REPORT
PUBLIC

CS 17: PARQUE MAQUINARIA, TERUEL (SPAIN)

RENOVATION APPROACH DOCUMENT

outPHit
Deep retrofits made faster, cheaper and more reliable

Call: H2020-LC-SC3-2018-2019-2020 / H2020-LC-SC3-EE-2020-1

Deliverable D5.2

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Nuria Díaz Antón

CONTACT

VAND ARQUITECTURA
+34 661 95 21 18 | info@vandarquitectura.info

OUTPHIT – DEEP RETROFITS MADE FASTER, CHEAPER AND MORE RELIABLE
outPHit pairs such approaches with the rigour of Passive House principles to make deep retrofits cost-effective, faster and more reliable. On the basis of case studies across Europe and in collaboration with a wide variety of stakeholders, outPHit is addressing barriers to the uptake of high quality deep retrofits while facilitating the development of high performance renovation systems,

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957175. The presented contents are the author's sole responsibility and do not necessarily reflect the views of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein.

CS17_PARQUE MAQUINARIA_TERUEL

Renovation Approach Description

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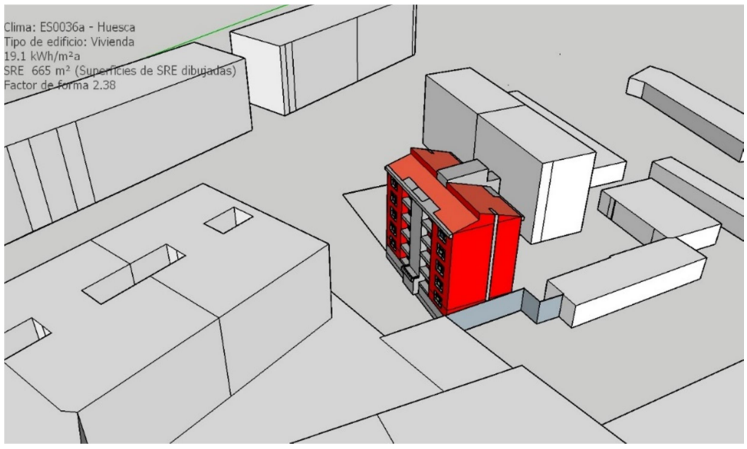
Renovation Approach Description

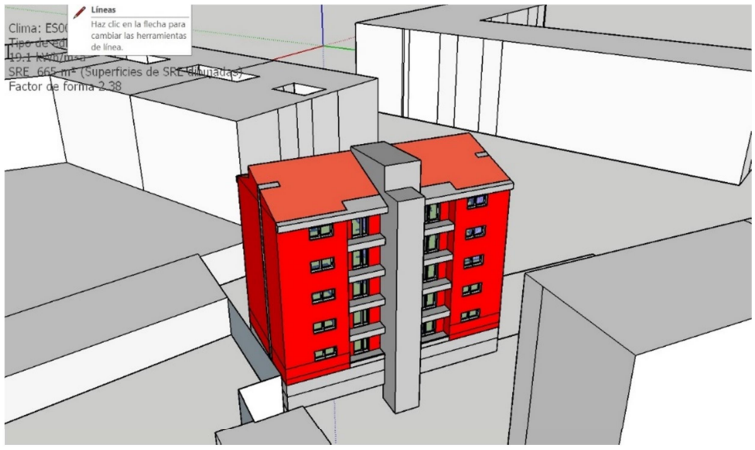
TABLE OF CONTENTS

1. Executive Summary

The building, located in the city of Teruel (Aragón) is a typical Spanish multi-storey social housing for rent from the 60s. It is owned and managed by the regional government of Aragón. The building presented numerous hygiene and comfort problems and featured a high energy consumption which renters simply could not afford.

The government of Aragon is an institution committed to society and environment. Since 2018 they have promoted the Passive House standard in all their proyects. They have already certified in 2020 two retrofits of social housing buildings (similar to the one presented here). With this third experience and with the help of Outphit resources, they intended to go one step further and develop internal strategies for the optimization of their projects (contract processes, design, execution and maintenance) in order to make them fast and cost efficient.





