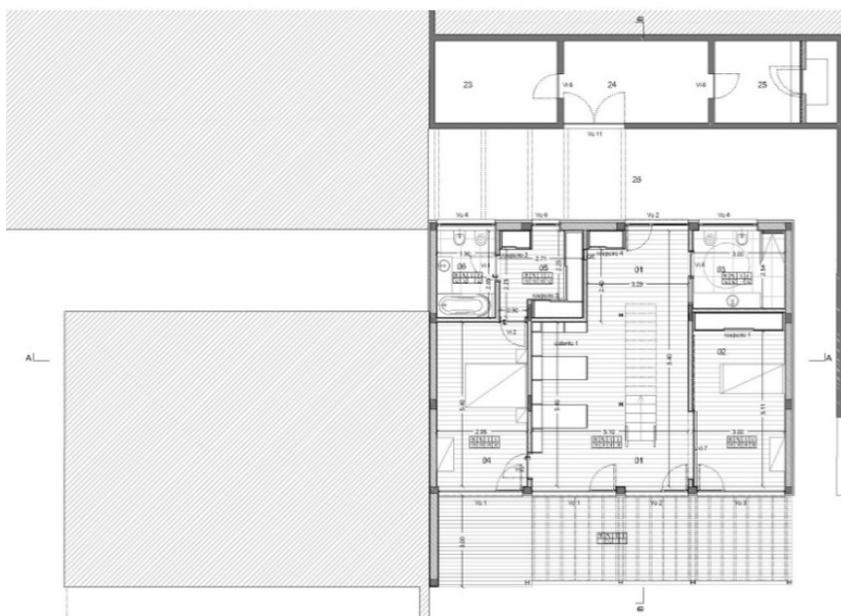


Cross section

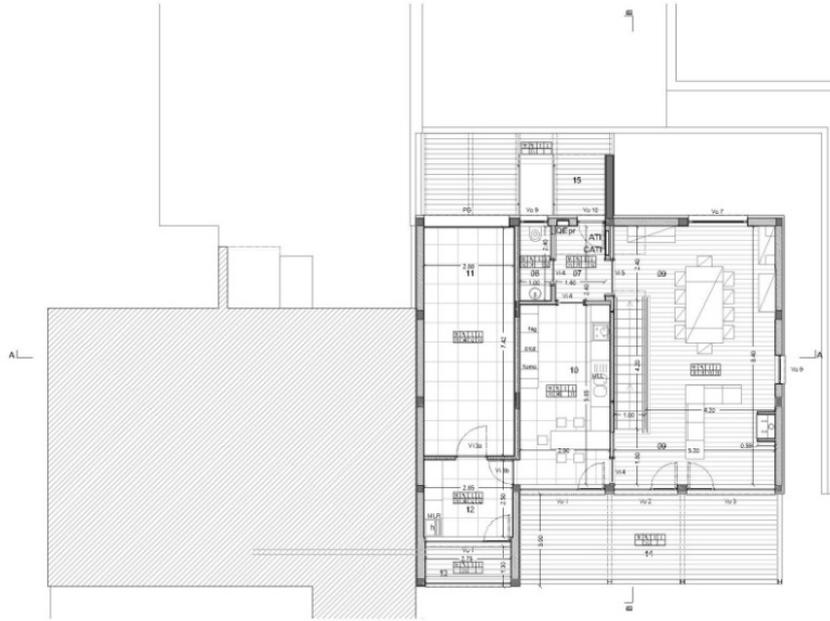


Cross section detailed

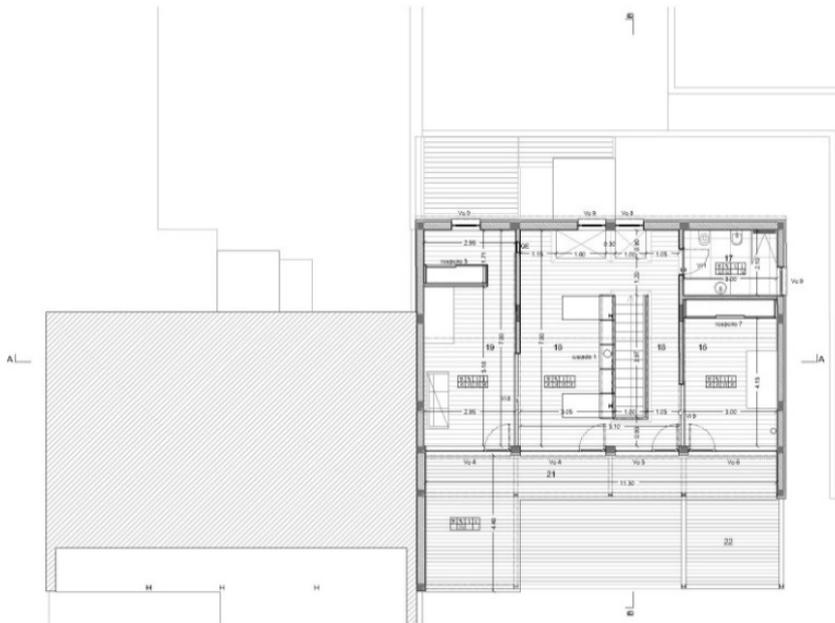
2.6 FLOOR PLANS



Plan 1st floor



