Two pioneer retrofit case studies

a two-family residential building and an office unit

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homegrid®

Introduction

João Gavião

homegrid®

- Architect
- Certified Passive House Designer
- Passive House trainer
- Founding member of Passivhaus Portugal Association

iPHA Affiliate
PORTUGAL PASSIVHAUS®
Associação Passivhaus Portugal - PHPT

Introduction - two case studies

Casa da Palmeira

✓ The first retrofitted building to obtain the Passive House Classic certification in Portugal

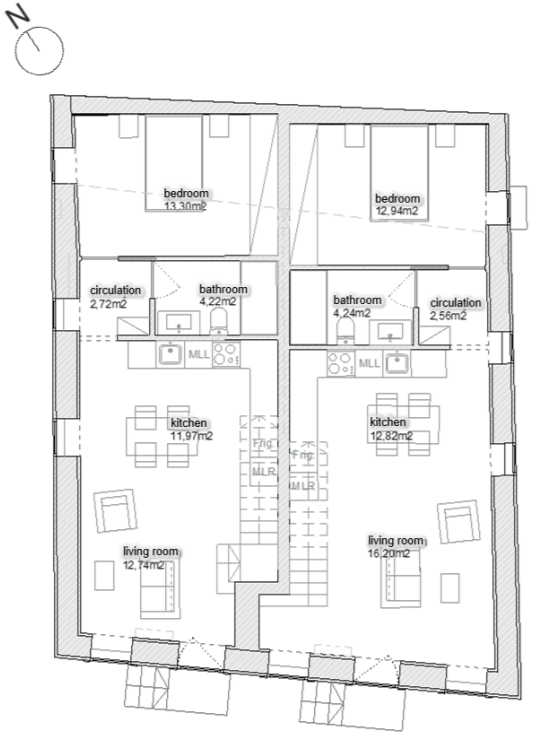
nZEB office +

✓ The first EnerPHit Certification in Portugal
✓ The first non-residential unit to obtain the EnerPHit Unit Certification worldwide

Case study 1: “Casa da Palmeira”

- **Location: Ílhavo, Portugal**
- **Two-family house**
- **Full electric**
- **TFA: 142 m²**

- **Operation/monitoring started: January 2023**
- **Period analyzed: January 2023 – January 2025**



Case study 1: “Casa da Palmeira”

Existing building

Case study 1: “Casa da Palmeira”

During the construction

Case study 1: “Casa da Palmeira”

During the construction

Case study 1: “Casa da Palmeira”

Texugo The Cat, “the construction supervisor”

Case study 1: “Casa da Palmeira”

After the retrofit

Case study 1: "Casa da Palmeira"

Monitoring

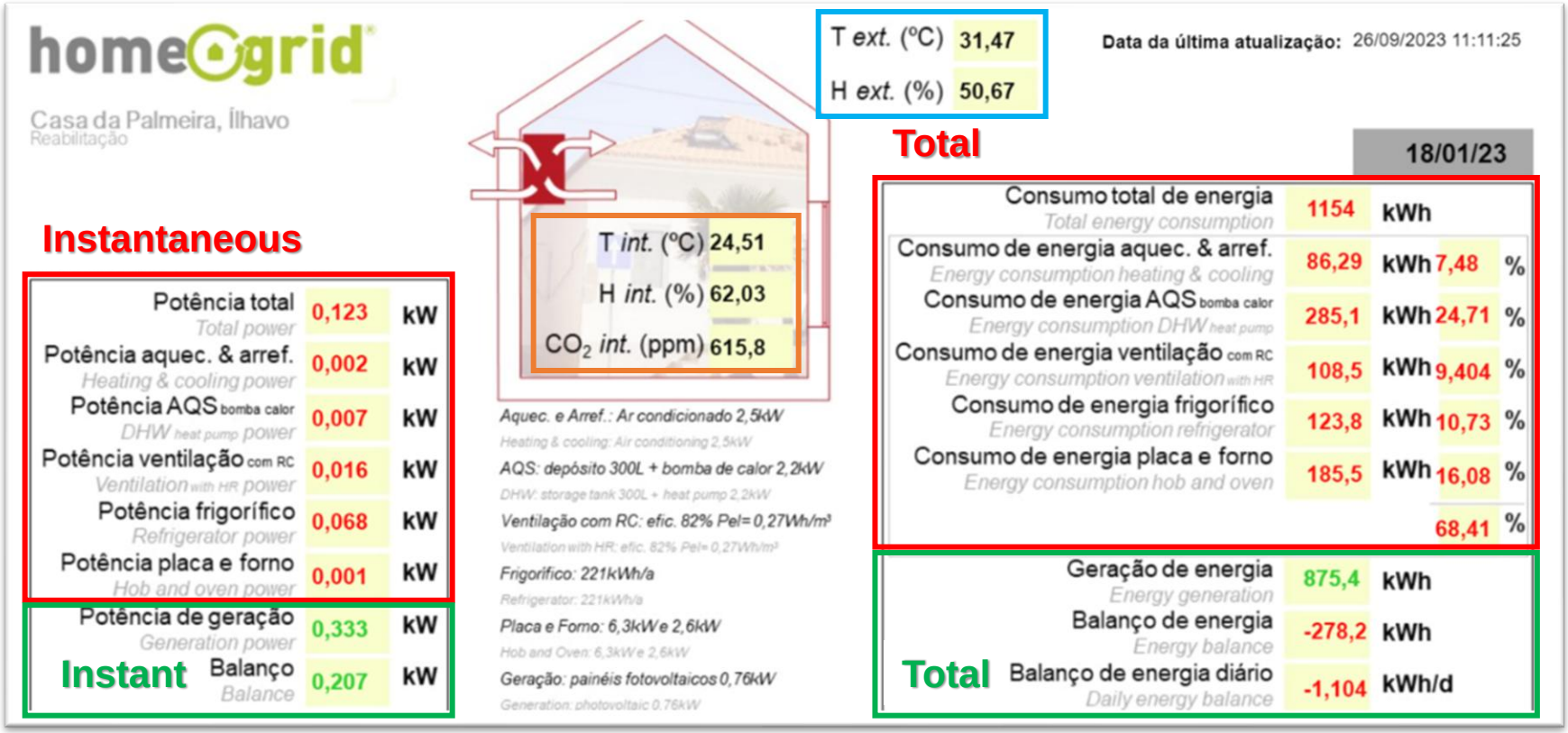
- The monitoring data analysed was collected during **two entire years**, from 18th January 2023 to 17th January 2025 in one apartment.
- The platform (ZEUS version 6.1.28 developed by Microcom) was configured by Homegrid and provides **open access** to the synoptic **real time data**.
- The data was collected **every minute**, totalizing 1 059 282 data points of each parameter.

Energy consumption – total and instantaneous (electrical only): total energy, air conditioning, DHW, ventilation, refrigerator, cooking

Energy generation – total and instantaneous (PV panels)

Indoor environment quality: temperature, relative humidity, CO_2 concentration

External conditions: temperature, relative humidity



Case study 1: "Casa da Palmeira"

Results – energy consumption

Type of use	Energy demand (kWh/year) Real - monitoring	%	
Heating and cooling	148 (heating) + 63 (cooling) 211 (total)	6,2	lowest share of the energy consumption
DHW	893	26,4	biggest share of the energy consumption
Ventilation	273	8,1	
Refrigerator	401	11,9	almost double the consumption of the split unit
Cooking	528	15,6	
Total	3383	-	Very low energy consumption equivalent to less than €1 per day
System	**Electricity generation (kWh/year) Real - monitoring**	**%**	
2 PV (0,76 kW)	1008	29,8	equivalent to 30% of the total consumption

Case study 1: "Casa da Palmeira"

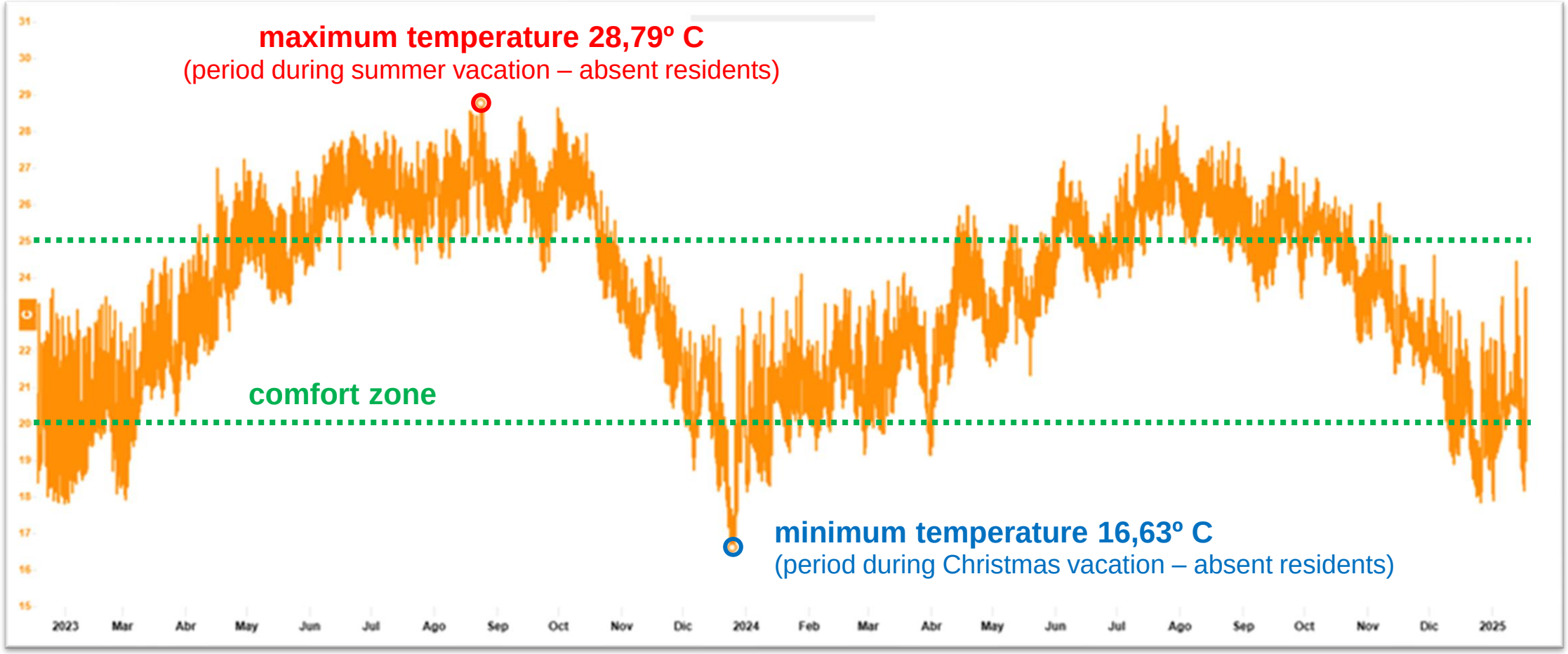
Results – energy consumption vs PHPP estimation