2. Description of the existing building

The building, located in the city of Teruel (Aragón) is a typical Spanish multi-storey social housing for rent from the 60s. It is owned and managed by the regional government of Aragón.

In the neighbourhood there are similar buildings that will be renovated in the coming years. One first building was already renovated till EnerPHit standard and certificated in 2020.

Existing building @ Nuria Díaz Antón / VAND

2.1. Building data

Year of construction:	1970
Treated Floor Area:	615 ^{m2}
Number of floors:	5
Number of apartments:	10
Building typology (residential / other):	Residential
Main construction type (e.g. massive)	Massive

2.2. Owner data

Name:	Gobierno de Aragón
City:	Teruel
Type (private / housing association):	Housing association

2.3. Location description

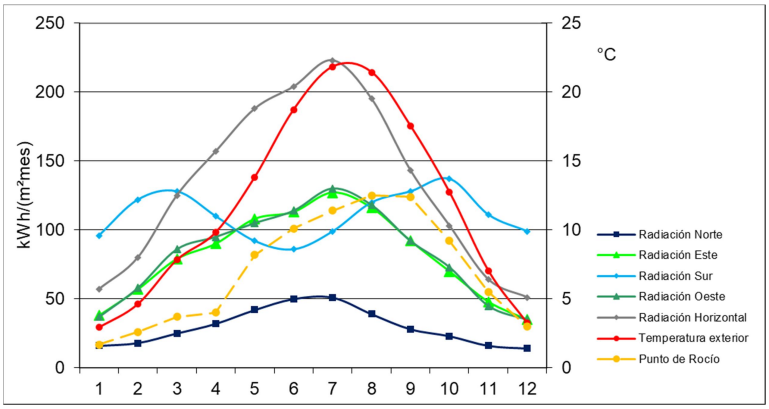
The building is located in the city of Teruel, in Aragón. Although Spain is a warm-temperate climate country, Teruel has quite cold winters due to the altitude of the region, almost 1000 meters above sea level. The lowest temperatures in Spain are measured every winter in a weather station close to Teruel.

Selección de los datos climáticos

País:	ES
Región:	D2 (CTE)
	2-Ordenar: Por ID
Datos climáticos:	ES0036a-Huesca
Zona climática:	4: Cálida-templada

