# Two pioneer retrofit case studies: a two-family residential building and an office unit

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## Introduction

This work presents two pioneer retrofit case studies in Portugal.

The first case study refers to the building operation of a two-family house, called "Casa da Palmeira", which is the first retrofitted building to achieve the Passive House Classic certification in Portugal.

The second case study refers to an office unit, called "nZEB office +", which corresponds to the first EnerPHit Certification in Portugal and the first non-residential unit to obtain the EnerPHit Unit Certification worldwide.

## Case study 1: "Casa da Palmeira"

### The project

"Casa da Palmeira" (Palm Tree House) is a two-family totally renovated house with a total treated floor area of 175 m2, located in Ílhavo, which operation started in January of 2023 [Homegrid 2023].

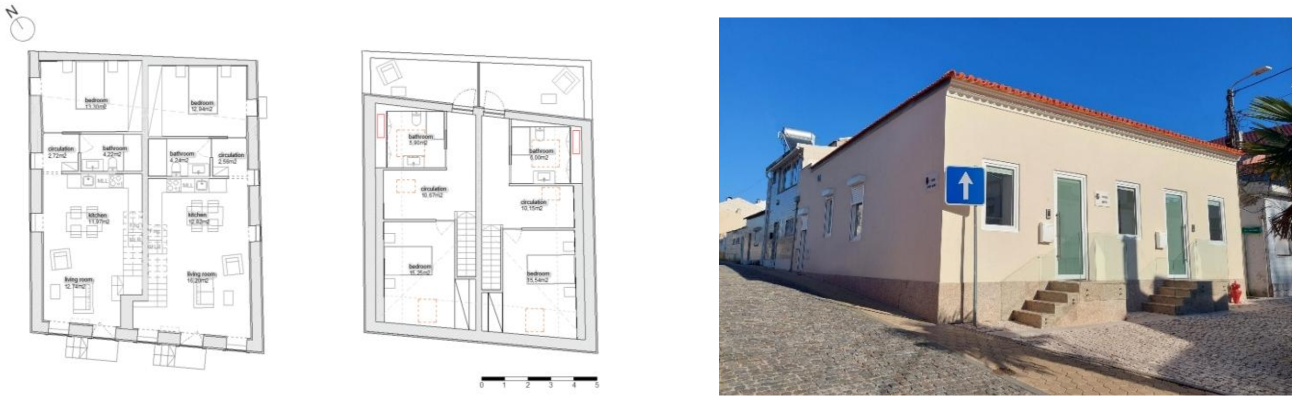

**Figure 1: The plans (ground floor and upper floor) and an exterior view.**

### Monitoring

The monitoring data under analysis was collected during two entire years, from 18th January 2023 to 17th January 2025 in one apartment. The monitoring platform (ZEUS version 6.1.28 developed by Microcom) was configured by Homegrid and provides open access to the synoptic real time data [Homegrid 2026]. The displayed data is collected every minute considering the following energy consumption data (electrical only): total energy, air conditioning, DHW, ventilation, refrigerator, cooking, energy generation (PV panels). It is also being collected the data of the indoor environment quality: temperature, relative humidity, $CO_2$ concentration. The sensors are located near the entrance door.

A total of 1 059 282 data points of each parameter, roughly one per minute during two years, were collected and analysed.

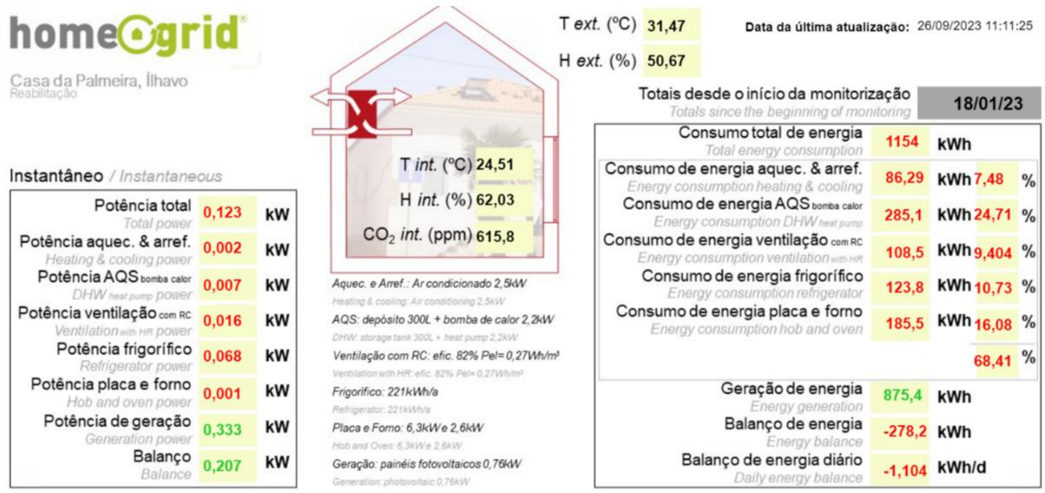


**Figure 2: The synoptic real time data of the open access monitoring platform.**

This work also presents the comparison between the data collected in the first two years of operation versus the PHPP estimated results.