Type of use	Energy demand (kWh/year) Real - monitoring	%	Energy demand (kWh/year) Estimated - PHPP	%
Heating and cooling	148 (heating) + 63 (cooling) 211 (total)	6,2	866 (heating) + 57 (cooling) 923 (total)	24,1
DHW	893	26,4	682	17,8
Ventilation	273	8,1	426	11,1
Refrigerator	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/year) Estimated - PHPP**	**%**
2 PV (0,76 kW)	1008	29,8	980	25,6

Case study 1: “Casa da Palmeira”

Results – indoor environmental quality: TEMPERATURE

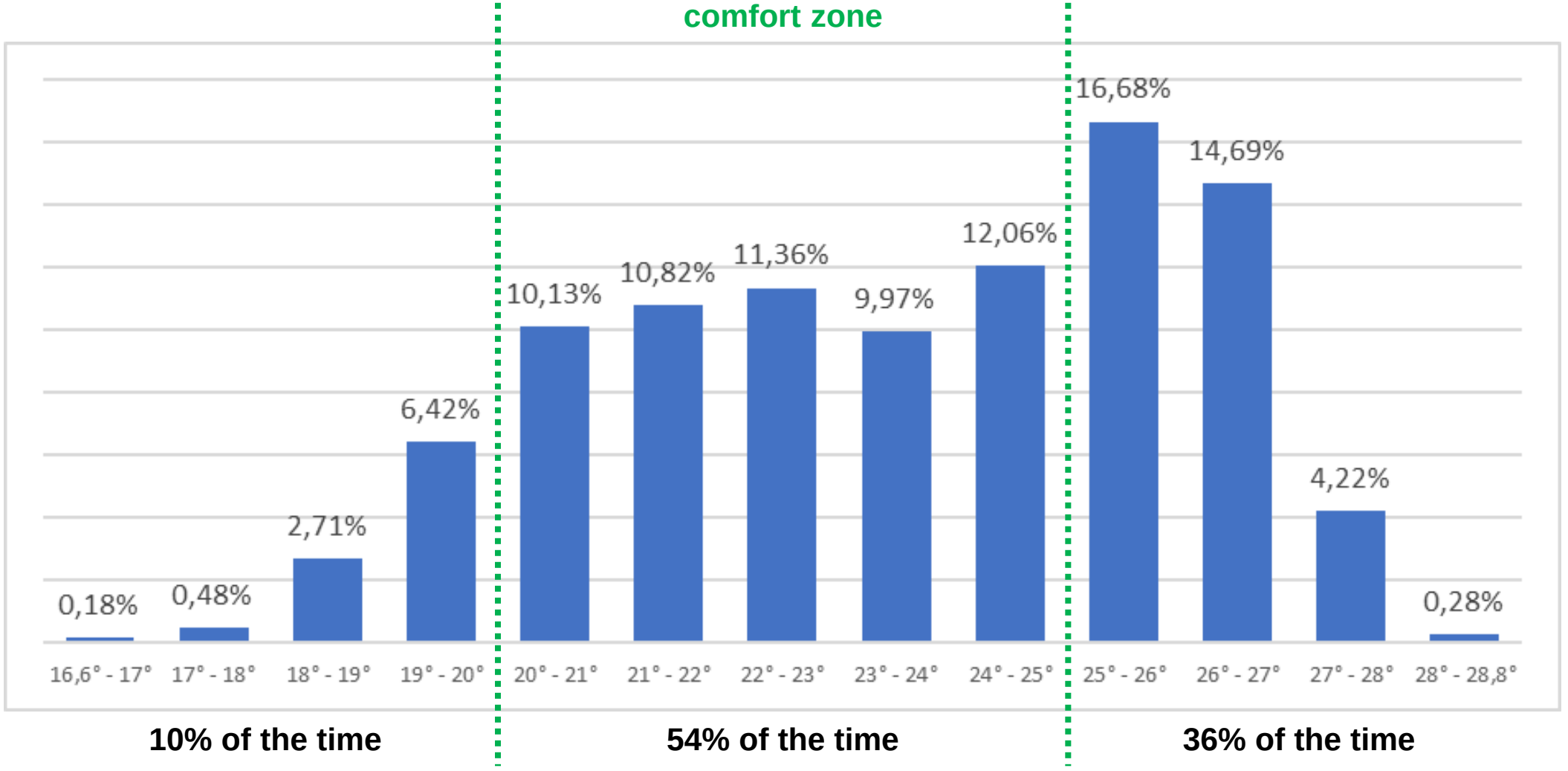
The indoor temperature measured points through the 2 years period of analysis.



Case study 1: “Casa da Palmeira”

Results – indoor environmental quality: TEMPERATURE

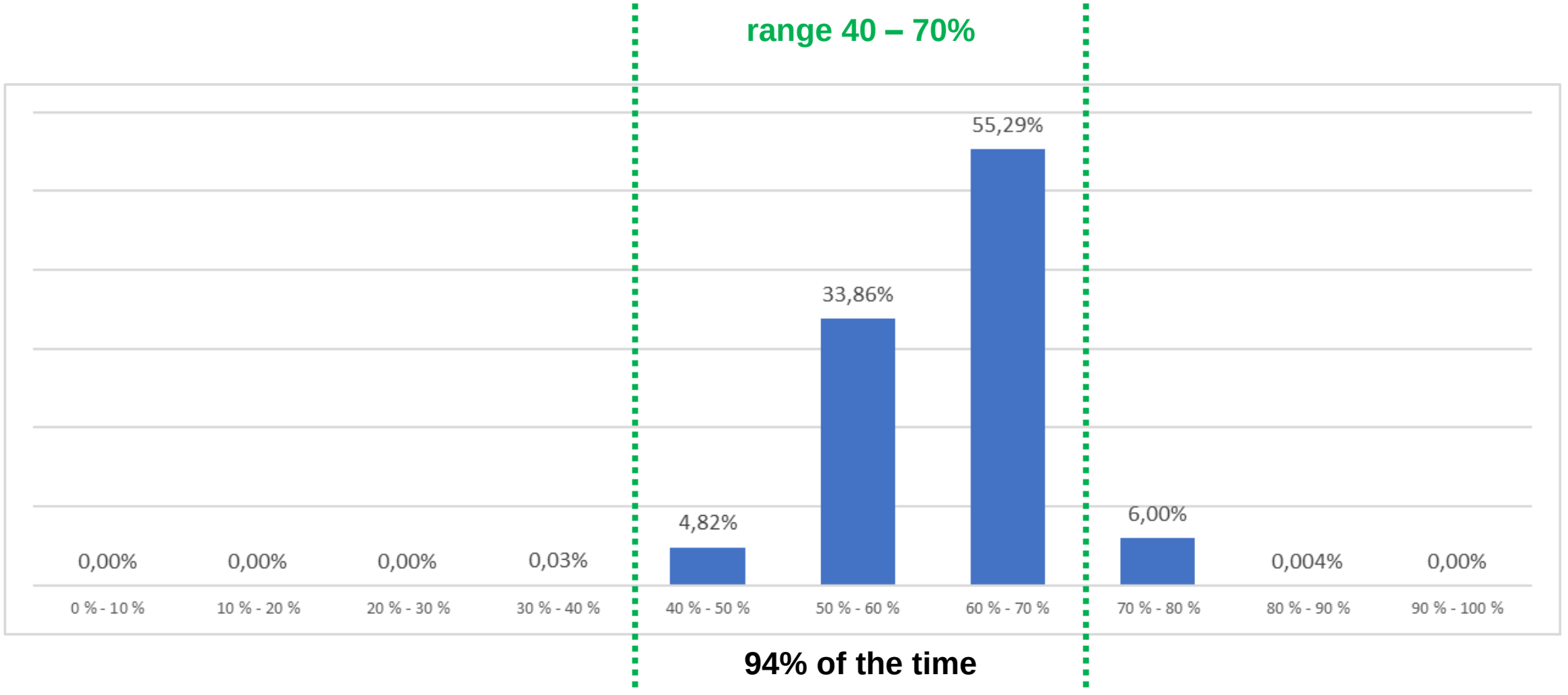
The percentage of the indoor temperature measured points in each degree range.



