The first Passive House Plus office building in Portugal

an optimization process

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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

Team

Promotor: danosa Building together

Architectural project: VA VINHAS ARQUITETOS

Engineering projects: VA VINHAS ARQUITETOS, CLIMACOM CLIMATIZAÇÃO, GETA, OTIS

Construction management: TUV Building Design Management

Contractor: transfor CONSTRUÇÃO

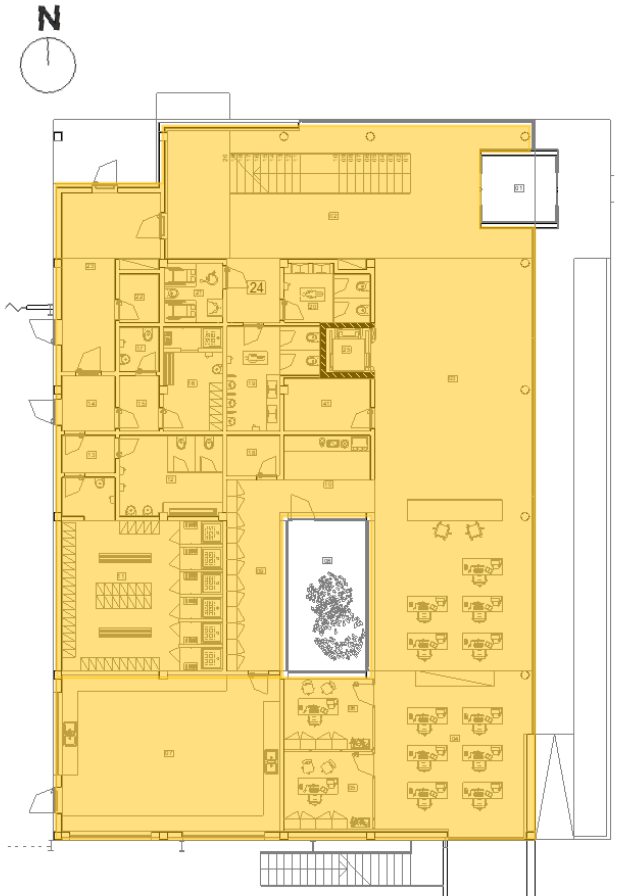
Blower door test: itecons

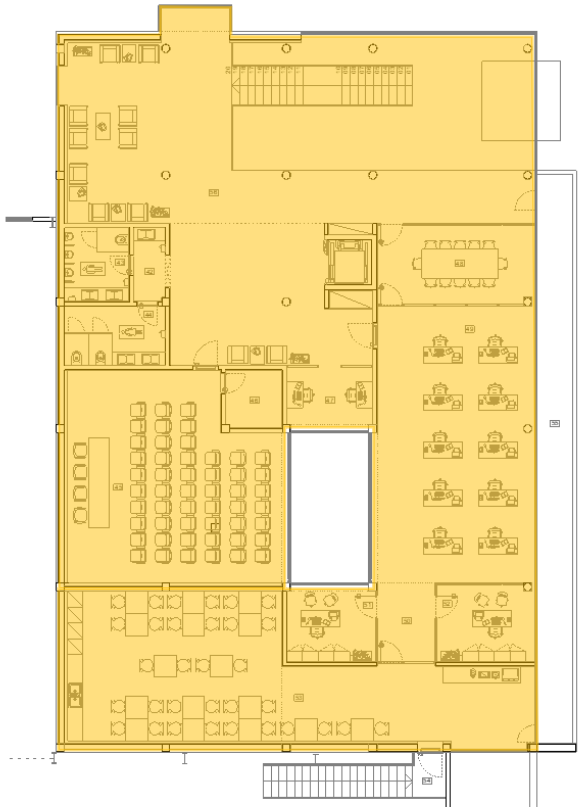
Passive House Designer: João Gustavo Silva