Altitud

Estación climática:	541,0
Ubicación del edificio:	919



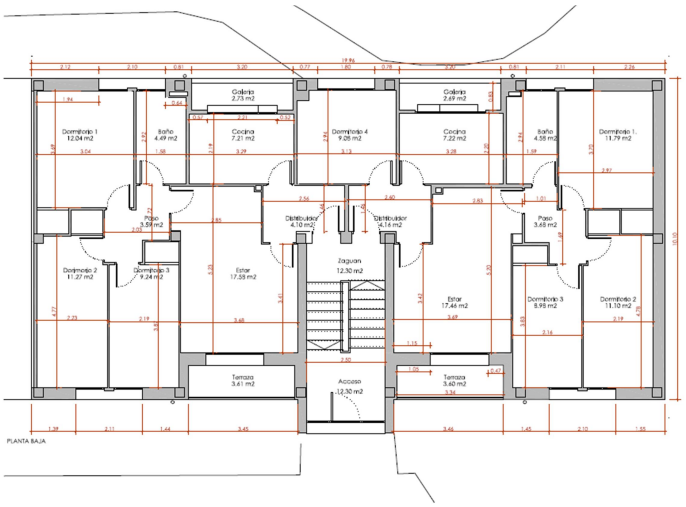
PHPP clima Teruel @ VAND arquitectura

2.4. Original situation

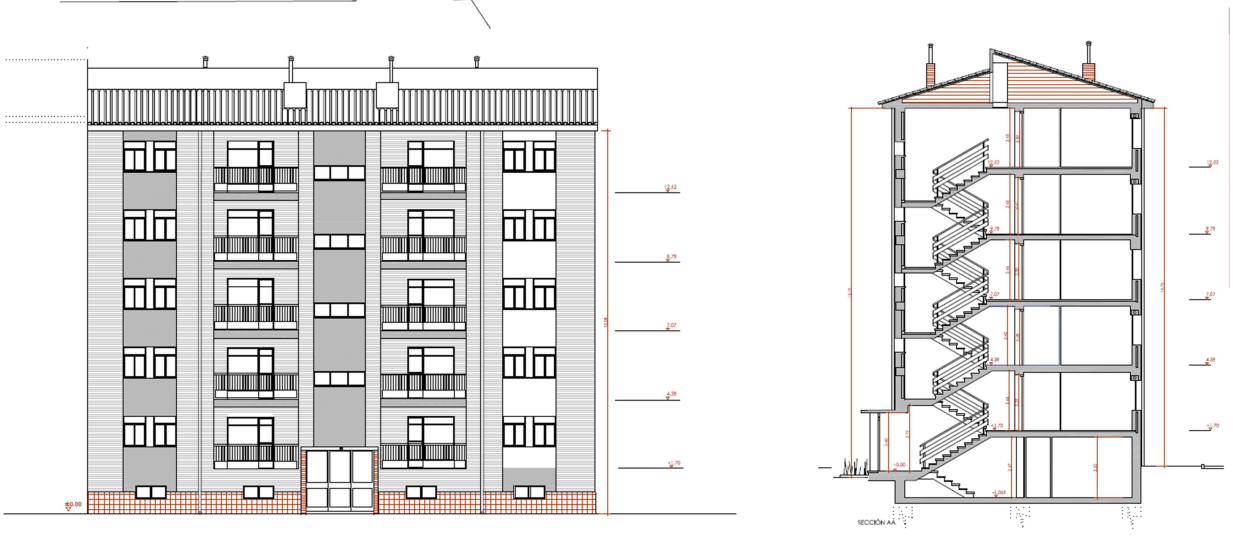
The building was erected in 1970 with a traditional construction system: a concrete skeleton with a ceramic, double-leaf façade with air chamber, an uninsulated pitched roof, balconies, an unheated attic and basement, steel framing and single glazed windows with roller shutters. It remains in its original condition and has not been renovated since it was built.

The building has numerous hygiene and comfort problems and features a high energy consumption which renters simply could not afford.

2.5. Plans and pictures of the existing building



Floor plan @ Miriam Tambo (architect, Gobierno de Aragón)



Elevation (left) and cross section (right) @ Miriam Tambo(architect, Gobierno de Aragón)

Existing building @ Nuria Díaz Antón / VAND

2.6. Envelope of the existing building

External walls

Material:	Brick /Air chamber/ Brick/ Interior plaster (airtight ayer)
Thickness:	25 [cm]
Surface (Render / Brick / Cladding):	Brick
U-Value:	3.73 [W/(m²K)]

Basement ceiling

Material:	Unheated ceiling
	Reinforce concrete floor
Thickness:	36 [cm]
U-Value:	0.631 [W/(m²K)]

Roof / Top floor ceiling

Material:	Unheated attic
Surface (Render / Brick / Cladding):	Ceramic Tiles
U-Value:	1.05 [W/(m²K)]

Windows

Material:	Original metal window frame with single glazing
Thickness:	5 [cm]
Material (Wood / Plastic / Aluminium):	Steel
U-Value (Uw, installed):	5.7 [W/(m²K)] (standard value)

2.7. Technical equipment of the existing building

Ventilation

Ventilation concept:	Window ventilation

Heating, Cooling and DHW

Heating:	Electrical
Cooling:	No cooling system
Domestic hot water:	Electrical boiler

2.8. Energy efficiency of the existing building

Passive House Planning Package (PHPP)

PHPP calculation:	PHPP_9.6
Space heating demand:	406.1 [kWh/(m²a)]
Heating Load:	139.2 [W/m²]
Overheating frequency:	7.9 %
Cooling demand:	- [kWh/(m²a)]
Cooling Load:	- [W/m²]
Primary Energy Demand:	789.2 [kWh/(m²a)]
PER Demand:	789.2 [kWh/(m²a)]

