The Passive House in Portugal: encouraging its spread in South West Europe

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1 Introduction

In 28 of May of 2011, during the 15th International Passive House Conference, it was established by Homegrid and the Passivhaus Institut the strategy to implement the Passive House concept in Portugal.

The strategy was defined: build the First Passive house; monitor its performance; create the Portuguese Organization to implement and develop the standard in Portugal.

It was decided to make the adaptation of two dwellings to the Passive House concept. It has been established several partnerships with a win/win logic, mainly with local companies, to achieve the Passive House standards with common constructive solutions.

The project adopted a holistic approach including the performance in energy, water, materials, and food production realizing the Passive House as a base to support the search for sustainability. This project was certified by the Portuguese sustainable assessment system, called LiderA achieving a sustainable class of factor 4 (A+) [Pinheiro, 2012].

2 The first Passive Houses in Portugal

Figure 1: Exterior view of the first Passive Houses in Portugal

Designing Passive Houses in the Mediterranean is more difficult than in Central Europe because the summer situation requires additional considerations that must be take into account to determine the energy balance. On the other hand designing Passive Houses in the Mediterranean is easier because of the lower requirements needed for the building components [Schnieders, 2009].

In 2008 it has started the planning of two single family houses. The site is located in Ílhavo within the limits of the urban area. The climate is in a transition range between Oceanic climate and Mediterranean climate. The houses were designed to have a good energy performance but they were not defined according to the Passive House concept.

The construction began in 19 of May of 2011, even before the adaptation process to the Passive House standards started. It was a daily challenge to solve the problems and to find new solutions to achieve Passive House requirements, to adapt the projects and to respond to the worker's doubts and demands.

It has been established a vast network of partnerships in a WIN / WIN relation to develop solutions to improve the building design. The certification was conducted by Susanne Theumer from the Passivhaus Institut.

2.1 Building envelope

Since that major changes could not occur, because of the municipal permits, the improvements were based on the existing design. Our major concerns to adapt to the Passive House standards were the building envelope, the ventilation and the airtightness.

building solution	U-value recommended W/(m²K)	design situation	description	U-value obtained W/(m²K)
wall	0,620 Lisboa 0,202 Porto	initial	1 ETICS (EPS) 80mm; 2 Thermal Block 250mm; 3 Plaster;	0,350
		final	**1 ETICS (EPS) 100mm; 2 Plaster 10mm; 3 Thermal Block 250mm; 4 Plaster 20mm;**	**0,262**
roof	0,330 Lisboa 0,155 Porto	initial	1 Ceramic tile; 2 Cement mortar; 3 Breathable barrier membrane; 4 XPS 100mm; 5 Concrete slab 200mm; 6 Plaster 20mm;	0,333
		final	**1 Ceramic tile; 2 Wood structure; 3 Breathable barrier membrane; 4 XPS 150mm; 5 Concrete slab 200mm; 6 Plaster 20mm;**	**0,221**
windows	1,35 Lisboa 1,35 Porto	initial	1 Aluminum frame with thermal rupture; 2 Double glazing (6+4mm) with air; 3 Granite sill; 4 ETICS (EPS) 80mm; 5 ETICS (EPS) 30mm; 6 Shutter box; 7 Plaster 20mm;	2,45 – 3,19
		final	**1 Aluminum frame with thermal rupture (improved); 2 Double glazing (6+4mm) with argon; 3 Aluminum sill; 4 ETICS (EPS) 150mm; 5 Shutter box; 6 XPS 100mm; 7 Wood panel 20mm;**	**1,55 – 2,00**

Table 1: comparison of U-values of both initial and improved solutions of some envelope parts

The definition of a continuous insulation layer and the increase of its thickness were achieved. The goal is to almost nullify the thermal bridges and improve the U-values of the envelope solutions, see table 1.

Improvements had been made in the U-values of the glass and aluminium frame, the spacers and the blind box. The window position was optimized but still far from an ideal solution (set the windows position in the insulation layer of the external wall) due to the blinds type.

2.2 Airtightness

Very good airtightness is important in all climates, and especially for coastal climates.The task to achieve the Passive House airtightness requirements demanded an extra effort to develop solutions that could assure those results. The standard airtight levels in new constructions in Portugal are 3 to 5 times higher than the Passive House standards. The blower door test results were 0,54 in house A and 0,45 in house B.

Every detail was defined rigorously by eliminating complex junctions and seeking the most logical, simple and cost-effective solutions. The workers effort and ability was crucial to achieve these results.

The main problems were related to the following: sockets and other electrical devices – it wasn't used special airtight sockets, instead it was installed with special types of sealants in the connections points; sanitary components – it was fixed after the inner plaster (inside the wall) was completed; non heated space inside the house – the penetration of the airtight layer and the plasterboard/pavement connections had been fixed with butyl adhesive tape.

It is possible to build a very airtight building's envelope, but at first the workers must be involved in the whole process and the principles must be explained. The Passivhaus Portugal training programme should pay attention to the airtightness aspects and develop a guide book which should include examples of properly solved construction details.