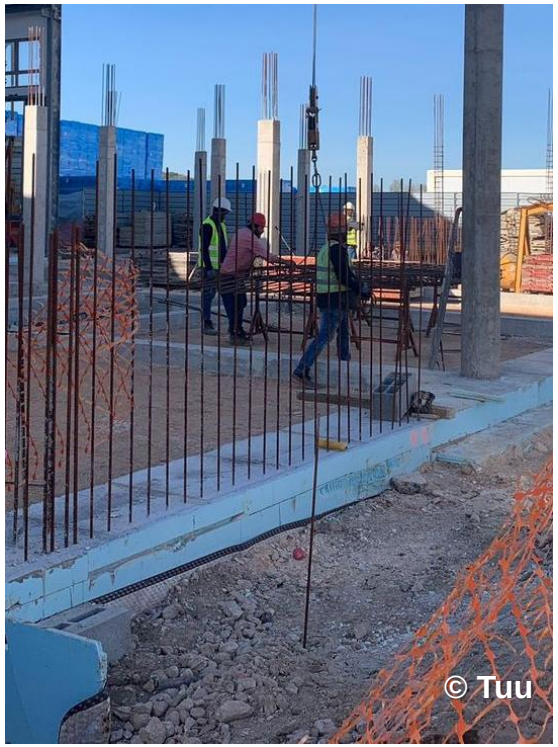
Passive House Certification: homegrid

Introduction

- **Location: Pombal**
- **TFA: 790,5 m²**
- **Two floors: initial design did not take into account the Passive House standard**
- **Construction started: July 2023**
- **Construction ended: October 2024**







Design stage - major challenges

No temporary external shading devices

- The architect only designed permanent overhangs and internal shading solutions – blackouts;
- As a consequence, very low g-value for glazing must be defined;

High window to floor ratio

- The windows area are equivalent to **47% of TFA**;

Non-optimal window orientation

- More than 65% of the windows in the external façade are facing east;

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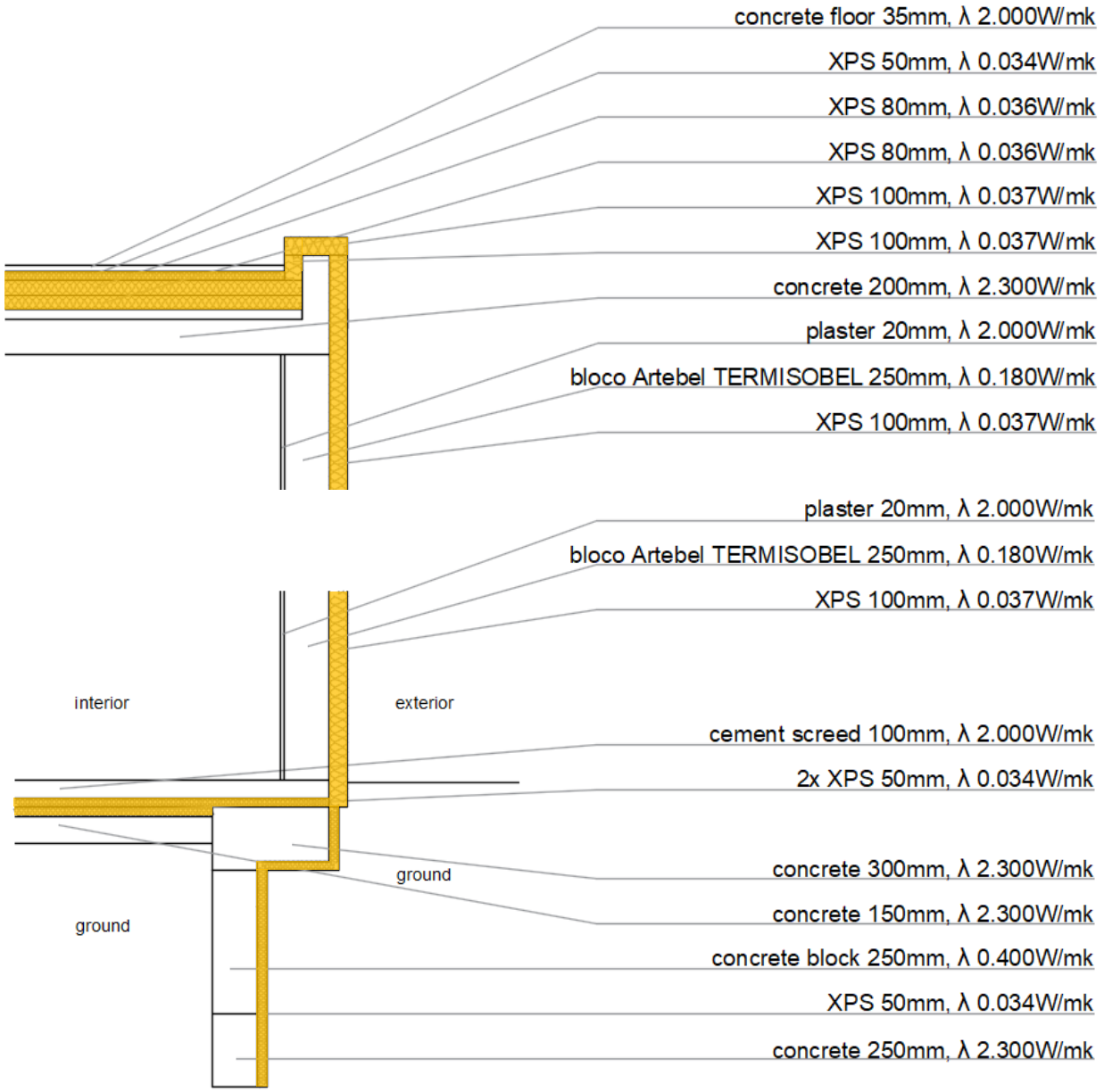
- Window installation, concrete balconies, envelope connections;