PHPP verification sheet before retrofit

						Criterio	Criterios alternativos	¿Cumplido?[2]
	Superficie de referencia energética	m²	661,6					
Calefacción	Demanda de calefacción	kWh/(m²a)	406	≤		-	-	-
	Carga de calefacción	W/m²	139	≤		-	-	
Refrigeración	manda refrigeración & deshum.	kWh/(m²a)	-	≤		-	-	-
	Carga de refrigeración	W/m²	-	≤		-	-	
	Frecuencia de sobrecalentamiento (> 25 °C)	%	8	≤		10		Sí
	Frecuencia excesivamente alta humedad (> 12 g/kg)	%	0	≤		20		Sí
Hermeticidad	Resultado ensayo presión n_{50}	1/h	10,0	≤		1,0		No
Energía Primaria no renovable (EP)	Demanda EP	kWh/(m²a)		≤		-		-
	Demanda PER	kWh/(m²a)	789	≤		734	-	No
Energía Primaria Renovable (PER)	Generación de Energía Renovable (en relación con área de la huella del edificio proyectado)	kWh/(m²a)	-	≥		-	-	

3. Renovation approach description

In this retrofit, the EnerPHit standard will be achieved through the Components Method. It is a complete renovation including the following actions:

-Building envelope insulation (facades, roof, floor towards basement and interior walls between apartments and staircase)

-Windows, doors, and roller shutter replacement

-Airtightness improvement

-Ventilation system with heat recovery installation

-Heating and cooling systems renovation

-Existing thermal bridges improvement

-Accessibility improvement

-No RES implemented in this step

Outside picture renovated building @b+haus

3.1. EnerPHit standard approach

EnerPHit standard target (class):	Classic
Climate Zone	Warm-temperate
EnerPHit verification method:	Component method

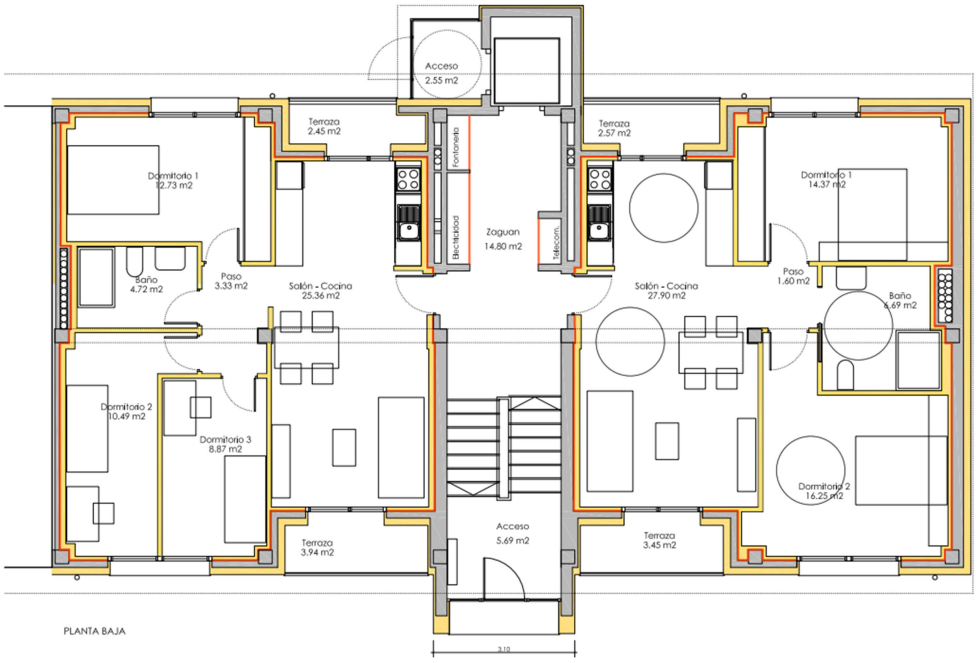
3.2. Design / Consultancy teams

Name:	Gobierno de Aragón / B+HAUS
City:	Zaragoza
Type (private / housing association)	Private

