Passivhaus El Plantío
Project Documentation

Single family house in El Plantío, Madrid. Spain.

Project Designer	Emilio Sánchez Quesada, arq.	http://www.emmepolis900.com/

First home built under the Passivhaus standard in Madrid city. A white compact and outright volume emerges from the centre of a trapezoidal plot, following the golden ratio, both in plan and facades. The large South windows capture the direct solar radiation in winter and automation blinds protects from it in summer. In all other facades, windows are designed in an apparently random way maintaining the golden ratio with the entire building

See also http://www.passivhausprojekte.de/index.php?lang=en#d_4599 Project ID: 4599

Special features: Standard Passivhaus adapted to Continental Mediterranean Climate with automation installation.

U-value of exterior wall	0,17 W/(m²K)	**PHPP Annual Heating Demand**	**10,8 kWh/(m²a)**
U-value basement ceiling	0,30 W/(m²K)		
U-value of the roof	0,18 W/(m²K)	PHPP Primary Engine demand	97 kWh/(m²a)
U-value window	0,98 W/(m²K)		
Heat recovery efficiency	80,7 %	Pressure test n_{50}	0,44 h^{-1}

1 Description of the construction task

The family house is a three storey building with an area of 357,13 m^2 and three storey building. In the basement floor it´s placed multipurpose room, room service, the office and a bathroom. Two underground patios, one to the north where the utility room is located and the other to the east, provide natural light needed to these rooms. On the ground floor there is a main entrance on the west facade and a service one on the east facade. At this level there are arranged day rooms: living room, kitchen and toilet. It is reserved an outside parking space. In the first floor there are two different levels, where bedrooms and bathrooms are located. The staircase is located at the geometric centre of the house.

2 Photographs of the elevation

North and West elevation of the Passivhaus building.