Plan 2nd floor

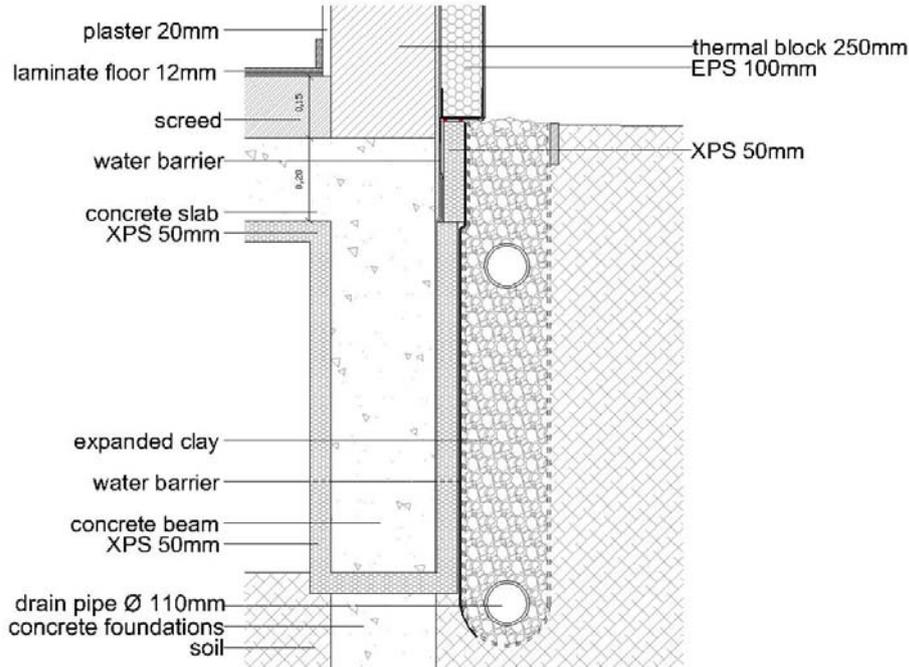


Plan 3rd floor

2.7 CONSTRUCTION DETAILS

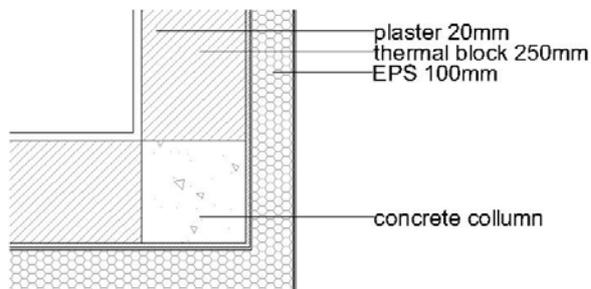
2.7.1 Floor slab with exterior wall connection