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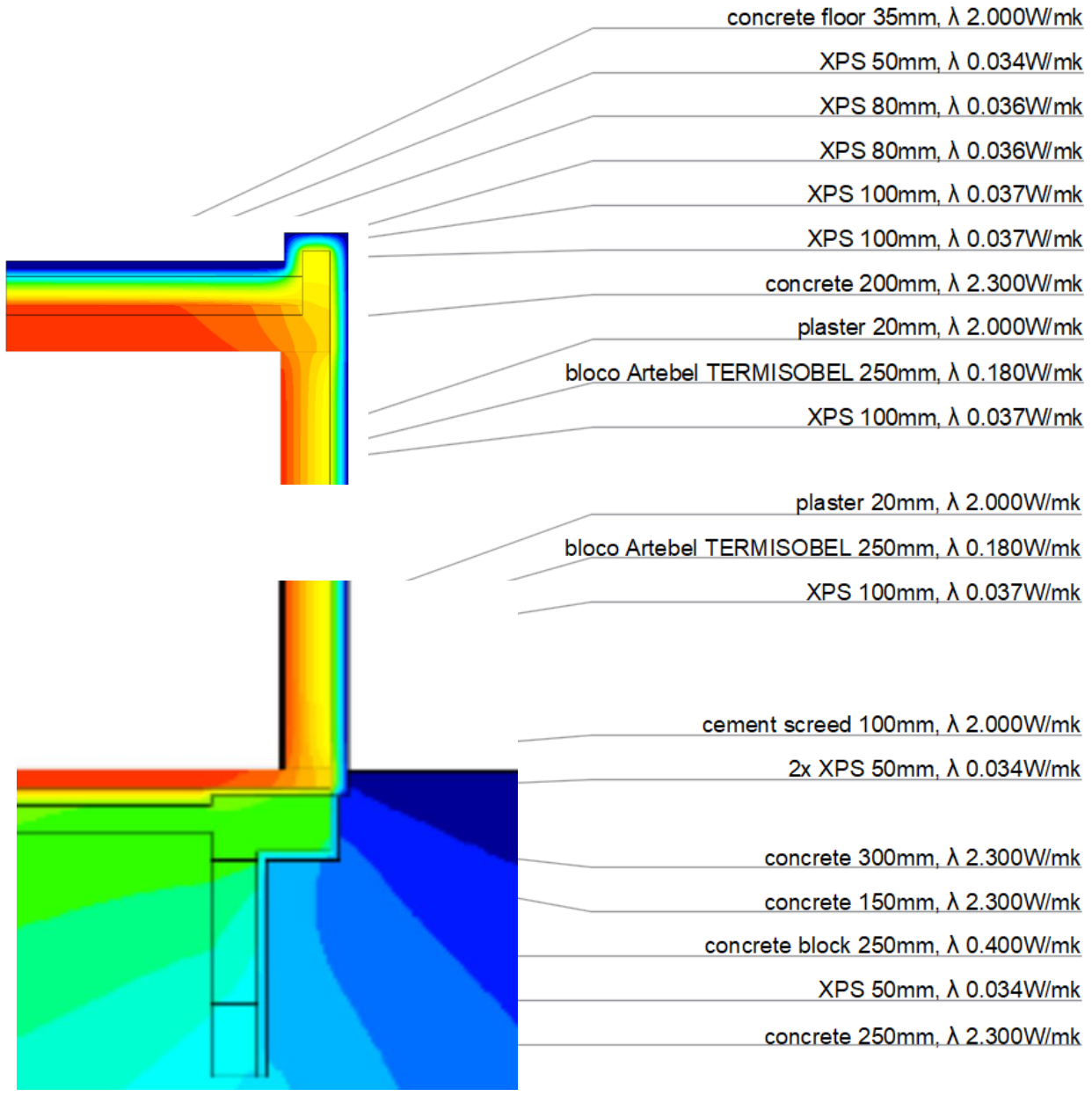