## Results – energy consumption

This Passive House has very low total energy needs. For each dwelling, the total electricity consumption is less than 1700 kWh/year which is equivalent to less than €1 per day.

The monitoring results show a total energy consumption lower than what was estimated, mainly due to the lower energy needs for heating and cooling (air conditioning), which correspond to only 6% of the total energy consumed.

The energy needs for air conditioning in this Passive House are extremely low. For example, the electrical consumption of the refrigerator is practically double the electrical consumption for air conditioning.

This work reveals that the energy demand for DHW has the largest share in this Passive House, corresponding to more than 1/4 of the global consumption.

The electricity generation corresponds to around 30% of the total measured energy consumption, with just 2 photovoltaic panels (0.76kW power).

| **Type of use** | **Energy demand (kWh/year) Real - monitoring** | **%** | **Energy demand (kWh/ano) Estimated - PHPP** | **%** |
|---|---|---|---|---|
| Heating and cooling | 211 | 6,2 | 866 (heat.) + 57 (cool.) 923 (total) | 24,1 |
| DHW | 893 | 26,4 | 682 | 17,8 |
| Ventilation | 273 | 8,1 | 426 | 11,1 |
| Reftigerator | 401 | 11,9 | 442 | 11,5 |
| Cooking | 528 | 15,6 | 458 | 11,9 |
| Total | 3383 | - | 3834 | - |
| **System** | **Electricity generation (kWh/year) Real - monitoring** | **%** | **Electricity generation (kWh/ano) Estimated - PHPP** | **%** |
| 2 PV (0,76 kW) | 1008 | 29,8 | 980 | 25,6 |

**Table 1: a comparison between the actual results (monitoring) and the estimated results (PHPP).**

## Results – indoor environmental quality

The measured interior temperature stayed in the comfort zone (20° C to 25° C) during 54,34% of the time: 35,86% above 25° C and 9,79% below 20° C. The minimum registered temperature was 16,63° C and the maximum was 28,79° C.

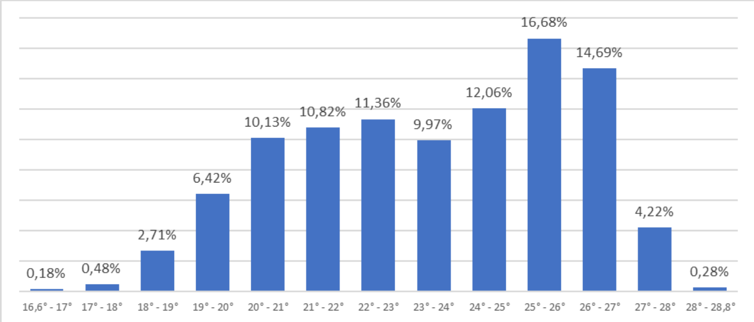


**Figure 3: The percentage of the indoor temperature measured points in each range.**

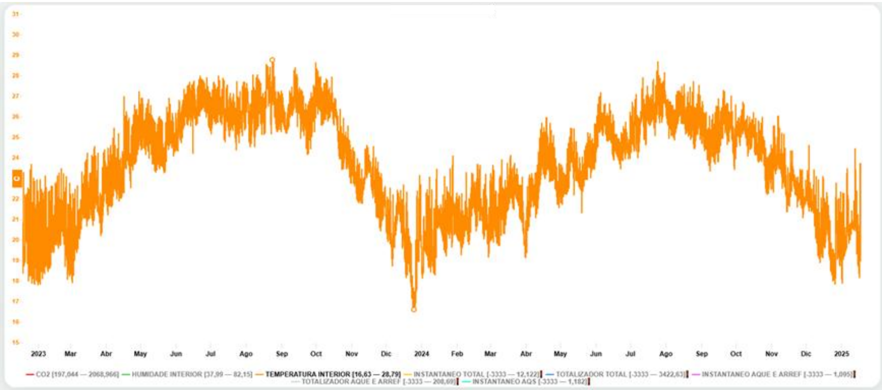


**Figure 4: The indoor temperature measured points through the 2 years period of analysis.**

Regarding the relative humidity, it stayed 89% of the time between 50% to 70%.

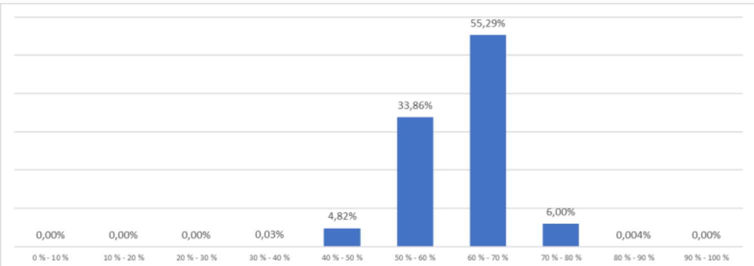


**Figure 5: The percentage of the relative humidity measured points in each range.**

The indoor $CO_2$ levels were above 1000 ppm only 1,09% of the time and above 800 ppm 9,57% of the time.