Case study 1: “Casa da Palmeira”

Results – indoor environmental quality: RELATIVE HUMIDITY

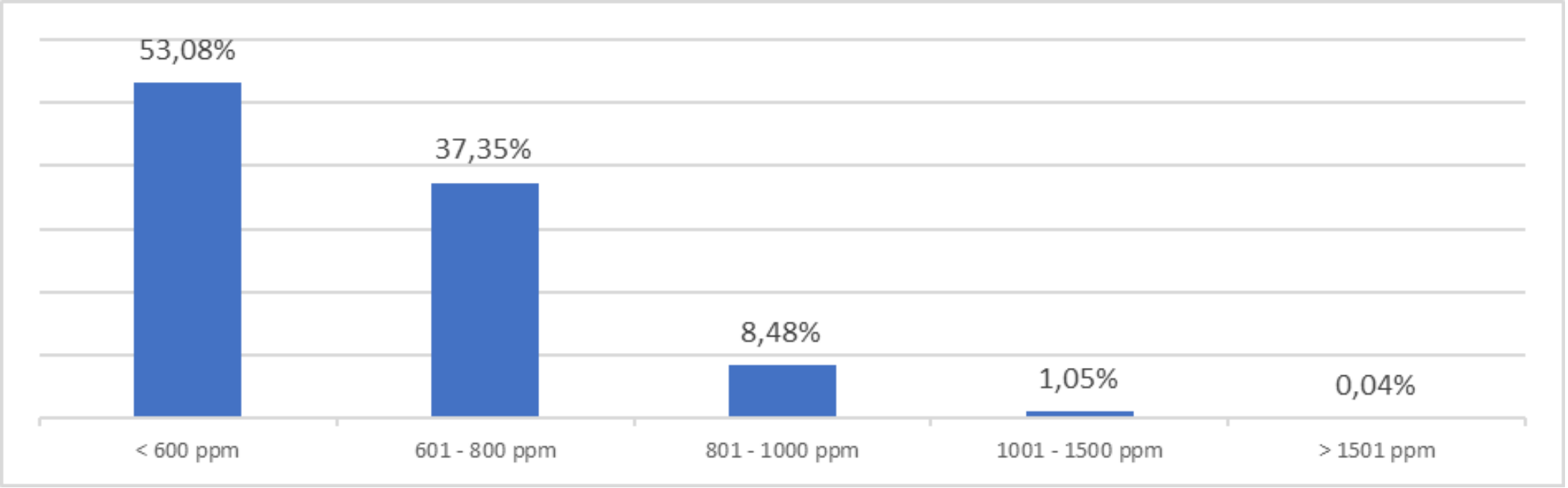
The percentage of the relative humidity measured points in each range.



Case study 1: “Casa da Palmeira”

Results – indoor environmental quality: CO_2 CONCENTRATION

The percentage of the CO_2 measured levels in each range.



Case study 1: “Casa da Palmeira”

Results – analysis

Understanding the high indoor temperatures and the low energy consumption for heating and cooling:

- **Climate data**
  - 2023 and 2024 were abnormally hot years: 2023 was the second hottest year since 1931 in Portugal and 2024 was the fourth.
  - The official climate data is from a near location and has slight differences.
- **User behaviour and preferences**
  - The highest and lowest temperatures occurred during vacation periods, when the house was vacant.
  - 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.
- **Sensor location**
  - The temperature sensor is placed in a location more prone to overheat, near the glazed entrance door facing south, although it never gets direct solar radiation.
- **Effective efficiency of the equipment**
  - The real conditions varied from the “official” setpoints leading to differences in the performance.

Case study 1: "Casa da Palmeira"

Results – energy consumption vs PHPP estimation

Tipo of use	Energy demand (kWh/year) Real - monitoring	%	Energy demand (kWh/year) Estimated - PHPP	%
Heating and cooling	148 (heating) + 63 (cooling) 211 (total)	6,2	866 (heating) + 57 (cooling) 923 (total)	24,1
DHW	893	26,4	682	17,8
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2 PV (0,76 kW)	1008	29,8	980	25,6

Case study 1: "Casa da Palmeira"

Results – energy consumption vs PHPP estimation *VERY ROUGHLY UPDATED climate data*

Tipo of use	Energy demand (kWh/year) Real - monitoring	%	Energy demand (kWh/year) Estimated - PHPP	%
Heating and cooling	148 (heating) + 63 (cooling) 211 (total)	6,2	155 (heating) + 181 (cooling) 336 (total)	10,3
DHW	893	26,4	682	21,0
Ventilation	273	8,1	426	13,1
Refrigerator	401	11,9	442	13,6
Cooking	528	15,6	458	14,1
Total	3383	-	3247	-
System	**Electricity generation (kWh/year) Real - monitoring**	**%**	**Electricity generation (kWh/year) Estimated - PHPP**	**%**
2 PV (0,76 kW)	1008	29,8	980	30,2

Case study 1: “Casa da Palmeira”

Texugo The Cat, “the happy resident”

Case study 2: “nZEB office +”

- **Location: Ílhavo, Portugal**
- **Office unit**
- **TFA: 50 m²**

- **Beginning of office operation: 2014**
- **The renovation project: 2017**
- **The renovation works: 2018**
- **Concluding the process: 2019**
- **Learning with the operation: 2020**
- **The certification: 2024**

Case study 2: “nZEB office +”

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- **Beginning of office operation: 2014**
- **The renovation project: 2017**
- **The renovation works: 2018**
- **Concluding the process: 2019**
- **Learning with the operation: 2020**
- **The certification: 2024**

The detailed presentation about this project is available here: https://passipedia.org/webinars

Case study 2: “nZEB office +”

2014

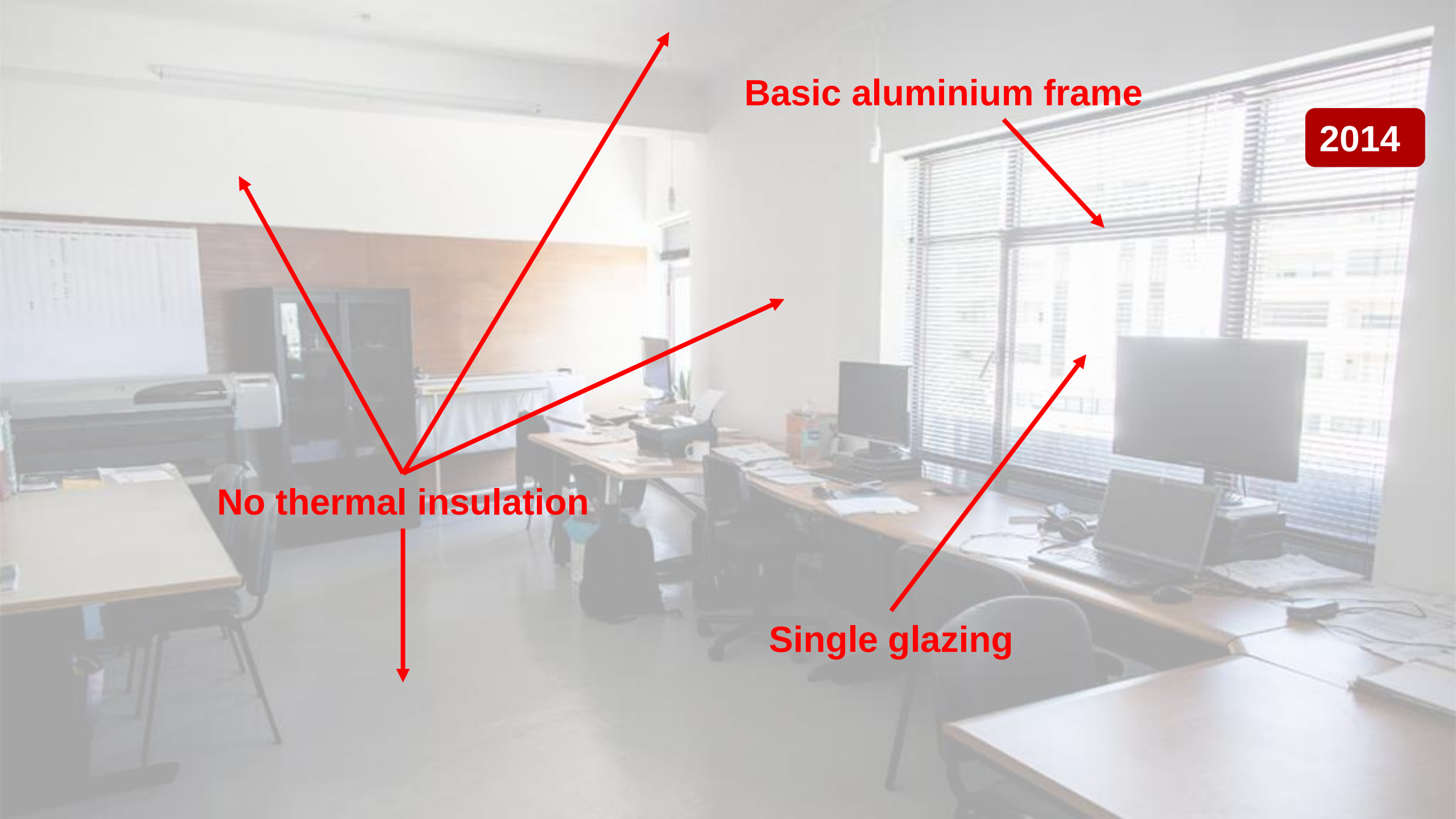
Case study 2: “nZEB office +”

Initial situation

2014

- Typical services building of the mid 90’s;
- Located in the center of Ílhavo, Portugal;
- Treated floor area: 52 m²
- We moved to that office in 2014