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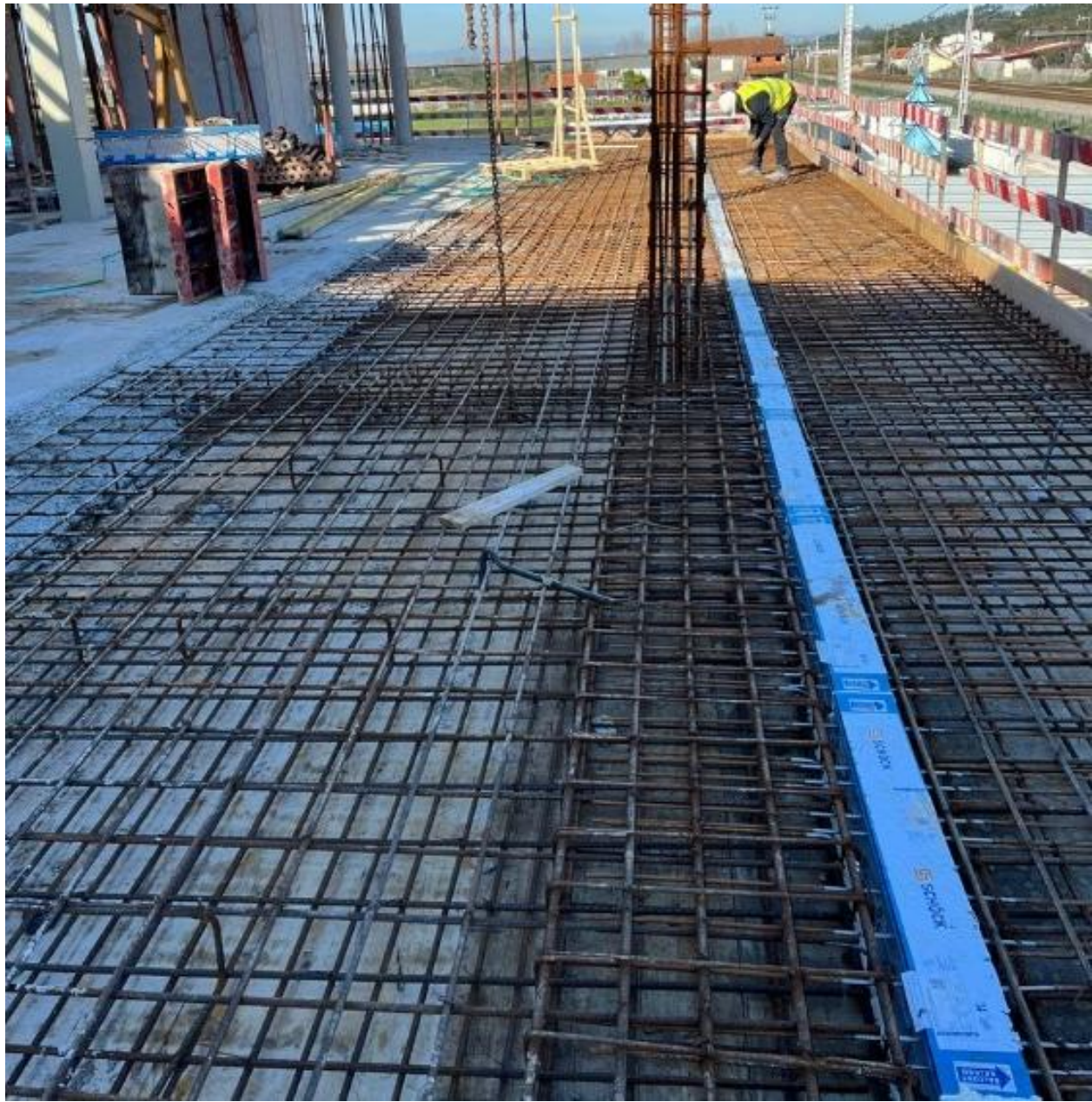