3.3. Design / Construction periods

Design period:	06.2021 – 01.2021
Construction period:	02.2021 – 07.2022

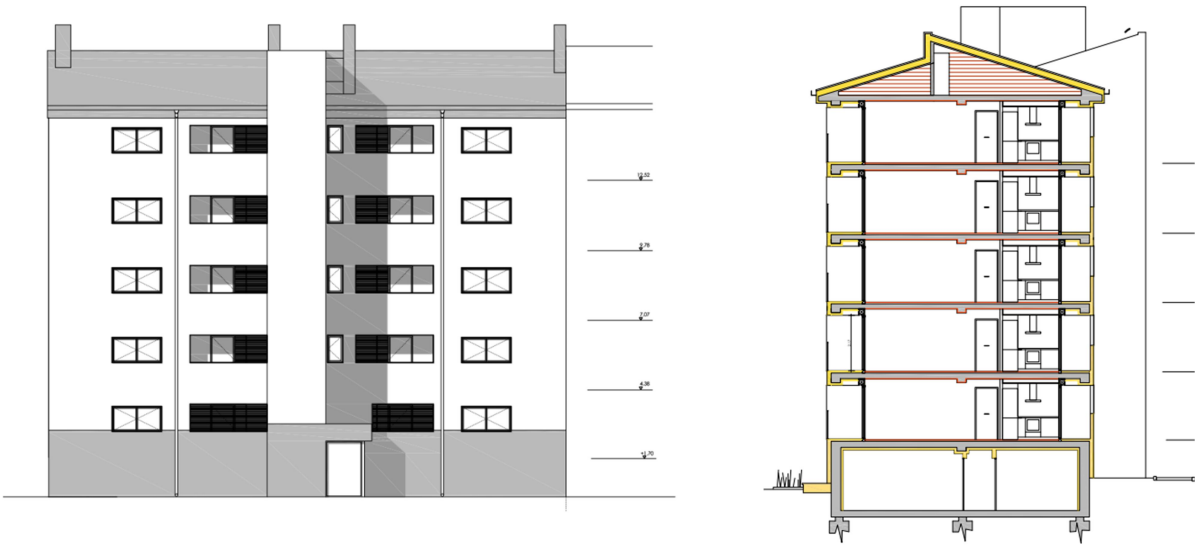
3.4. Plans and pictures of the renovation



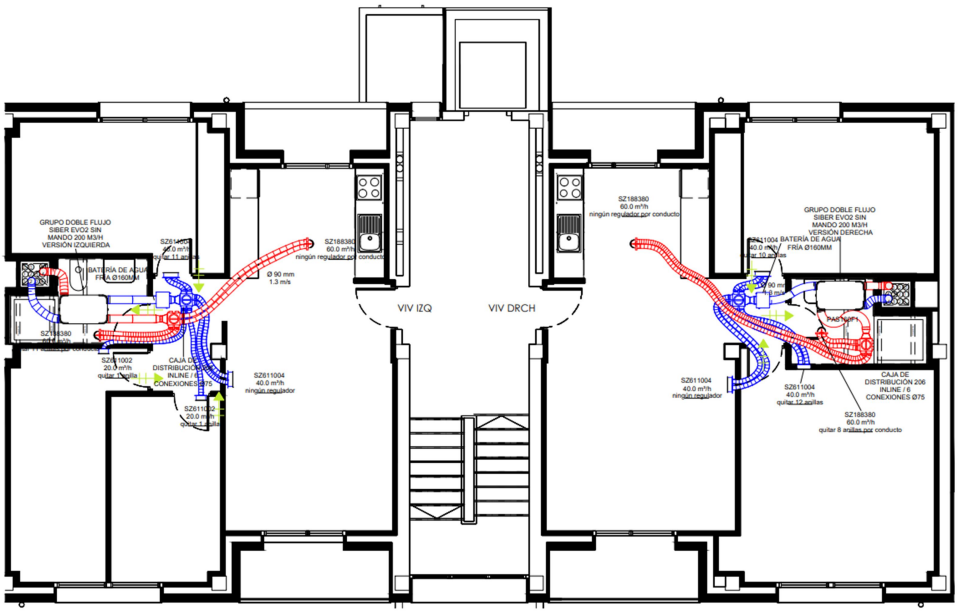
Floor plan @ Miriam Tambo (architect, Gobierno de Aragón)