2014


Basic aluminium frame
2014
No thermal insulation
Single glazing

Case study 2: “nZEB office +”

2017

Case study 2: “nZEB office +”

Initial PHPP results

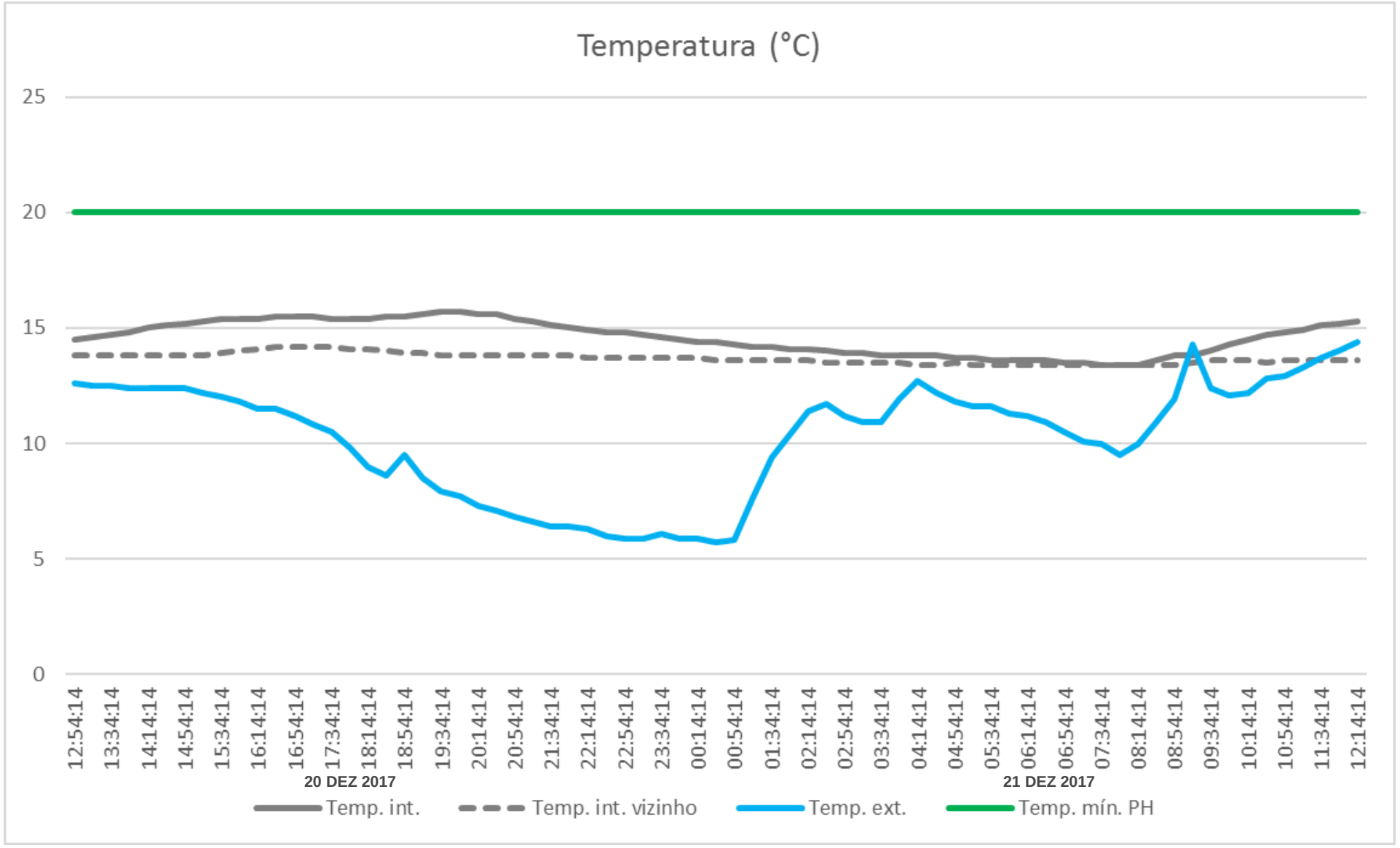
2017

Specific building characteristics with reference to the treated floor area							
					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	52,0				
Space heating	Heating demand	kWh/(m²a)	**121**	≤	15	-	**No**
	Heating load	W/m²	**59**	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	**-**	≤	-		**-**
	Frequency of overheating (> 25 °C)	%	**11**	≤	10		**No**
	Frequency of excessively high humidity (> 12 g/kg)	%	**1**	≤	20		**Yes**
Airtightness	Pressurisation test result n_{50}	1/h	**5,0**	≤	1,0		**No**
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	**406**	≤	-		**-**
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	**232**	≤	236	236	**Yes**
	Renew. energy generation (in rel. to projected building footprint area)	kWh/(m²a)	**0**	≥	-	-	

Case study 2: “nZEB office +”

Initial situation – monitoring (temp. ºC)

2017



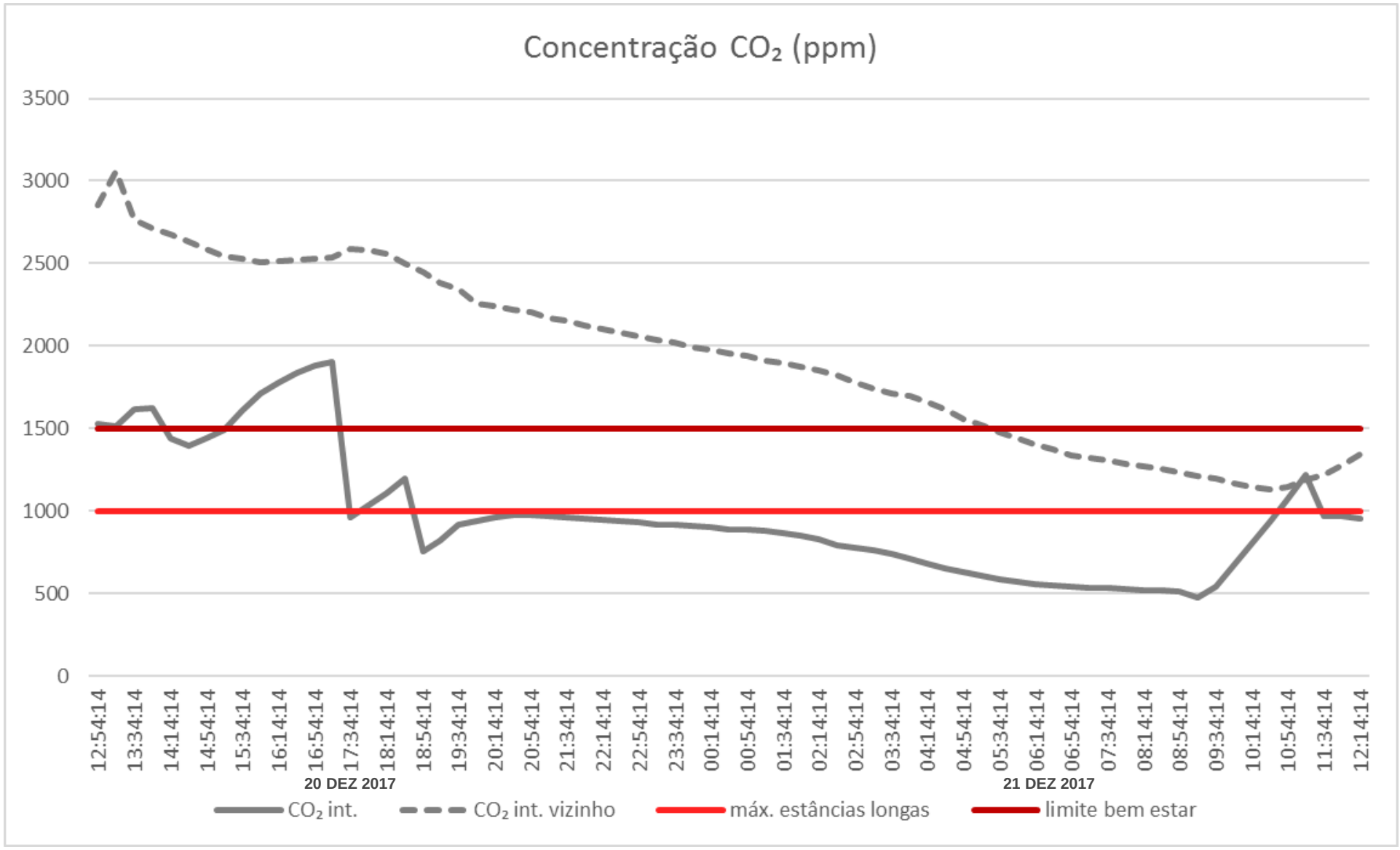
The heating supply was realized by 2 electrical radiators (2 kW + 1,5 kW).

During the coldest periods the higher internal temperature only reached 16ºC.