Design stage - initial vs final solutions

ID	COMPONENT	INITIAL	FINAL	
1	Roof U-value (insulation)	U = 0,209 W/m²K (160 mm)	U = 0,156 W/m²K (220 mm)	Building envelope
2	External walls U-value (insulation)	U = 0,268 W/m²K (100 mm)	U = 0,268 W/m²K (100 mm)	
3	Floor U-value (insulation)	U = 0,609 W/m²K (50 mm)	U = 0,330 W/m²K (100 mm)	
4	Window frame[1]	U_f = 9,00 to 12,00 W/m²K structural sealant glazing	U_f = 1,40 to 4,10 W/m²K standard solution	
5	Glazing	U_g = 1,00 W/m²K; g = 0,22	U_g = 1,00 W/m²K; g = 0,28	
6	Glazing edge	aluminium Ψ = 0,10 W/mK	warm edge Ψ = 0,05 W/mK	
7	Shading	Internal blackouts	Internal blackouts + external screens (if needed)[2]	
8	Thermal bridges	Balcony thermal bridges	Thermal break balcony connector	
9	Airtightness	Nothing defined	Airtight solutions + training	
10	Ventilation	Air flow: 2604 m³/h; Air change rate: 0,91 1/h	Air flow: 1688 m³/h Air change rate: 0,59 1/h	Building services
11	Air conditioning heating / cooling	Power output: 111 / 121 kW	Power output: 69 / 75 kW	

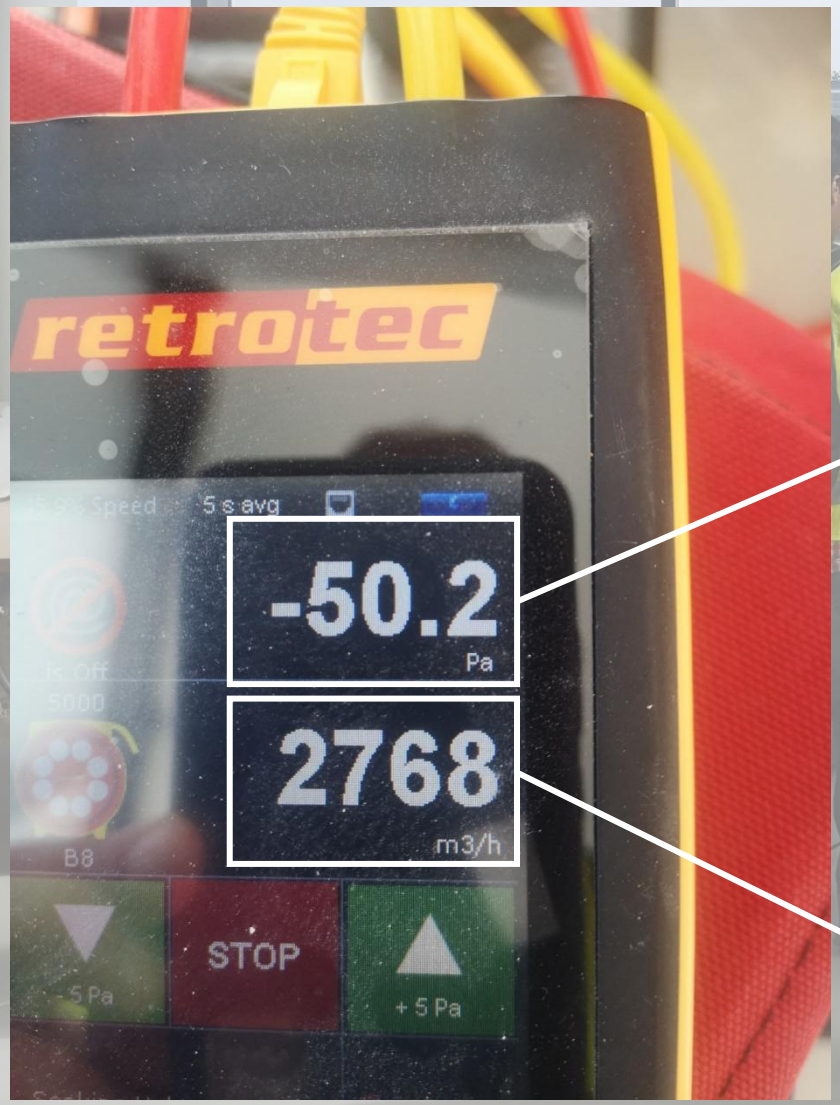
[1] in curtain wall façades the performance parameter is called U_{tj} – which is the U_f equivalent
[2] will only be installed if needed, after post-occupancy evaluation

Construction stage - major challenges

During the construction phase the focus of all the stakeholders was in achieving the required **airtightness level**.