North and East elevation

South Elevation of the Passivhaus Building

3 Exemplary photograph of the interior

Living Room and Dining Room

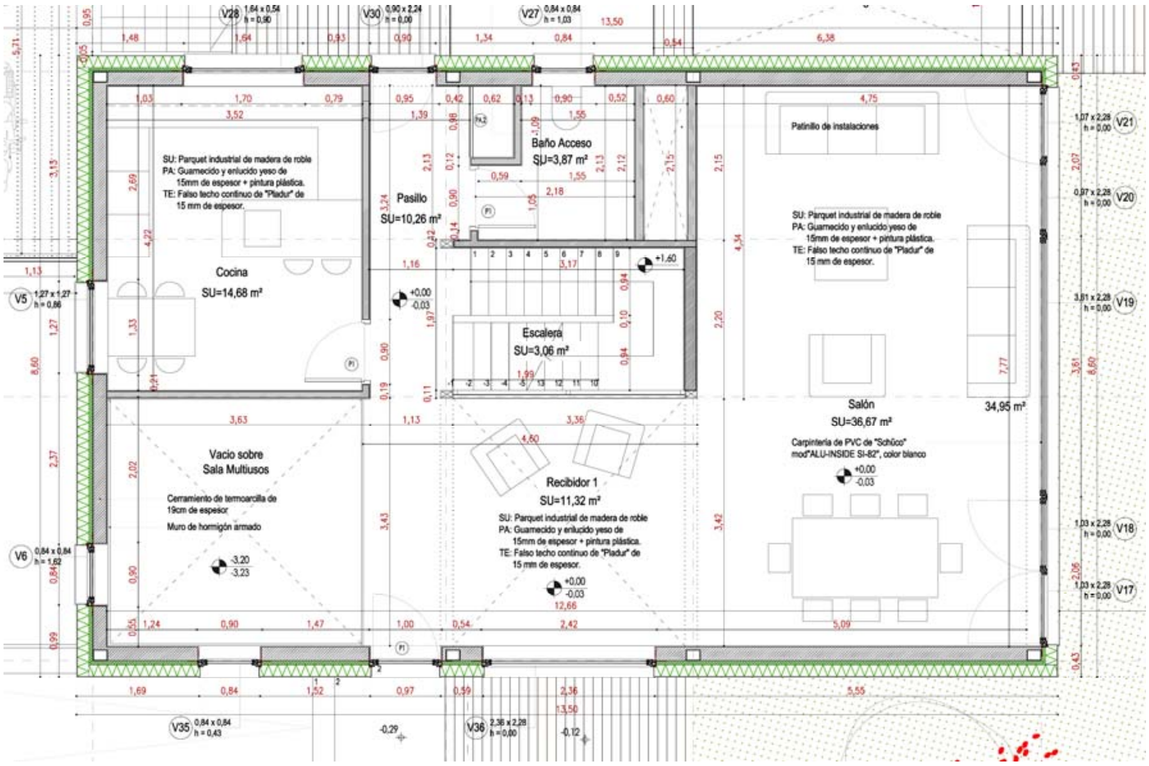
Staircase and Hall

4 Cross – Section

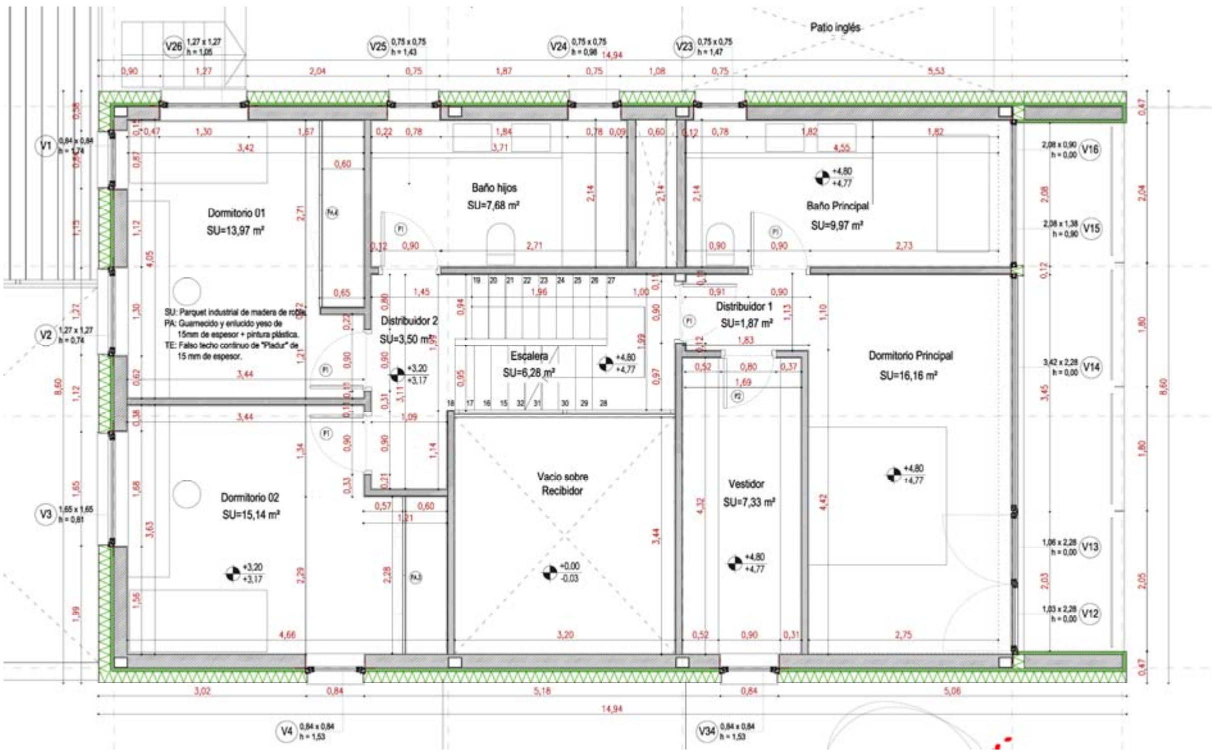
The facade was built with honeycomb clay bricks 19 cm thick with a thermal conductivity of 0.28 W/(mK), is externally applied a layer of waterproof mortar 15 mm, it has been set double rigid volcanic rock wool panel with double density 40 + 160 mm thick, with a thermal conductivity of 0.036 W/(mK). The insulation is placed maintaining continuity in all the facades, eliminating thermal bridges in fronts of slab and junctions between walls and roof. The exterior finish was made with cement mortar, reinforcing mesh and three layers of flexible mineral stucco, water vapour permeable and resistant to impact. The last inside layer of the façade is made by 20mm of plaster, air-tight and permeable to water vapour. On all junctions of the facade with slab, it has been set an airtightness membrane with bioadhesive and a level grid for plaster.

The roof consist of a slab of hollowcore plank and compression layer 20 + 5 cm thick, lightweight concrete for the gradient, waterproofing layer of PVC and geotextile armed protection, thermal insulation, consisting of double extruded polystyrene rigid boards of 100 + 100 mm thick, smooth surface and half wood edge, with a thermal conductivity of 0.034 W/(mK), and heavy protection with concrete layer.