Case study 2: “nZEB office +”

Initial situation – monitoring (CO_2)

2017

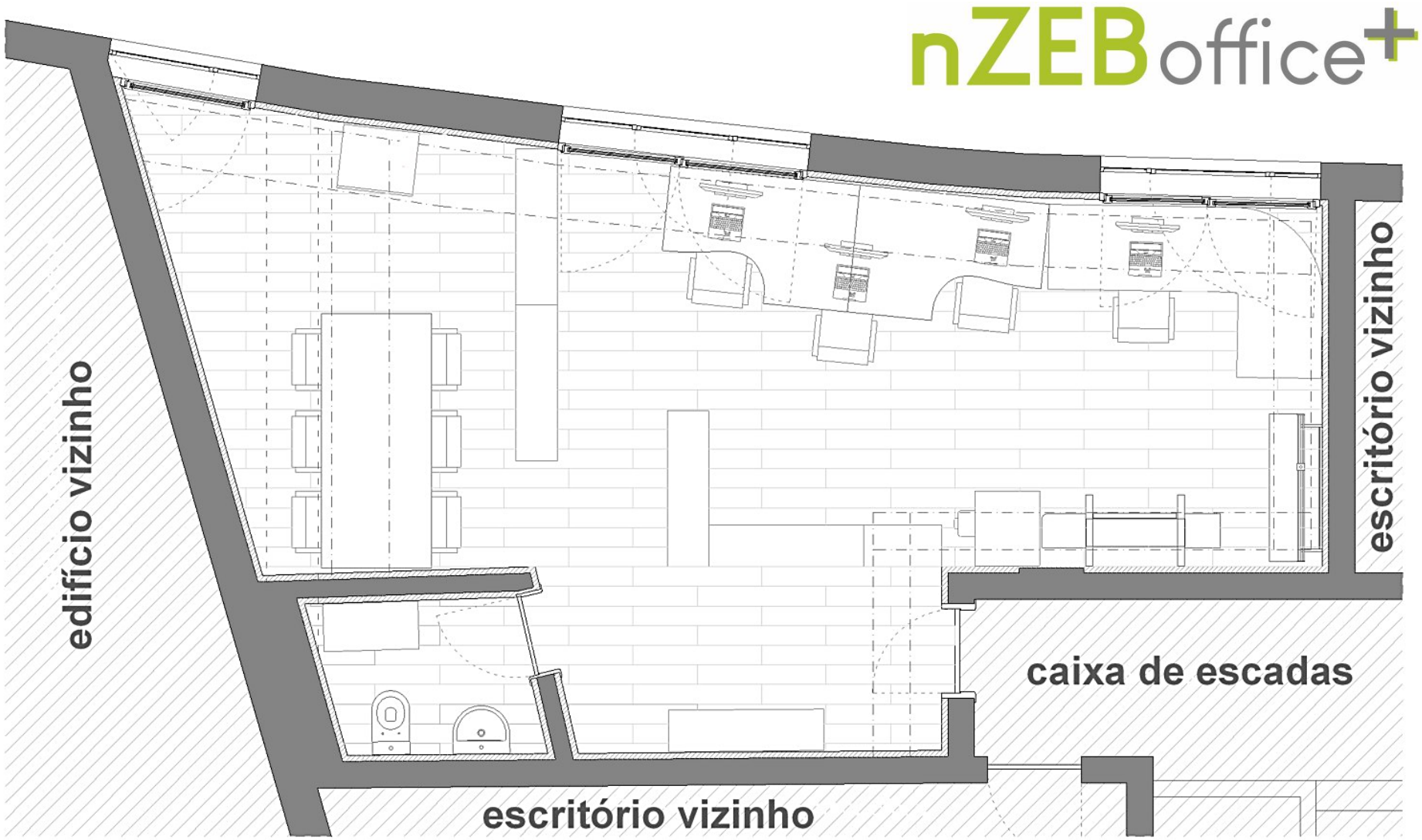


The ventilation was realized by regular windows opening.

Case study 2: “nZEB office +”

Renovation project

2017




2017

Case study 2: “nZEB office +”

Final PHPP results

2017

Specific building characteristics with reference to the treated floor area							
	Treated floor area m²	50,0					
Space heating	Heating demand kWh/(m²a)	**17**	≤	-	-		**-**
	Heating load W/m²	**14**	≤	-	-		
Space cooling	Cooling & dehum. demand kWh/(m²a)	**-**	≤	-			**-**
	Frequency of overheating (> 25 °C) %	**8**	≤	10			**Yes**
	Frequency of excessively high humidity (> 12 g/kg) %	**0**	≤	20			**Yes**
Airtightness	Pressurisation test result n_{50} 1/h	**0,7**	≤	1,0			**Yes**
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	**124**	≤	-			**-**
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	**56**	≤	64	64		**Yes**
	Renew. energy generation (in rel. to projected building footprint area) kWh/(m²a)	**26**	≥	-	-		

Criteria	Alternative criteria	Fullfilled?[2]

Case study 2: “nZEB office +”

PHPP comparison results

2017

86% reduction

final			initial		Criteria	Alternative criteria	Fullfilled?[2]
	Specific building characteristics with reference to the treated floor area						
50,0		Treated floor area m²	52,0				
17	**Space heating**	Heating demand kWh/(m²a)	121	≤	15	-	No
14		Heating load W/m²	59	≤	-	-	
-	**Space cooling**	Cooling & dehum. demand kWh/(m²a)	-	≤	-		-
8		Frequency of overheating (> 25 °C) %	11	≤	10		No
0		Frequency of excessively high humidity (> 12 g/kg) %	1	≤	20		Yes
0,7	**Airtightness**	Pressurisation test result n_{50} 1/h	5,0	≤	1,0		No
124	**Non-renewable Primary Energy (PE)**	PE demand kWh/(m²a)	406	≤	-		-
56	**Primary Energy Renewable (PER)**	PER demand kWh/(m²a)	232	≤	236	236	Yes
26		Renew. energy generation (in rel. to projected building footprint area) kWh/(m²a)	0	≥	-	-	

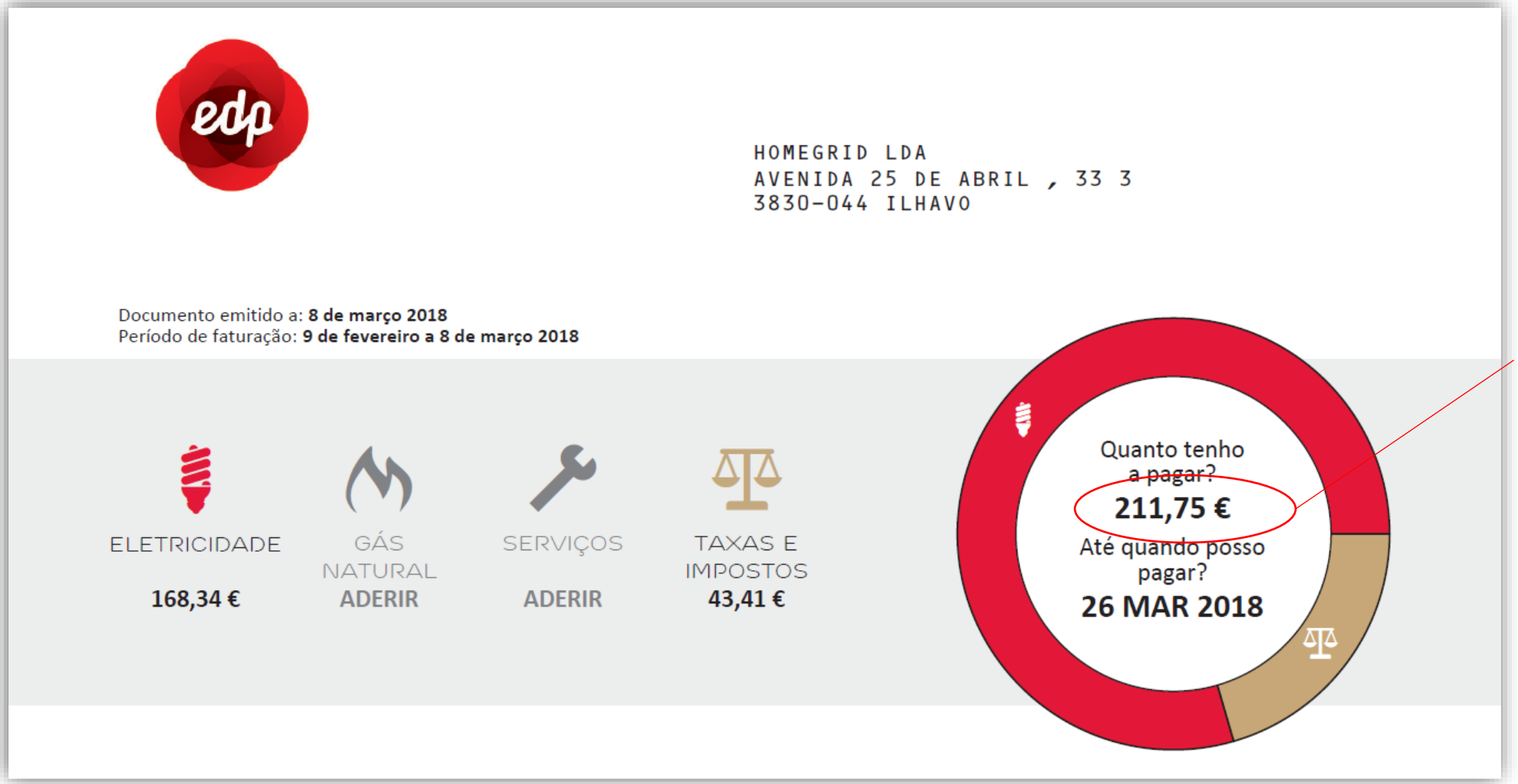
Case study 2: “nZEB office +”

2018

Case study 2: “nZEB office +”

Initial situation – electrical bill

2018



HOMEGRID LDA
AVENIDA 25 DE ABRIL , 33 3
3830-044 ILHAVO

Documento emitido a: **8 de março 2018**
Período de faturação: **9 de fevereiro a 8 de março 2018**

ELETRICIDADE	GÁS NATURAL	SERVIÇOS	TAXAS E IMPOSTOS
168,34 €	ADERIR	ADERIR	43,41 €

Quanto tenho a pagar?
211,75 €
Até quando posso pagar?
26 MAR 2018

4 €/m²

This represents a 2nd rent

In 2018, in Ílhavo, the average office rental was around 5€/m² per month


2018


2018
Temos de celebrar a vida,
a natureza, a abundância humana
As pessoas não são felizes porque não têm tempo para celebr
Estão sempre ocupadas,
vivem demasiado depressa."