The floor slab was modified to achieve the high performance levels of Passivhaus. From inside to outside we have: floor, 10mm; polyethylene film 2mm, screed, 150 mm, fungiform slab of clay [0,85 W/(mK)], 250mm; Polystyrene board [0,035 W/(mK)], 50mm.



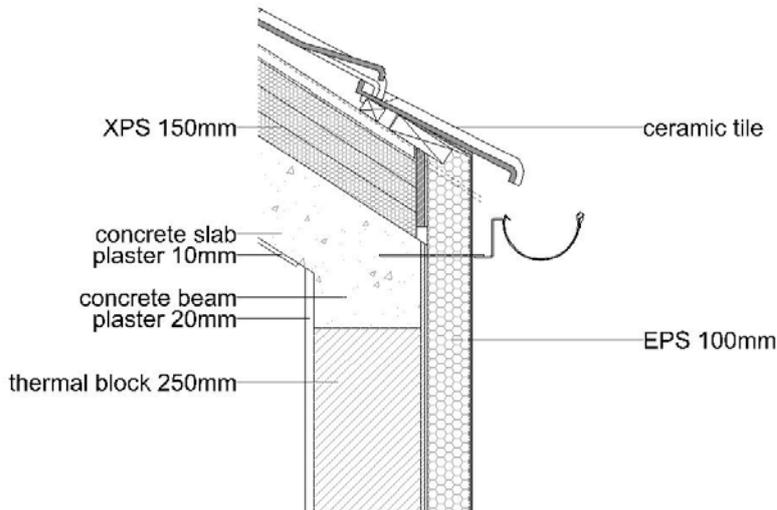
2.7.2 Exterior walls connection

The exterior walls are in simple masonry, 390 mm thick. From inside to outside we have: Plaster, 20mm; thermal blocks *BTE 25* from the manufacturer *Artebel* composed by expanded clay aggregates [0,268 W/(mK)], 250 mm; Plaster, 20mm; EPS [0,037 W/(mK)], 100mm.



2.7.3 Roof and wall connection

The roof is 420 mm thick. From inside to outside we have: Plaster, 20mm; fungiform slab of clay blocks [0,85 W/(mK)], 250mm; XPS [0,035 W/(mK)] + timber frame (5%), 150mm; Rothoblaas Breathable barrier membrane; Ceramic tile over wood structure.