2.3 Ventilation

The climate data show that we can promote natural ventilation during six months.

During the heating season and to achieve the air renovation requirements of 0.4 h^{-1} a compact building service units certified by Passivhaus Institut was provided for extracting hot, humid air from kitchens, bathrooms. The energy recovered is used to provide domestic hot water and to heat the incoming air.

The house has 223 m^2 of treated floor area and 671 m^3 of enclosed volume. We needed 100 m of ϕ75 mm pipes and 38 m of ϕ160 mm pipes. The pipes are in PVC in accordance with EN 1329. The system is in equilibrium between the incoming fresh air and outgoing exhaust air. It were installed 9 extractions / insufflations with ϕ75 mm pipes that transport each one a maximum of 30 m^3/h of air, guaranteed with the installation of constant flow regulators [Marcelino & Gavião, 2012]

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 ϕ160 mm PVC pipes with insulation.

It is crucial to begin a Passive House design only after finding an expert / company in this area that will allow an exact definition of the requirements: type and diameter of pipes for each division, localization of the central unit, air discharge/ intake pipes and verify the access for maintenance and annual cleaning.

2.4 Design strategies

The strategies to build Passive Houses with simple and cost-effective solutions are the following [Theumer et al, 2012]: define a compact building shape, avoiding non heated places inside the building; guarantee the adequate windows and external doors installation and choose the most energy efficient solutions; take in consideration the solar design strategies (orientation).

The passive use of solar energy for heating is more promising in southern Europe than in central Europe [Schnieders, 2009].

2.5 PHPP results

The PHPP results obtained for the certification process were compared with three other scenarios: the first is the optimized building orientation with the main windows facing south; the second is the improvement of the windows system with an U-value of 1,35 W/(m2K), which is the recommended U-value for Portugal [Krick & Feist, 2012]; the third is these first two combined. Table 2 show the obtained and estimated results in house B:

	Obtained	1st scenario	2nd scenario	3rd scenario	Limit values
Heating energy demand	**8**	1	4	0	≤15 kWh/(m^2)
Building heating load	**10**	8	6	6	≤10 W/m^2
Useful cooling demand	**0**	0	0	0	≤15 kWh/(m^2)
Primary energy demand	**63**	51	56	49	≤120 kWh/(m^2)
Excess temperature freq.	**0**	0	0	0	≤ 10 %
Windows annual balance	**2.203**	4.581	3.421	6.749	.....kWh/a

Table 2: Comparison between the PHPP results obtained and 3 scenarios

Due to higher levels of solar radiation the windows and shading system plays the major role in the global energy balance in warmer climates. Passive Houses with zero heating and zero cooling demand can be realized with relatively little effort.

2.6 Costs

In the case of the first Passive Houses in Portugal the total construction cost will be assessed. However it is estimated that the extra costs associated to the implementation of the Passive House concept won't exceeding 5% over conventional construction costs.

The additional costs may be reduced or even nullify in upcoming projects with the integration of the Passive House since the beginning of the process, reflecting the experience acquired.

2.7 Monitoring

The monitoring program was established along with some of Homegrid partners. 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 will be monitor and controlled.

3 Homegrid projects

Homegrid is developing four additional projects according to the Passive House Standards: a touristic unit; a dog hotel; a small office and a social activities and community center.

4 Passivhaus Portugal Association

The Portuguese Passivhaus Portugal Association (Associação Passivhaus Portugal – PHPT) was founded in November 2012. This organization aims to promote and spread the Standard in Portugal by promoting Passive House training, building and certification, and by sharing experiences and knowledge (www.passivhaus.pt).

5 Communication

Homegrid has been promoting the first Passive Houses in Portugal and has been receiving media coverage requests, by national general television, radios and newspapers and by related magazines. The inauguration of both houses will occur in March 2013 and it will be an important event to publically announce the Passivhaus Portugal Association, its leading team, mission and vision.

The interest in the Passive House concept is increasing among the national Universities. One master thesis about the Passive House concept in Portugal (focussing Homegrid's work) has been concluded. In addiction several master and doctoral thesis about the first Passive Houses have been proposed, which objective is to follow the monitoring program and analyses its results.

6 Results

The first Passive Houses in Portugal are completed.

The analysis of the monitor results will contribute to validate the Passive House concept and the PHPP tool in Portugal.

There are four new Passive House buildings to start in short-term.

The Passivhaus Portugal Association was created.

The Passive House concept is starting to be recognized in Portugal (by companies and media) as the highest standard for energy performance and comfort in the building sector.

7 Conclusions

After this initial experience, it is possible to build Passive Houses in Portugal with the same budget as the traditional buildings.

Passive Houses with zero heating and zero cooling demand can be realized with relatively little effort in Portugal.

Our experience shows that it is possible to spread the Passive House standards in moderate and warm climates such as the majority of the South West Europe.

8 References

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