2018


2018


2018


2018

2018

Component	Building assemblies	U-value W/(m²K)
External wall	Existing wall, 60 mm extruded polystyrene insulation boards + wooden beams, plaster board	**0,38**
Roof	Existing roof, 60 mm extruded polystyrene insulation boards + wooden beams, plaster board	**0,42**
Floor	Existing floor, 20 mm extruded polystyrene insulation boards, composite cork flooring	**0,65**
Window	Existing window + new window (PVC frame: U_f: 1,30 W/(m²K), double glazing: U_g: 1,00 W/(m²K); g: 0,38, warmedge spacer	**1,19**

Case study 2: “nZEB office +”

2018

Building services

Ventilation system

- Zehnder ComfoAir Q350 HRV
- Average air change rate: 0,6 1/h
- Average electrical power: 16 W
- Annual electricity cost: 35 €

Heating/Cooling

- 2 kW split unit
- Daikin Premium +

Case study 2: “nZEB office +”

Blower door test

2018

	Resultado	Intervalo confiança 95%	
q_{50} [m^3/h]	93.4	89.8	97.3
n_{50} [h^{-1}]	0.65	0.63	0.68
q_{E50} [$m^3/(h \cdot m^2)$]	0.37	0.35	0.38
q_{F50} [$m^3/(h \cdot m^2)$]	1.84	1.76	1.91

Case study 2: “nZEB office +”

Photos after conclusion

2018


2018
nZEB office+


2018
zehnder
nZEB office+

Case study 2: “nZEB office +”

2019

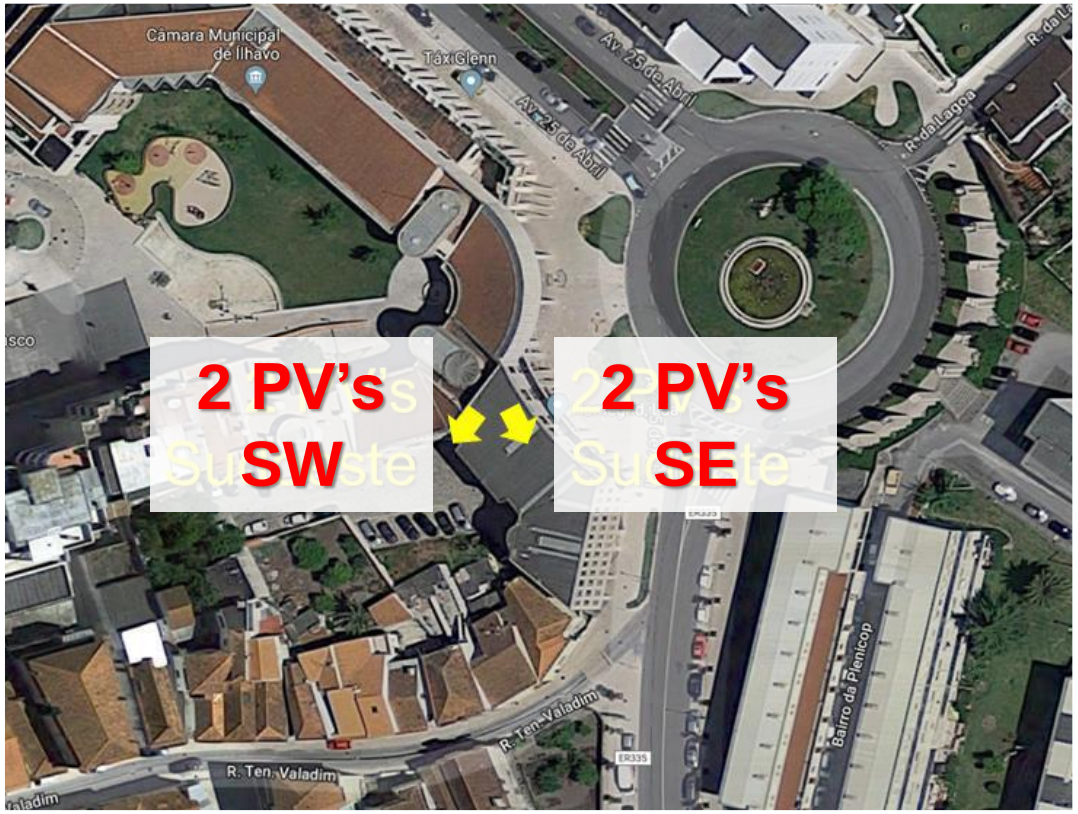
Case study 2: “nZEB office +”

Energy production

2019

4 PV panels

- Power: 1040 W

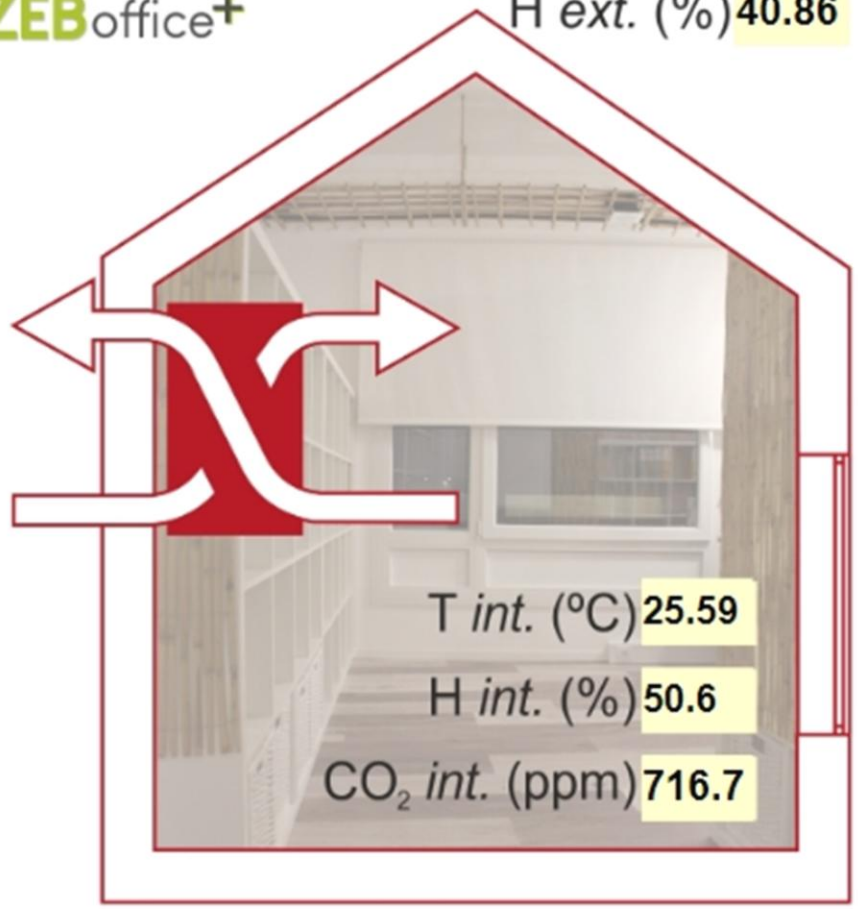


Case study 2: “nZEB office +”

Start of the monitoring

2019

homegrid
NZEBoffice+



Instantâneo / *instantaneous*

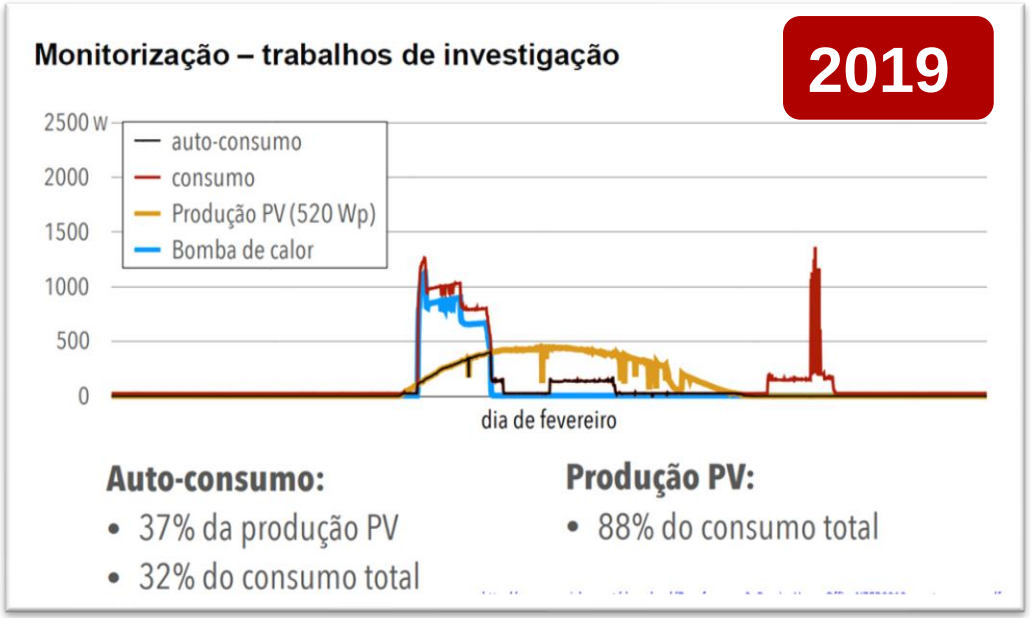
Consumo total de energia *Total energy consumption*	0.78	kW
Consumo de energia (aquec & arref) *Energy consumption (heating & cooling)*	0.526	kW
Produção de energia *Energy production*	0.782	kW
Balanço de energia *Energy balance*	0	kW