CS17_PARQUE MAQUINARIA_TERUEL

Renovation Approach Description



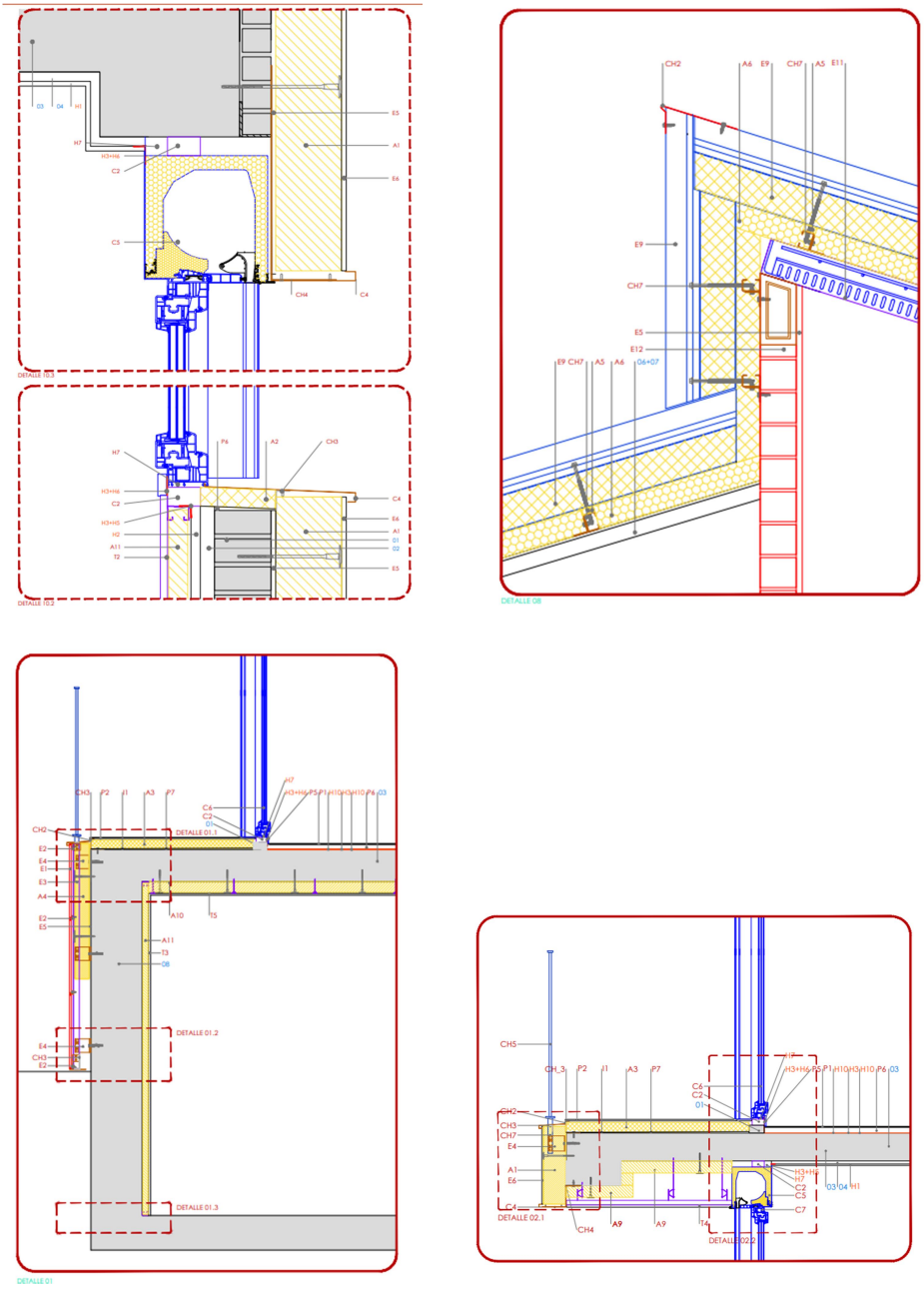
Elevation (left) and cross section (right) @ Miriam Tambo(architect, Gobierno de Aragón)