5 Floor plans Passivhaus El Plantío

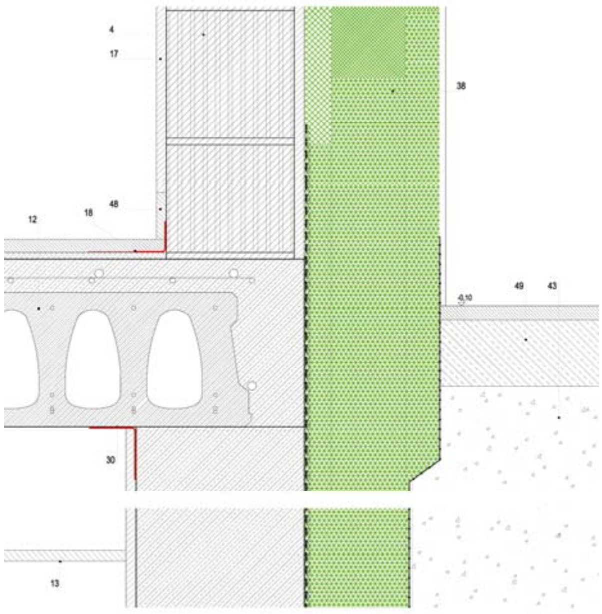


Main Floor: The staircase organize the uses around it. Kitchen, Toilet and Living room



First Floor: Private area with the Bedrooms, Bathroom and Main Principal Suite with closet.

6 Construction including insulation of the basement ceiling

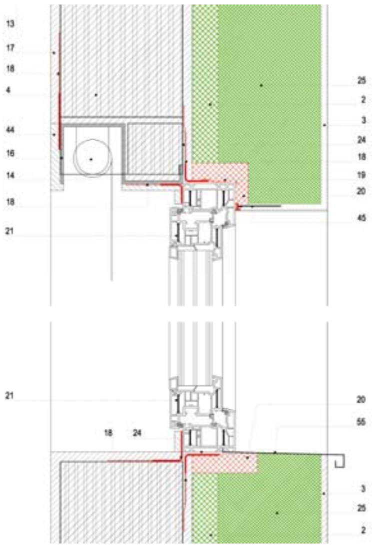


For avoiding thermal bridges in the basement ceiling structure it is necessary to overlap the two different insolation layers with another third one.

Wall and basement ceiling

From the outside to the inside: Waterproof layer, Styrodur insolation 150 mm, Vapour barrier, concrete wall 250 mm, gypsum plaster 15 mm.	U-Value 0,237 W/(m²K)

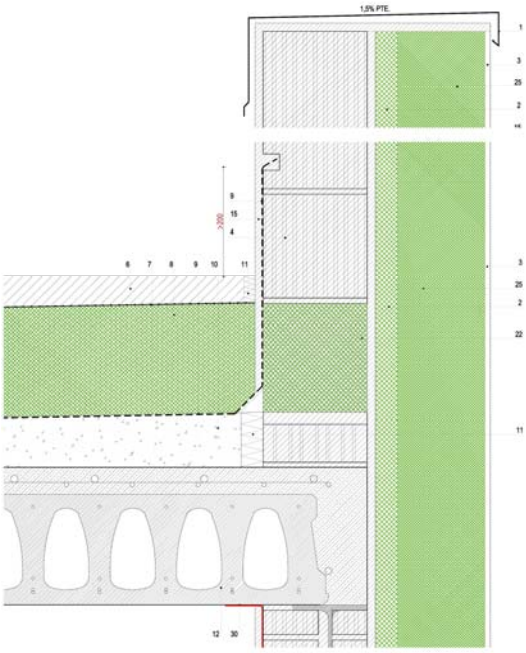
7 Construction including insulation of the exterior walls



The structure of the outer wall. The facade was built with honeycomb clay bricks 19 cm thick with a thermal conductivity of 0.28 W/(mK), is externally applied a layer of waterproof mortar 15 mm, it has been placed double rigid volcanic rock wool panel double density 40 + 160 mm thick, with a thermal conductivity of 0.036 W/(mK). The insulation is placed maintaining continuity in all the facades, eliminating thermal bridges in front of slab and joins between wall and roof. The outside final finish layer was made with cement mortar, reinforcing mesh and three layers of flexible mineral stucco, which is water vapour permeable and resistant to impact. The inside final finish layer of the façade is 20 mm plaster, air-tight and permeable to water vapour. On all junctions of the facade with slab, it has placed an airtightness membrane with bioadhesive and level grid for plaster.