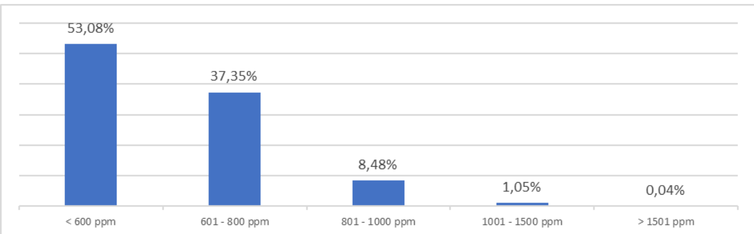


**Figure 6: The percentage of the $CO_2$ measured levels in each range.**

**Results – analysis**

The justification for the high indoor temperatures and the low energy consumption for heating may be due to the following factors:

- The difference between the outdoor average temperature climate data set and the real outdoor temperatures during the years under analysis, 2023 and 2024, which were both abnormally hot years – 2023 was the second and 2024 was the fourth hottest year since 1931 in Portugal. For instance, the average temperature in January in 2024 in Ílhavo was at least 2 Celsius degrees higher than the long-term average.
- The highest temperature occurred during a vacation period, where the house was not being used.
- The different perceptions of comfort of the users in relation to the standard comfort range. The feedback from the users did not reveal overheating problems.
- The temperature sensor is placed in a location more prone to overheat, near the glazing entrance door, although it never gets direct solar radiation.

**Conclusions and lessons learned**

This work demonstrates the potential of the Passive House standard when applied to the existing building stock and its ability to perform the needed transition to higher levels of performance.

## Case study 2: "nZEBoffice+"

**Certification**

**2014**

This story began in 2014, when Homegrid rented and started to use this office with 52 square meters of TFA. Located in Ilhavo's town center, it is a typical Portuguese office building of the mid 90's: no thermal insulation in the opaque envelope; basic aluminium frames and single pane glazing; windows ventilation.


**Figure 7: A general view of the building: the nZEBoffice+ corresponds to the top right 3 windows.**

Because of the urgency to start using the office, it wasn't implemented any deep renovation measure. As expected, the indoor environment quality was very poor, for instance the interior temperature didn't exceed 16° C in colder days with 2 electrical radiators (3,5 kW power).

**2017**

Being a company fully dedicated to Passive House services (design, consulting and certification), Homegrid decided to begin a renovation project with the goal to achieve the EnerPHit standard.

Since it wasn't possible to perform a renovation to the entire building, the only available option was to implement the improvement measures exclusively from the inside of the unit.

**2018**

With every measure defined, the definitive impulse to start the construction phase came with the electrical bill of February which was equivalent to 4 €/m². When compared to 5 €/m², the average office rental in Ílhavo at that time, the electrical bill represented a second rent… without providing comfort.

During 2018 all the envelope and building services solutions were implemented and the next winter was definitely much more comfortable.

The final TFA is 50 square meters.

**Figure 8: A moment during the renovation of the nZEBoffice+.**

**2019**

The beginning of the year was marked by the blower door test, performed in January. The results complied with the EnerPHit standard.

The final step was also implemented in the beginning of the year: the installation of the 4 PV panels. After this last step, the monitoring program started in February and the data has been collected and made available since then.

This year also marked the beginning of the research works and the media coverage.

**2020**

During this year, with the collected data, the users continued learning with the operation and additional research works took place.

**2024**

When PHI started the pilot phase of EnerPHit Unit Certification, Homegrid decided to join the initiative and the certification process started. The certification was conducted by Laszlo Lepp, PHI's certifier, and finally the certificate was issued in May of 2024 [Passipedia 2024].


**Figure 9: The certification plaque of the first non-residential EnerPHit Unit.**

### Conclusion and lessons learned

This project started without aiming the certification because it was not a possible scenario at that time. This process demonstrates that, if the work is consistent and rigorous, we can get the validation in a later phase.

## References

[Homegrid 2023] Homegrid: *Casa da Palmeira*. Homegrid's webpage available here: https://homegrid.pt/projects/casa-palmeira/

[Homegrid 2026] Homegrid: *Real time monitoring platform.* Homegrid's webpage available here: https://homegrid.pt/projects/plataforma-de-monitorizacao-em-tempo-real/

[Passipedia 2024] Passipedia: *Two pilot EnerPHit Unit projects in Italy and Portugal*: iPHA Webinar July 2024. Available here: https://passipedia.org/webinars/enerphit_unit