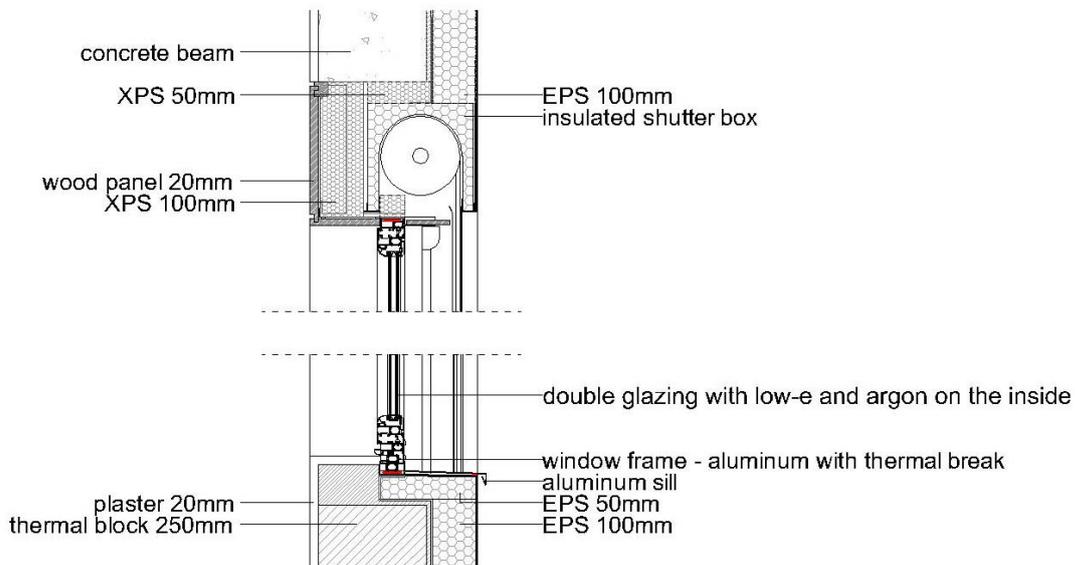
2.7.4 Window installation details

Window frame: Anicolor, Ati series - Aluminum frame with thermal rupture, [standard Uf-value 2,7 (W/mK)], small frame dimensions

Glazing: Double glazing (Planilux 6mm + Argon 16mm WE + Stadip Planitherm Ultra N 44.1mm), U g-value = 1 W/(m²K), g -value = 60 %

Spacer: Chromatech Plus 16

Installation: the average window installation U value is 1.77 W/(m²K)



2.7.5 Description of the airtight envelope; documentation of the pressure test

An internal coat plaster system was applied to form the wall/ceiling airtightness barrier. Butyl adhesive tape (black band from Rothoblaas) and butyl silicones were used at different junctions to avoid the airtightness barrier from cracking due to differential movement and drying of different materials.

One major disadvantage of using internal plaster as the airtightness barrier, is the late stage at which the test can be done, only after works such as fix electrics, plumbing, ventilation, joinery and plastering were complete. Most of cabling and plumbing was kept in internal walls and in the floor void.

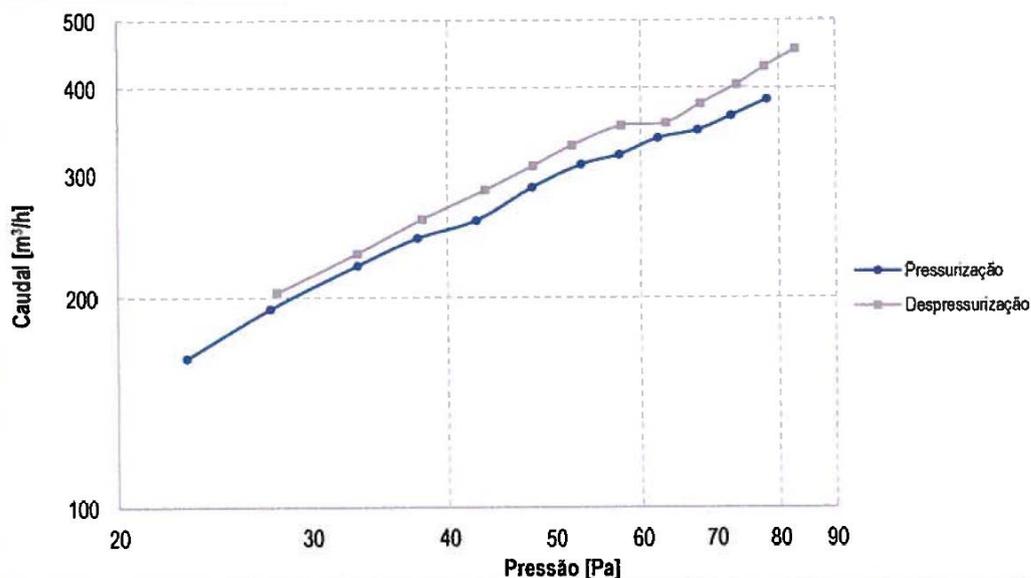


View of some connections

The Blower Door Test result was $0,45h^{-1}$, assuring the adequate airtightness.