From the outside to the inside: Stucco, Waterproof mortar layer 15 mm, Volcanic Rock Wool insolation 40 + 160 mm, Honeycomb clay bricks 190 mm, gypsum plaster 20 mm.	U-Value 0,165 W/(m²K)

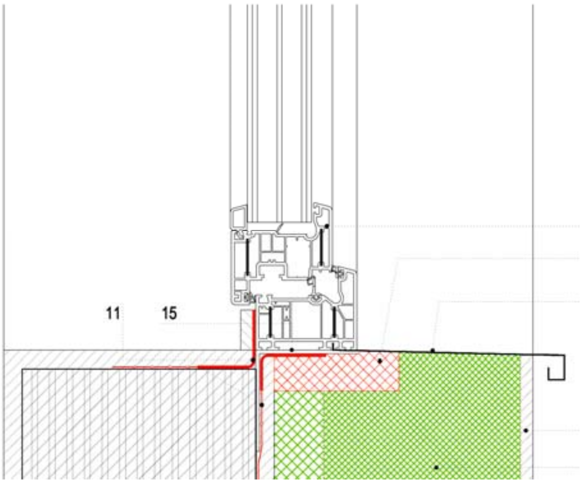
8 Construction including insulation of the roof



The roof consist of a slab of hollowcore plank and compression layer 20 + 5 cm thick, lightweight concrete for the gradient, waterproofing layer of PVC and geotextile armed protection, thermal insulation, consisting of double extruded polystyrene rigid boards of 100 + 100 mm thick, smooth surface and half wood edge, with a thermal conductivity of 0.034 W/(mK), and heavy protection with concrete layer.

Hollowcore plank and compression layer 200 + 50 mm, Lightweight concrete 50 mm, waterproof layer, geotextile protection, thermal insulation of Styrodur 100 + 100 mm, concrete layer 50 mm.	U-Value 0,178 W/(m²K)

9 Cross-section of window including installation drawing



It has placed a high performance joinery, certified Passivhaus, ref. Alu Schüco Inside-82, with a thermal transmittance of 0.78 W / m^{2}K. The glasses have a solar factor and an overall heat transmission coefficient which varies according to the orientation. The joinery has been placed in the same plane of the insulation to avoid interruption of thermal building envelope and avoid thermal bridges. The joinery has been fixed with punctual galvanized steel angled anchored to the honeycomb clay block. In the Inside face it has been placed an airtightness membrane with bioadhesive and a mesh for plaster, and in the outer face a membrane of water tightness, also with adhesive and mesh for plaster, vapour barrier and adhesive tape with butyl.

Frame: The outside joinery is chosen PVC frame energy-efficient. Furthermore, this protection gives the framework of maintenance as a joinery. All windows and doors are sealed preventing uncontrolled air infiltration.

Type of glazing: The choice of glass has been done with the study of values ** G * U that facilitate the manufacturers.

* The U value is the thermal transmittance and is related to the amount of heat flowing through a constructive system. The lower this value further thermal insulation. To the north it is essential that this value is the lower the better. To the South, this value also ought to be low but it must be balanced with high solar factor G.

** The solar factor G is related to the protection of solar radiation. This means that the higher the solar factor G is, more solar radiation capture and thus transmitted to the interior. To the north this value is irrelevant, however, to the south the higher this value, the better for heat gains from solar radiation winter.

Glasses proposed north are high performance defined for this location, with a very low value * U = 0.76 W / m^{2}K and value ** G = 0.54 (although this value is not important to north)

Glasses proposed south have a values * U = 0.746 / m^{2}K and value ** G = 0.54

Frame PVC Schuco Alu Inside SI82 and a triple insulating glass with air filling the inside. 4+4/16 air/4/16 air/4+4.	U-Value 0,76 W/(m^{2}K)

10 Description of the airtight envelope; Documentation of the pressure test result

To ensure very low energy demand, we must also control unwanted air infiltration, unusual among the concerns of many technicians but well known among users. We solve the unwanted infiltration placing a tight air barrier that is a polyethylene film that is also a vapour barrier regulator. Joints between any construction elements are reinforced with adhesive tape to ensure the continuity of the barrier airtight.

All this solutions are checked with the completion of an essay called blower door test.

Final Blower Door test n^{50} =0,44 1/h

Joints between construction elements

airtight barrier

The airtightness of the building has been checked twice, the first one in work in progress phase and the second one with the finished building. A Blower door test was done before the installation of the insulation, consisting in the modification of the artificial shape of the pressure conditions of the housing, creating a difference between the inside and the outside. With the help of a fan installed on the access door to the warehouse, the air was extracted in a controlled way, to generate a negative pressure of 50 Pascals. A smoke generator was used to detect possible air infiltration. The final test result was 0.44 renovations / hour.

Roof tightness: The slab consists of precast concrete hollow core units and compression layer 20 + 5 cm in thickness and fire resistance REI-120. In all the junctions honeycomb clay bricks with slab, it has been installed airtightness membrane with bioadhesive and grid for plaster.