Construction stage - blower door test #1

26-07-2024



Pressure difference

Interior volume: 2612 m³

Air flow rate

$n_{50} \cong 1{,}06$ 1/h ✗

> 0,6 1/h


Construction stage - blower door test #1
26-07-2024
itecons
transfor
Worried faces…


Construction stage - blower door test #1
26-07-2024
AIRFLOW
TA410
3.14
Leaks detection


Construction stage - blower door test #1
26-07-2024
Leaks detection

Construction stage - blower door test #2

09-08-2024

Pressure difference

Interior volume: 2612 m³

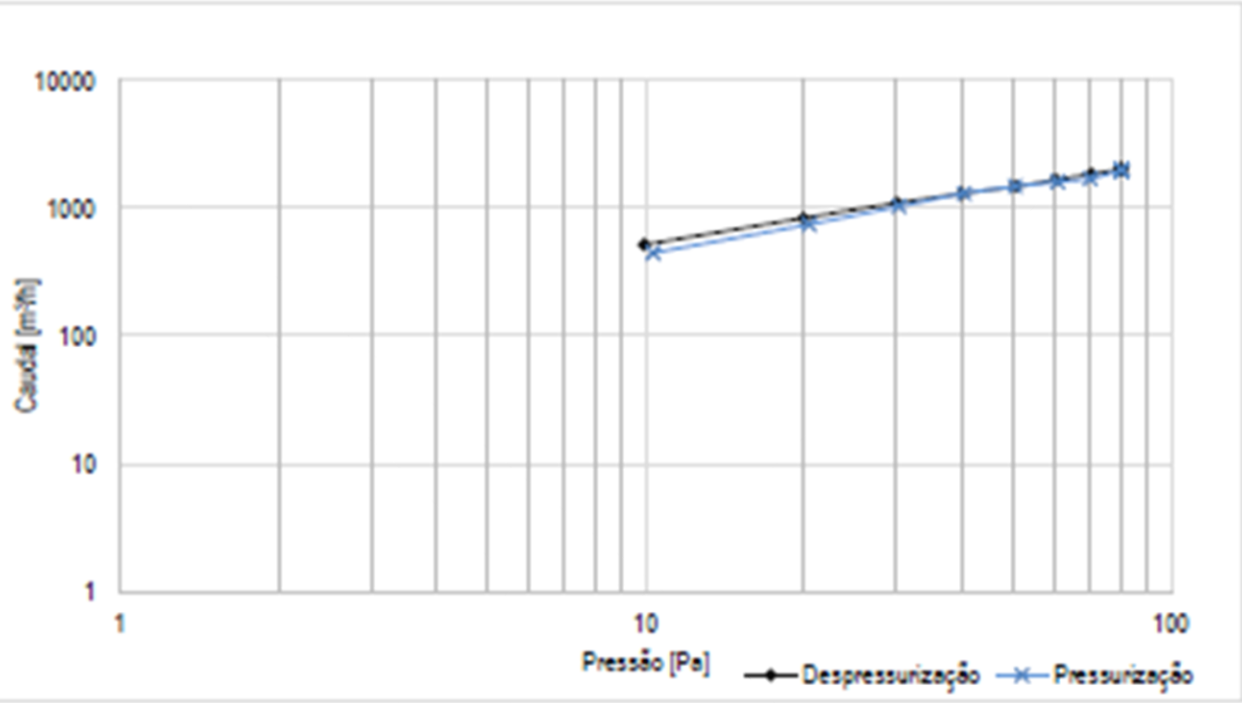
Air flow rate

$n_{50} \cong 0{,}56$ 1/h

> 0,6 1/h

Construction stage - blower door test #2

09-08-2024



Conclusões / Resultados combinados:

	Resultado	Intervalo confiança 95%	
q_{50} [m³/h]	1447.91	1401.79	1495.95
n_{50} [h⁻¹]	0.55	0.54	0.57
q_{E50} [m³/(h·m²)]	0.92	0.89	0.95
q_{A50} [m³/(h·m²)]	1.83	1.77	1.89
ELA_{10} [cm²]	332	318	348
ELA_{E10} [cm²/m²]	0.21	0.20	0.22
ELA_{A10} [cm²/m²]	0.42	0.40	0.44

Relieved faces…

Results - the Certification

Certificate

Certified Passive House Plus

homegrid

Authorised by:

Passive House Institute
Dr. Wolfgang Feist
64283 Darmstadt
Germany

Sede da Danosa
Rua do Norte, 3100-342 Pombal, Portugal

Certified Passive House
Passive House Institute
classic | plus | premium

Client	DANOSA EUROFOAM LDA Rua do Norte 3100-342 Pombal, Portugal
Architect	Vinhas Arquitectos Rua Professor Gonçalves Figueira 3100-485 Pombal, Portugal
Building Services	Climacom Rua da Junqueira, Armazém nº4 3800-034 Cacia, Portugal
Energy Consultant	João Gustavo Caetano Abrantes da Silva Avenida da Fonte Nova, S/N 3050-379 Mealhada, Portugal

Passive House buildings 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 building meets the criteria defined by the Passive House Institute for the 'Passive House Plus' standard:

Building quality		This building		Criteria	Alternative criteria
Heating					
Heating demand	[kWh/(m²a)]	15	≤	15	-
Heating load	[W/m²]	13	≤	-	10
Cooling					
Cooling + dehumidification demand	[kWh/(m²a)]	4	≤	15	15
Cooling load	[W/m²]	10	≤	-	11
Frequency of overheating (> 25 °C)	[%]	-	≤	-	
Frequency of excessively high humidity	[%]	0	≤	10	
Airtightness					
Pressurization test result (n_{50})	[1/h]	0.6	≤	0.6	
Non-renewable primary energy (PE)					
PE demand	[kWh/(m²a)]	103	≤	-	
Renewable primary energy (PER)					
PER-demand	[kWh/(m²a)]	55	≤	45	55
Generation (reference to ground area)	[kWh/(m²a)]	1852	≥	60	76

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

ílhavo
13/03/2025

Certifier: João Marcelino, Homegrid, Lda

www.passivehouse.com

47851-47858_HGRID_PH_20250317_JOM

Results - construction costs (based in the data provided by the promoter and the construction manager)

ID	COMPONENT	INITIAL	FINAL	COST VARIATION	
1	Roof U-value (insulation)	U = 0,209 W/m²K (160 mm)	U = 0,156 W/m²K (220 mm)	+ 0,19 %	Building envelope
2	External walls U-value (insulation)	U = 0,268 W/m²K (100 mm)	U = 0,268 W/m²K (100 mm)	0,00 %	
3	Floor U-value (insulation)	U = 0,609 W/m²K (50 mm)	U = 0,330 W/m²K (100 mm)	+ 0,16 %	
4	Window frame[1]	U_f = 9,00 to 12,00 W/m²K structural sealant glazing	U_f = 1,40 to 4,10 W/m²K standard solution	0,00 %	
5	Glazing	U_g = 1,00 W/m²K; g = 0,22	U_g = 1,00 W/m²K; g = 0,28	0,00 %	
6	Glazing edge	aluminium Ψ = 0,10 W/mK	warm edge Ψ = 0,05 W/mK	+ 0,09 %	
7	Shading	Internal blackouts	Internal blackouts + external screens (if needed)[2]	0,00 %	
8	Thermal bridges	Balcony thermal bridges	Thermal break balcony connector	+ 0,63 %	
9	Airtightness	Nothing defined	Airtight solutions + training	0,00 %	
10	Ventilation	Air flow: 2604 m³/h; Air change rate: 0,91 1/h	Air flow: 1688 m³/h Air change rate: 0,59 1/h	0,00 %	Building services
11	Air conditioning heating / cooling	Power output: 111 / 121 kW	Power output: 69 / 75 kW	- 1,40 %	
				balance: - 0,34 %	

[1] in curtain wall façades the performance parameter is called U_{tj} – which is the U_f equivalent
[2] will only be installed if needed, after post-occupancy evaluation

Lessons learned

This work demonstrates that the Passive House certification is a perfectly achievable goal in warmer climates, even when the building was not designed initially as a Passive House.

It also reveals that, in the presented context, the design optimization to comply with the Passive House standard can lead to the reduction of construction costs.

Thank you

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