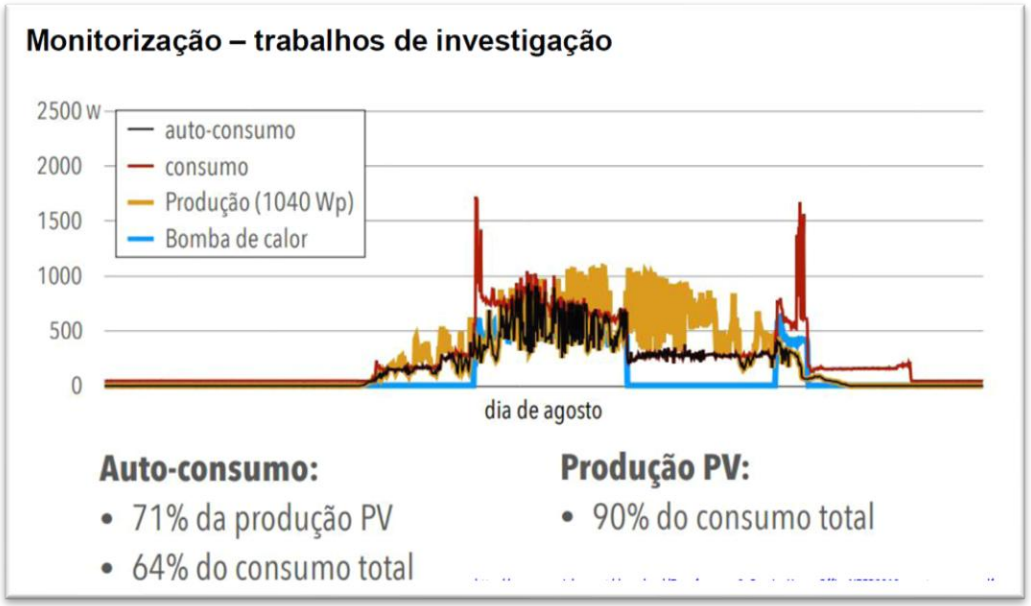
Totais desde o início da monitorização
Totals since the beginning of monitoring 20 / 2 / 2019

Consumo de energia *Energy consumption*	488	kWh
Consumo de energia (aquec & arref) *Energy consumption (heating & cooling)*	94.88	kWh
Produção de energia *Energy production*	815	kWh
Balanço de energia *Energy balance*	327	kWh
Balanço médio de energia (por dia) *Average energy balance (per day)*	2.319	kWh/d

Case study 2: “nZEB office +”

Research works





Case study 2: “nZEB office +”

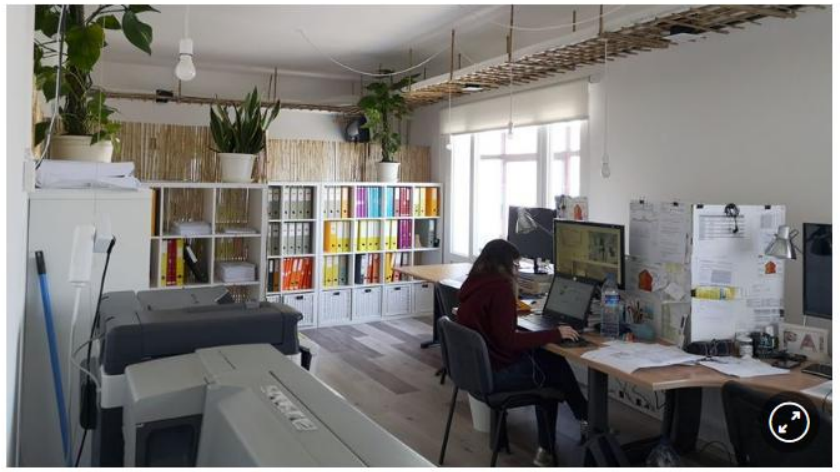
Media coverage – national radio

2019

É o primeiro escritório sustentável em Portugal e produz mais energia do que consome

28 fev. 2019 - 10:20 • Marília Freitas

Localizado em Ílhavo, este espaço foi reabilitado segundo os princípios da construção ecoeficiente e sustentável. O resultado é uma poupança na ordem dos 75%.



O nZEBoffice+ é o novo escritório da Homegrid e também sede da Associação Passivhaus Portugal. Foto: Homegrid

Trabalhar num escritório com necessidades quase nulas de energia. É o que faz João Gavião há cerca de dois meses. O primeiro escritório sustentável em Portugal fica em Ílhavo, Aveiro, e está em pleno funcionamento desde dezembro do ano passado.

Link: https://rr.sapo.pt/especial/pais/2019/02/28/e-o-primeiro-escritorio-sustentavel-em-portugal-e-produz-mais-energia-do-que-consome/142639/

Case study 2: “nZEB office +”

2020

Case study 2: “nZEB office +”

Research works

2020


Ciências ULisboa

Desempenho do nZEBoffice+

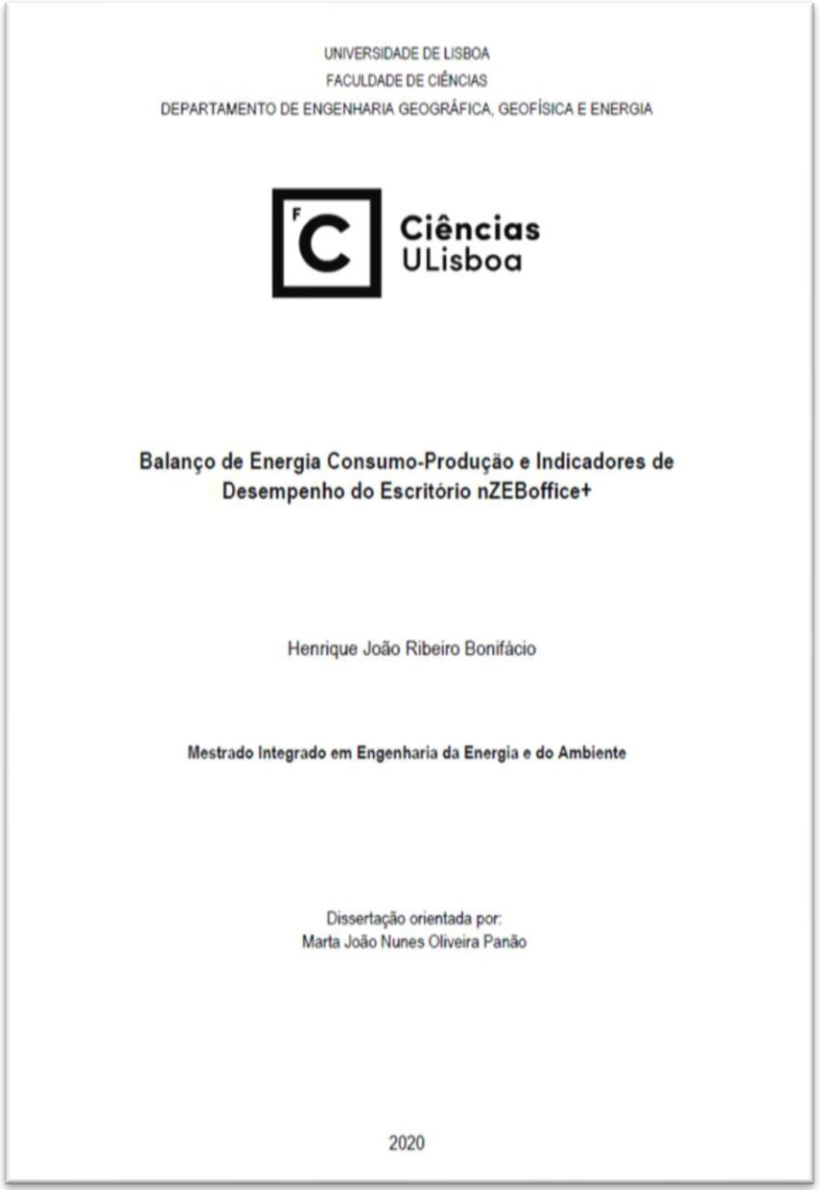
Primeiros resultados da simulação com EnergyPlus

Henrique João Ribeiro Bonifácio
Marta Oliveira Panão
20/05/2020

PARA TODOS PASSIVE HOUSE CONFERÊNCIA

homeGrid

PORTUGAL PASSIVHAUS


UNIVERSIDADE DE LISBOA
FACULDADE DE CIÊNCIAS
DEPARTAMENTO DE ENGENHARIA GEOGRÁFICA, GEOFÍSICA E ENERGIA

Ciências ULisboa

Balanço de Energia Consumo-Produção e Indicadores de Desempenho do Escritório nZEBoffice+