Tightness in outer wall: The facade has been executed with honeycomb clay bricks 19 cm thick (ceramic block of clay lightened with multiple cells and tongue and groove system which achieves a thermal conductivity of 0.28 W / (mK) The vertical joints have been sealed with cement mortar and the horizontal ones have been executed with two bands of mortar to hold the "tube" over the entire height of the facing. A 15 mm of waterproof mortar layer has been applied in the exterior.

The inside of the wall was run with 20 mm of trim and plaster, which ensures air tightness and permeability to water vapour. In all the honeycomb clay bricks joints with slab, it has been installed an airtightness membrane with bioadhesive and a grid for plaster.

Tightness in windows: We have installed a high performance joinery, certified Passivhaus, ref. Schüco Inside Alu -82, with section profile of 82 mm and 8 cameras.

The joinery is placed level with the plane of the insulation to avoid interruption of the thermal building envelope and to avoid thermal bridges. It is fixed with specific galvanized steel angled screwed onto the honeycomb clay bricks. Inside, it is placed a membrane airtightness with bioadhesive and a grid for plaster, and the outer membrane of water tightness, also with adhesive and grid for plaster, vapour barrier and adhesive tape with butyl, PVC profile to finish the exterior side.

Tightness ground floor: The ground floor has been executed with a 300 mm reinforced concrete floor over a drainage layer of gravel, a concrete cleaning and levelling base, 40 mm thermal insulation, ref. Styrodur 3035 CS, consisting of a rigid plate of extruded polystyrene high compressive strength, smooth surface.

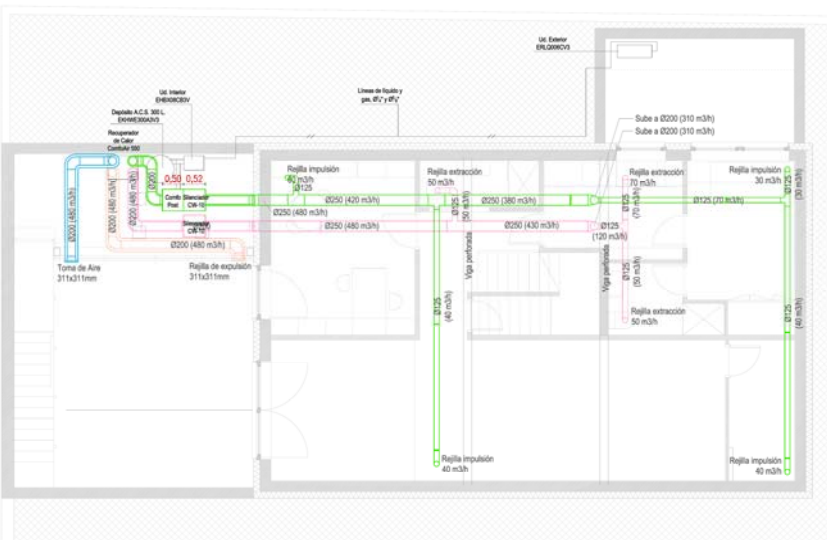
By DIN 1045-2 rules, the concrete is airtight.

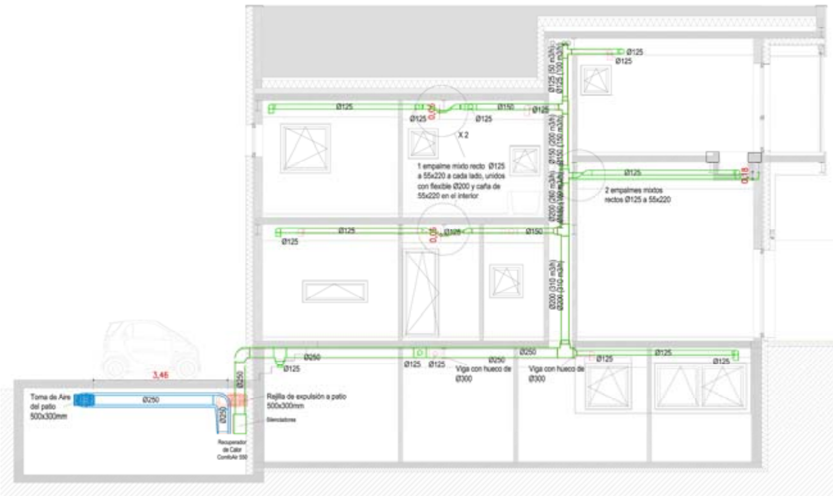
Pressure test measurement results from 11/06/2015-29/09-2015

Blower door test	**50 Pa-Blower door n_{50} h^{-1}**
Date 11-06-2015	0,24
Date 29-09-2015	0,44

11 Ventilation ductwork planning

The air diffusion is done through ducts thermally insulated by glass wool layer, 30 mm thick, with a thermal conductivity of 0.035 W / (mK) to 10 ° C, coated on its outer face with an aluminium foil reinforced with Kraft paper and fiberglass mesh, which acts as holder and as a vapour barrier. To ensure air circulation from the dry to the wet rooms, inlets are arranged in bedrooms and living areas, and extraction vents in the kitchen and bathrooms, all connected by a flexible ducts section also isolated.