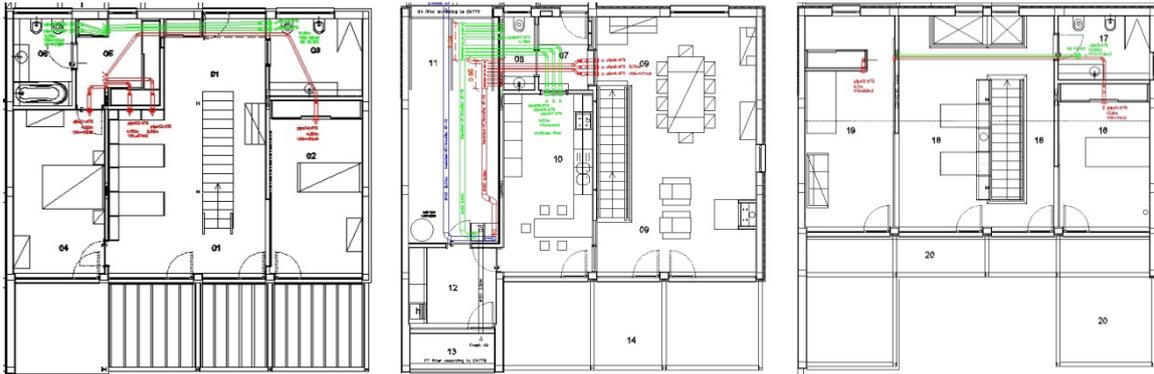
The Blower Door Test



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

2.7.6 Ventilation plan for the ductwork

The house has 223,7 m² of treated floor area and 671,2 m³ of enclosed volume. We needed almost 100 m of ϕ 75 mm pipes and 38 m of ϕ 160 mm pipes. The pipes are in PVC in accordance with EN 1329. The system is in equilibrium between the insufflation and extraction. It were installed 9 extractions / insufflations with ϕ 75 mm pipes that transport each one a maximum of 30 m³/h of air, guaranteed with the installation of constant flow regulators.



Plans with the ductwork



View of the insulated pipes

2.7.7 Ventilation plan for the central unit / type / specific value

The heat recovery ventilation unit used was a **Nilan Compact P**, certified by PHI with an efficient of 80% and an electrical efficiency of 0.40 Wh/m³.

The compact unit was positioned in the only place available in the garage, a non-heated place inside the house. This location is far from optimal, resulting in additional 32 m of $\phi 160$ mm PVC pipes with insulation.

The air is transferred from the supply rooms to extract air rooms by a 15 mm gap under all internal doors.



View of the central unit

2.7.8 Heat supply

The heating is provided by air. PHPP results show that heating by air would be enough for the second and third level but not enough for the two bedrooms of first level. Heating load transportable by supply air was 2054 W, and the heating load was 2212 W.

Two small water radiators were installed in the bedrooms of the first level connected to the ROMOTOP KV6.6.2 TV fireplace burning wood with a hot water exchanger installed in the living room. When the temperature drops down 20° C the client can activate the fireplace burning wood. Towel radiators were installed in the three bathrooms, for additional comfort (it is not required to maintain an internal temperature of 20° C).

2.8 PHPP RESULTS

Passive House Verification



Building:	House B	
Location and Climate:	Ilhavo, Portugal	Porto with correction by PHI.
Street:		
Postcode/City:		
Country:	Portugal	
Building Type:	Semi-detached house	
Home Owner(s) / Client(s):		
Street:		
Postcode/City:		
Architect:	homegrid	
Street:		
Postcode/City:		
Mechanical System:		
Street:		
Postcode/City:		
Year of Construction:	2011	
Number of Dwelling Units:	1	Interior Temperature: 20,0 °C
Enclosed Volume $V_{e,i}$:	671,2 m ³	Internal Heat Gains: 2,1 W/m ²
Number of Occupants:	6,4	