Henrique João Ribeiro Bonifácio

Mestrado Integrado em Engenharia da Energia e do Ambiente

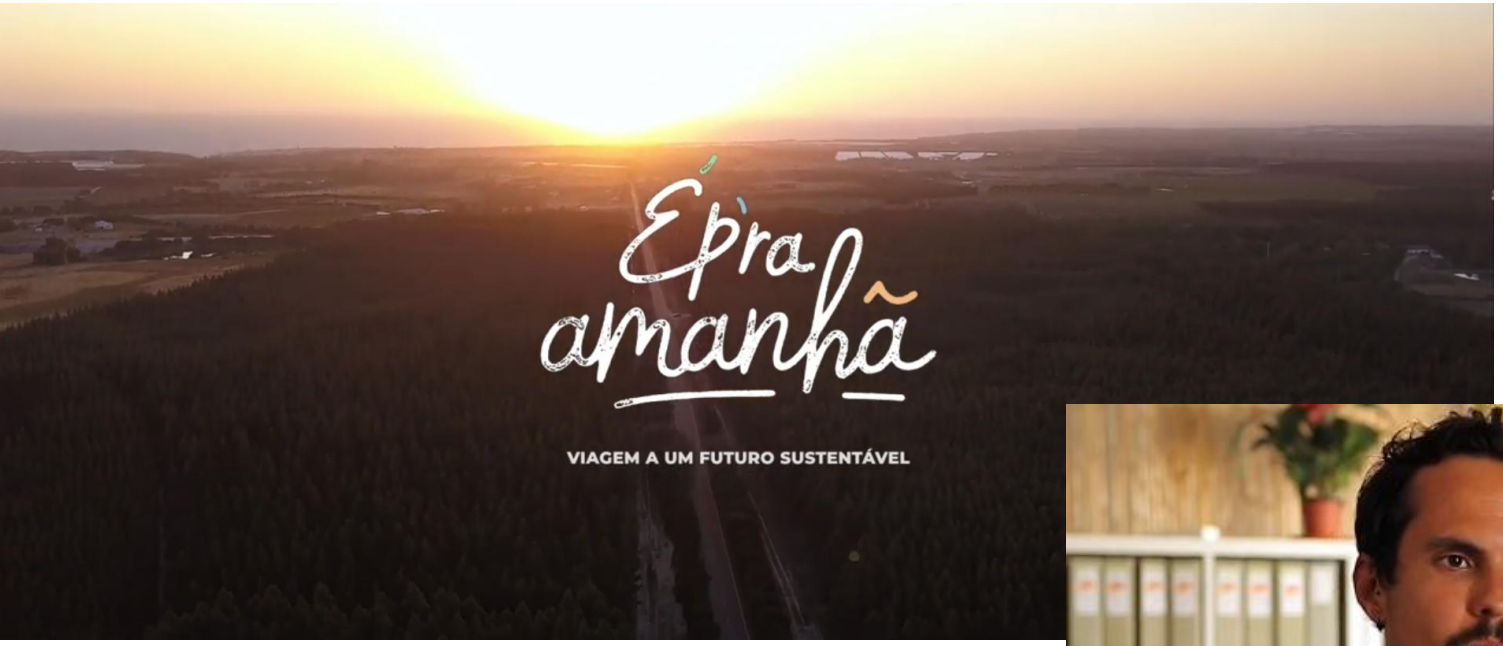
Dissertação orientada por:
Marta João Nunes Oliveira Panão

2020

Case study 2: “nZEB office +”

Media coverage – national TV

2020



Full episode: https://youtu.be/kP7uVSyeXPo?si=WInlAs-_UDQAJWX3

Case study 2: “nZEB office +”

2024

Case study 2: “nZEB office +”

2024

?

EnerPHit

Certified Retrofit

Passive House Institute

?

Case study 2: “nZEB office +”

PHPP10 final results

2024

Specific building characteristics with reference to the treated floor area

					Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area	m²	50,0				
Space heating	Heating demand	kWh/(m²a)	**17**	≤	-	-	**-**
	Heating load	W/m²	**14**	≤	-	-	
Space cooling	Cooling & dehum. demand	kWh/(m²a)	**-**	≤	-		**-**
	Frequency of overheating (> 25 °C)	%	**8**	≤	10		**Yes**
	Frequency of excessively high humidity (> 12 g/kg)	%	**0**	≤	20		**Yes**
Airtightness	Pressurisation test result n_{50}	1/h	**0,7**	≤	1,0		**Yes**
Moisture protection							
	Smallest temperature factor $f_{Rsi=0.25\ m²K/W}$	-	**-**	≥	0,19	0,00	**-**
Thermal comfort	All requirements fulfilled?	-					**Yes**
	U-value	W/(m²K)		≤	1,65		
	U-value	W/(m²K)		≤	1,30		
	U-value	W/(m²K)		≤	1,40		
	U-value	W/(m²K)		≤	0,90		
Non-renewable Primary Energy (PE)	PE demand	kWh/(m²a)	**124**	≤	-		**-**
Primary Energy Renewable (PER)	PER demand	kWh/(m²a)	**56**	≤	64	64	**Yes**
	Renew. energy generation (in rel. to projected building footprint area)	kWh/(m²a)	**26**	≥	-	-	

Case study 2: “nZEB office +”

EnerPHit Certification

2024

Certificate

Certified retrofit
'EnerPHit Unit'
(Climate zone: Warm)

Passive House Institute

Dr. Wolfgang Feist
6020 Innsbruck
Austria

nZEB office+
Avenida 25 de Abril, nº33, 3º esquerdo frente, 3830-044
Ílhavo, Portugal

EnerPHit Certified Retrofit Passive House Institute
Unit

Client	Homegrid, Lda Avenida 25 de Abril, nº33, 3º esquerdo frente 3830-044 Ílhavo, Portugal
Architect	Homegrid, Lda
Building Services	Climacom
Energy Consultant	João Gavião

Buildings retrofitted to the EnerPHit Standard offer excellent thermal comfort and very good air quality all year round. Due to their high energy efficiency, energy costs as well as greenhouse gas emissions are extremely low.

The design of the above-mentioned project meets the criteria defined by the Passive House Institute for modernization to the 'EnerPHit Unit' standard:

Building quality			This building		Criteria	Alternative criteria
Heating	Heating demand	[kWh/(m²a)]	17	≤	-	-
Cooling	Frequency of overheating (> 25 °C)	[%]	8	≤	20	
Airtightness	Pressurization test result (n_{50})	[1/h]	0,7	≤	0,6	
Renewable primary energy (PER)	PER-demand	[kWh/(m²a)]	56	≤	64	64
	Generation (reference to ground area)	[kWh/(m²a)]	26	≥	-	-
Component quality						
Wall with interior insulation to ambient air (U-value)		[W/(m²K)]	0,40	≤	0,75	
Windows/Exterior doors (Uw,installed)		[W/(m²K)]	1,26	≤	1,28	
	Glazing (g-value)	[-]	0,41	≥	-	
	Glazing/shading (max. solar load)	[kWh/(m²a)]	68	≤	-	
	Ventilation (effect. heat recovery efficiency)	[%]	82	≥	-	

The associated certification booklet contains more characteristic values for this building.

Innsbruck
15.05.2024

Certifier: Laszlo Lepp, Passivhaus Institut

www.passivehouse.com & www.phi-ibk.at

42641_PHI_EP_20240515_LL

Case study 2: “nZEB office +”

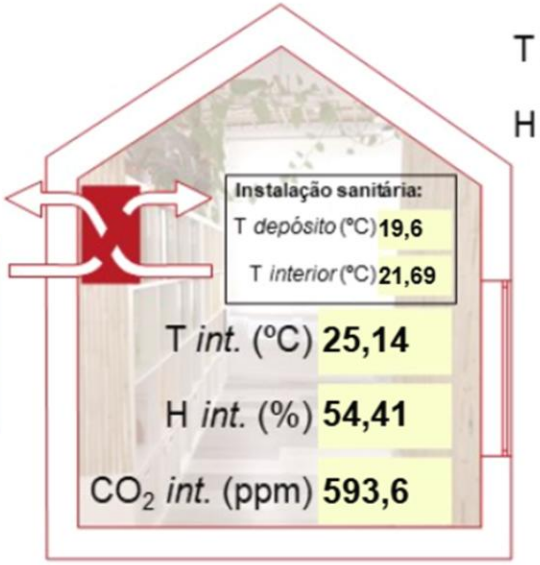
Ongoing monitoring

2024

homegrid

NZEB office+, Ílhavo
Reabilitação

Habitação vizinha não Passive House.
Neighbor dwelling not PH.
T *int.* (ºC) 21,03
H *int.* (%) 61,05
CO_2 *int.* (ppm) 576,4



T *ext.* (ºC) 24,22
H *ext.* (%) 57,45

Data última actualização: 14/04/2026 15:27:58

Ventilação com RC: efic. 91% Pel= 0,24Wh/m³
Ventilation with HR: efic. 82% Pel= 0,27Wh/m³
Geração: painéis fotovoltaicos 1kW
Generation: photovoltaic 1kW

Instantâneo / *Instantaneous*

Potência total *Total power*	0,418	kW
Potência aquec. & arref. *Heating & cooling power*	0,004	kW
Potência de geração *Generation power*	0,599	kW
Balanço *Balance*	0,216	kW

Totais desde o início da monitorização *Totals since the beginning of monitoring* **20/02/2019**

Consumo total de energia *Total energy consumption*	15 746	kWh	
Consumo de energia aquec. & arref. *Energy consumption heating & cooling*	3936	kWh	25 %
Produção de energia *Energy production*	11 852	kWh	
Balanço de energia *Energy balance*	-3894	kWh	
Balanço de energia diário *Daily energy balance*	-1,497	kWh/d	


2024
nZEB office+


EnerPHit
Unit
Passive House Institute
Passivista
2024

Conclusion and lessons learned - two case studies

Casa da Palmeira

nZEB office +

Conclusion and lessons learned - two case studies

These projects demonstrate the potential of the Passive House standard when applied to the existing building stock.

The PHPP demonstrated its robustness in predicting building performance during the operation.

It must be paid attention to the fact that the users preferences and tolerances may differ from standard notions of thermal comfort, specially in warmer climates.

Case study 1: ***Casa da Palmeira***

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.

Case study 2: ***nZEB office +***

Thank you

João Gavião | Joana Cortinhas | Maria Franca

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homegrid®