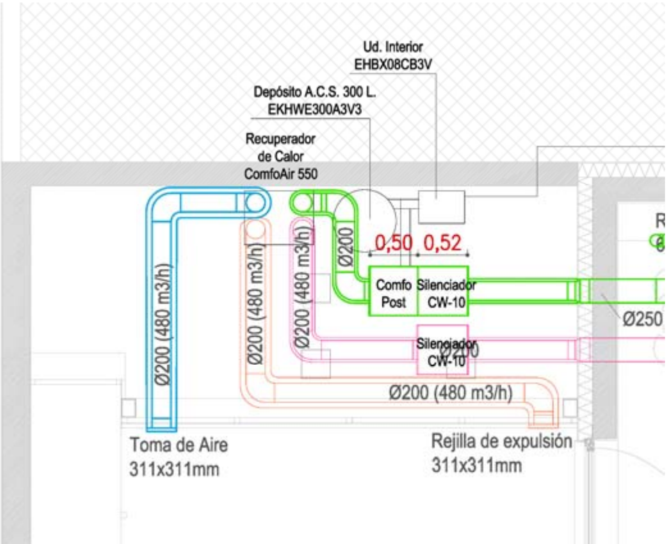




12 Panning of ventilation, central unit information

It has been installed a global system of double mechanical flow ventilation with heat recovery, ref. Zehnder ConfoAir 550, which provides up to 550 m3 / h of renovated and acclimatized air, low energy consumption and frost protection. The heat exchanger has an efficiency up to 95%, that is to say, this housing will be permanently ventilated, losing just 5% of the energy contained in the air.

A heat pump aerothermal has been installed for the production of air conditioning, heating and domestic hot water, ref. Daikin Altherma bibloc. Between 66 and 80% of the heat produced from the outside and it's free, no direct CO_2 emissions, optimized for extreme temperatures with antifreeze system.



- Ventilation system model: Zehnder ConfoAir 550
- Effective heat recovery efficiency: 95%
- Electrical efficiency: 0,30 Wh/m^3

The picture shows the facility room with the heat recovery and the main ducks, and the water tank.

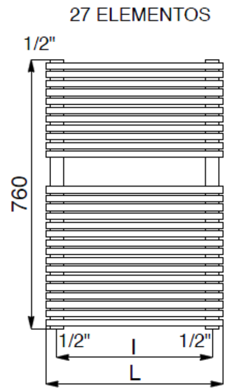
13 Heat Supply

The design of the building envelope has reduced the specific needs of installed thermal power for heating to 12.7 W / m2, which is sufficient heating capacity of 3.4 kW. The reduced value of this parameter allows the heating energy demanded to be conducted in full to the different dry rooms (bedrooms, living room ...) by air flowing through the admission. Therefore, aerothermal unit is installed in order to provide the necessary little heat or cold in winter or summer.

The ventilation system is of continuous use. The warm air flows from the rooms into the adjacent wet areas, being finally led to the high efficiency heat recovery. This heat is transferred into a 90% renewal incoming air and redistributed throughout the home. Aerothermal system will provide the rest of heat needed to ensure thermal comfort in the building, only in an assistant way and being controlled by room thermostat, it is coming on stream only when their use is required.

Aerothermal exterior unit

Aerothermal interior unit



Electric heater (bathroom)

It is installed a thermodynamic storage tank (SHW) 300 litres, which is heated by a heat pump air / water and transfers heat contained in the air to the sanitary water in the tank. The tank has an insulating material without CFC (polyurethane) 50 mm thick. It contains two heater elements, a heat exchanger at the bottom, through which circulates the hot water from the indoor unit, and an electric additional heater of 3kW on top.