Specific Demands with Reference to the Treated Floor Area				
	Treated Floor Area:	Applied:	PH Certificate:	Fulfilled?
	223,7 m ²	Monthly method		
Specific Space Heating Demand:		8 kWh/(m²a)	15 kWh/(m ² a)	Yes
Heating Load:		10 W/m²	10 W/m ²	Yes
Pressurization Test Result:		0,5 h⁻¹	0,6 h ⁻¹	Yes
Specific Primary Energy Demand (DHW, Heating, Cooling, Auxiliary and Household Electricity):		63 kWh/(m²a)	120 kWh/(m ² a)	Yes
Specific Primary Energy Reduction through Solar Electricity:		kWh/(m ² a)		
Frequency of Overheating:		0 %	over 25 °C	
Specific Useful Cooling Energy Demand:		kWh/(m ² a)	15 kWh/(m ² a)	
Cooling Load:		0 W/m ²		

We confirm that the values given herein have been determined following the PHPP methodology and based on the characteristic values of the building. The calculations with PHPP are attached to this application.

Issued on: _____
signed: _____

Verification sheet

2.9 CONSTRUCTION COSTS

The construction cost is being estimated.

2.10 BUILDING COSTS

The overall building cost is being estimated.

2.11 YEAR OF CONSTRUCTION

2011/2012

2.12 ARCHITECTURAL DESIGN OVERVIEW

To achieve the Passive House standards we followed the KISS principle: Keep It Smart and Simple. It was established an extended network of partnerships in a WIN / WIN relation.

The daily work was seen as a daily challenge always assuming the responsibility for the chosen path:

- solve problems and find new solutions;
- adapt the projects;
- give answers to the builder's requests without compromising the certification process;
- define a global cost-effective solution;

One of the major concerns in the adaptation to the Passive House standards was the building envelope. We focus great part of our work in the creation of a continuous insulation layer and the increase of its thickness. The goal was to almost nullify the thermal bridges and improve the U-values of the envelope solutions – roof, floor slab, structural foundations, external wall and windows.

Due to the mild climate, which leads to thinner insulation and lower energy demand compared with colder climates, the influence of the thermal bridges has been estimated on the safe side and taken in account through applying coefficients with empirical values. The projection proved that its influence is very low in mild climates. The thermal bridges were calculated to verify both energy loss and surface temperature. They were calculated by PHI and the PSI values were inserted in the PHPP calculation. Passive Houses in warm climates have advantages: thermal bridges in Mediterranean climate have a much lower effect than thermal bridges in central European climate.

The windows solutions had the leading role in the global envelope performance. Improvements had been made in the U-values of the glass and aluminum frame, the spacers and the shutter box. The window position was optimized but still far from an ideal solution. We couldn't set the windows position in the insulation layer of the external wall due to the shutter box type.

2.13 TECHNICAL DESIGN OVERVIEW

Another important feature is the re-use of rainwater, which is stocked in one 10.000 liters tank and then used for WC and gardens watering.

After the optimization of the system we intend to introduce a Photovoltaic system or a micro Eolic system in order to cover all the electrical needs.

2.14 PHPP CERTIFICATION

The certification was conducted by Susanne Theumer from the Passivhaus Institut based in Darmstadt, Germany.

2.15 STRUCTURAL ENGINEERING

The structural engineering was defined by Homegrid.

2.16 EXPERIENCES

The author of the present documentation and his family live in this building and found no inconsistencies between planned and real behavior.

2.17 MONITORING

Combined sensors will constantly measure indoor air temperature, relative humidity, and CO₂ concentrations in three points (one for each level of the building). In the exterior will be installed a weather station that will measure temperature, wind speed, luminosity and rain precipitation. All electrical consumption (including the compact unit) and water consumption (potable and non-potable) will be monitor and controlled.