14 PHPP-Calculations

Comprobación Passivhaus

Edificio:	Casa en "El Plantío"				
Calle:	Alvaro Caballero, nº 13				
CP / Ciudad:	28023 Madrid				
País:	España				
Tipo de edificio:	Vivienda unifamiliar				
Clima:	[ES] - Madrid, Madrid D3			Altitud del sitio del edificio (en [m] sobre el nivel del mar):	689
Propietario / cliente:	Andres Aberasturi Paez y Ana María Ynzenga Aranda				
Calle:	Alvaro Caballero, nº 13				
CP / Ciudad:	28023 Madrid				
Arquitectura:	Emilio Sánchez Quesada y Bruno Gutiérrez Cuevas. EMMEPOLIS NOVECENTO SL				
Calle:	Tribeca campus empresarial. ed.3, loc.36. Ctra de Fuencarral 44				
CP / Ciudad:	28108. Alcobendas. Madrid				
Instalaciones:	Emilio Sánchez Quesada y Bruno Gutiérrez Cuevas. EMMEPOLIS NOVECENTO SL				
Calle:	Tribeca campus empresarial. ed.3, loc.36. Ctra de Fuencarral 44				
CP / Ciudad:	28108. Alcobendas. Madrid				

Año construcción:	2014-2015	Temperatura interior invierno:	20,0	°C	Volumen exterior V_e m³:	1283,27
Nr. de viviendas	1	Temperatura interior verano:	25,0	°C	Refrigeración mecánica:	x
Nr. de personas:	5,0	Cargas internas de calor invierno:	2,1	W/m²		
Cap. específica:	180	Wh/K por m² SRE ídem verano:	4,3	W/m²		

Valores característicos del edificio con relación a la superficie de referencia energética y año

		Valor	Unidad	Requerimientos	¿Cumplido?*
	Superficie de referencia energética	247,55	m²		
Calefacción	Demanda de calefacción	10,8	kWh/(m²a)	15 kWh/(m²a)	sí
	Carga de calefacción	11,3	W/m²	10 W/m²	-
Refrigeración	Demanda total refrigeración	6,9	kWh/(m²a)	15 kWh/(m²a)	sí
	Carga de refrigeración	9,2	W/m²	-	-
	Frecuencia de sobrecalentamiento (> 25 °C)		%	-	-
Energía primaria	Calef., ref., deshum., ACS, elect. auxiliar, ilum., aparatos eléct.	97	kWh/(m²a)	120 kWh/(m²a)	sí
	ACS, calefacción y electricidad auxiliar	62	kWh/(m²a)	-	-
	Ahorro de EP a través de electricidad solar		kWh/(m²a)	-	-
Hermeticidad	Resultado ensayo de presión n_{50}	0,44	1/h	0,6 1/h	sí

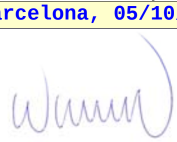
* Campo vacío: faltan datos; '-': sin requerimiento

Passivhaus? sí

Confirmamos que los valores aqui presentados han sido determinados siguiendo la metodoloía PHPP y están basados en los valores característicos del edificio.
Los cálculos con PHPP están adjuntos a esta aplicación.

#¡REF!

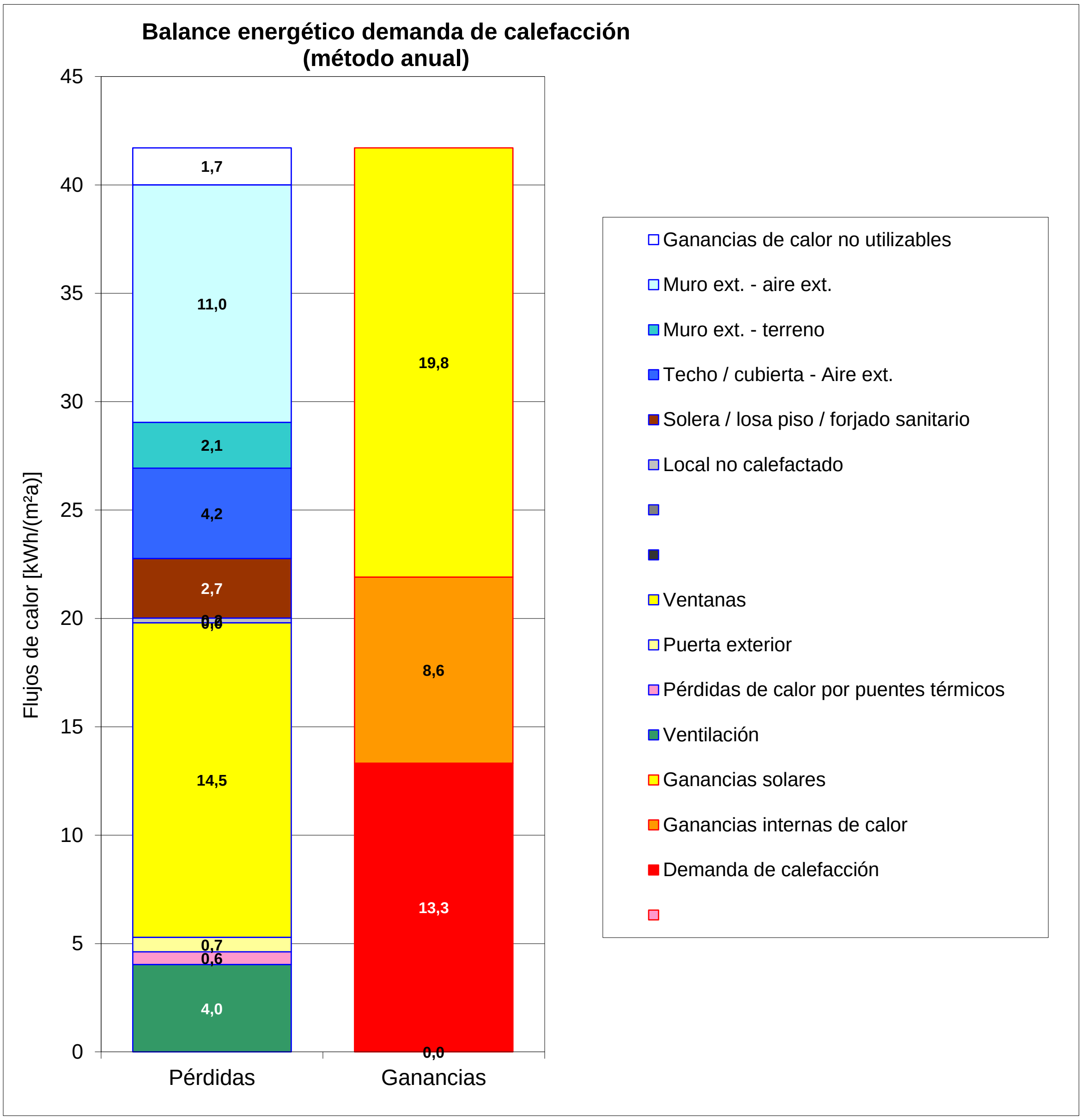
Nombre:	Micheel	**Número de registro PHPP:**	PEPES_200913_25834567_esp8
Apellidos:	Wassouf	**Expedido en:**	Barcelona, 05/10/2015
Compañía:	Energiehaus Arq. SL	**Firma:**	



The PHPP is an easy to use planning tool for energy efficiency for the use of architects and planning experts. The reliability of the calculation results and ease of use of this planning tool has already been experienced by several thousand users.

Passivhaus El Plantío PHPP- Calculation: According to developed tests in the building, the data for heating demand is 10.8 kWh / (m^2a) so that it gets the limit of 15kWh / (m^2a). In terms of primary energy demand also it complies with the limit established according to the standard of 120 kWh / (m^2a) having 97 kWh / (m^2a).

Energy balance, heating demand (annual method)



The biggest energy loss takes place through windows with almost a quarter of the total (14.5 kWh / (m^2a)). Half of the losses arise through the walls, and especially the facades in contact with the outside (11.0 kWh / (m^2a)). Moreover half the energy necessary it is provided by solar gains which balance losses through windows. All this added to the internal gains (25% - 8.6 kWh / (m^2a)), give us a result of heating demand of 30% of the losses, 13.3 kWh / (m^2a).

15 Total Construction cost and Building costs

The building has been built for a private client privately financed in the years of economic crisis but with slight growing trend (2014/2015). The average price of construction in Spain in 2014 is set at between 453 – 528 € / m^2.

The Passivhaus El Plantío has a total floor area of 327.81 m^2 and 270.63 m^2 floor space.

The price per square meter of the building ended up being de1.620 € / m^2.

16 Information about the architectural design

It is the first home built under the standard Passivhaus in Madrid city. A white, compact and outright volume emerges from the centre of the trapezoidal plot, following the golden ratio, both in plan and facades. Two large windows to south capture direct sunlight in winter and a slats home automation system protect it in summer. In the remaining facades holes are arranged in an apparently random, maintaining aurea relation with the whole building. Inside, a chain of linked spaces diagonally through the play of double heights, where natural light is very present.

The three storey house has a total floor area of 357.13 m^2. The multipurpose room, the service bedroom, the office and the toilet are located in the basement. Two underground patios, one to the north which gives access to the utility room and multipurpose room and another to the east that provide natural light needed to the service room.

On the ground floor is a main entrance on the west facade and a service in eastern façade. At this level, social areas are placed: living room, kitchen and toilet. An outside parking space it´s reserved.

On the first floor there are two levels where the bedrooms and bathrooms are located. A staircase at the geometric centre of the house rises through all levels to passable cover.