Ventilation concept @ b+haus

CS17_PARQUE MAQUINARIA_TERUEL

Renovation Approach Description



Details @ Miriam Tambo(architect, Gobierno de Aragón)

CS17_PARQUE MAQUINARIA_TERUEL

Renovation Approach Description

3.5. Envelope of the renovated building

External walls 1

Material:	Ventilated façade with mineral wool insulation
Thickness:	34 [cm]
Surface (Render / Brick / Cladding):	Ceramic
U-Value:	0.223 [W/(m²K)]

External walls 2

Material:	ETIC façade with mineral wool insulation
Thickness:	38 [cm]
Surface (Render / Brick / Cladding):	Plaster
U-Value:	0.188 [W/(m²K)]

Basement ceiling

Material:	Concrete floor with mineral wool insulation
Thickness:	47.5 [cm]
Surface (Render / Brick / Cladding):	Suspended ceiling
U-Value:	0.244 [W/(m²K)]

Roof / Top floor ceiling

Material:	Panel sandwich
Thickness:	28 [cm]
Surface (Render / Brick / Cladding):	Panel sandwich
U-Value:	0.151[W/(m²K)]

Windows

Material:	PH certificated frame + triple glazing
Thickness:	12[cm]
Material (Wood / Plastic / Aluminium):	PVC
U-Value (Uw, installed):	Uf 1.02 [W/(m²K)]

	Ug 0.52 [W/(m²K)]
	Uw 1.00 [W/(m²K)]

3.6. Technical equipment of the renovated building

Ventilation

Ventilation concept	Decentralized supply and extract air ventilation system separate for each apartment.
Ventilation heat recovery efficiency	84 %
Ventilation specific efficiency	0.31 [Wh/m³]
Ventilation standard air flow rate	0.4 [m³/h]
Add short description if required	New ventilation units have been placed in suspended ceiling in bathrooms. All rooms in the building are ventilated

Heating, Cooling and DHW

Heating:	Central heat pump for heating production
	Apartments are heated via supply air.
	An additional fan coil is installed in the living room to cover the heating load when it is needed.
Cooling:	Central heat pump for cooling
	Apartments are cooled down via supply air.
	An additional fan coil is installed in the living room to cover the cooling load when it is needed.
Domestic hot water:	Central heat pump for domestic hot water production

3.7. Summer comfort

To improve summer comfort the following solutions have been implemented:

- Light surfaces color of the façade.
- Low g value of the glazing (g= 0.44) to reduce solar gains through the window (optimized for the heating and cooling period)

- Roller shutters to ensure temporary summer shading in windows, when tenants require it.
- Optimized domestic hot water system: well insulated pipelines, low distribution temperatures
- Energy efficient appliances within the building
- Heat recovery bypass and higher ventilation rate in summer (possible through windows and also with the ventilation system)

No night ventilation strategy has been taken into account for the PHPP calculations, although it is be a very effective strategy in the climate of Teruel where the temperature drops considerably during summer nights.

The building has a heat pump for heating and hot water production which can be used also for cooling in prevision of warmer summers in the future. With an active cooling we can avoid user influence problems.

3.8. Energy efficiency of the renovated building

Passive House Planning Package (PHPP)

PHPP calculation:	PHPP_9.6
Space heating demand:	29 [kWh/(m²a)]
Heating Load:	14.8 [W/m²]
Overheating frequency:	6 %
Cooling demand:	1.1 [kWh/(m²a)]
Cooling Load:	2.9 [W/m²]
Primary Energy Demand:	107 [kWh/(m²a)]
PER Demand:	71 [kWh/(m²a)]
Airtightness n50 target:	0.7 1/h

Final Energy demand

Final energy demand electricity:	35.3 [kWh/(m²a)]

PHPP verification sheet after retrofit

Valores específicos del edificio con referencia a la superficie de referencia energética

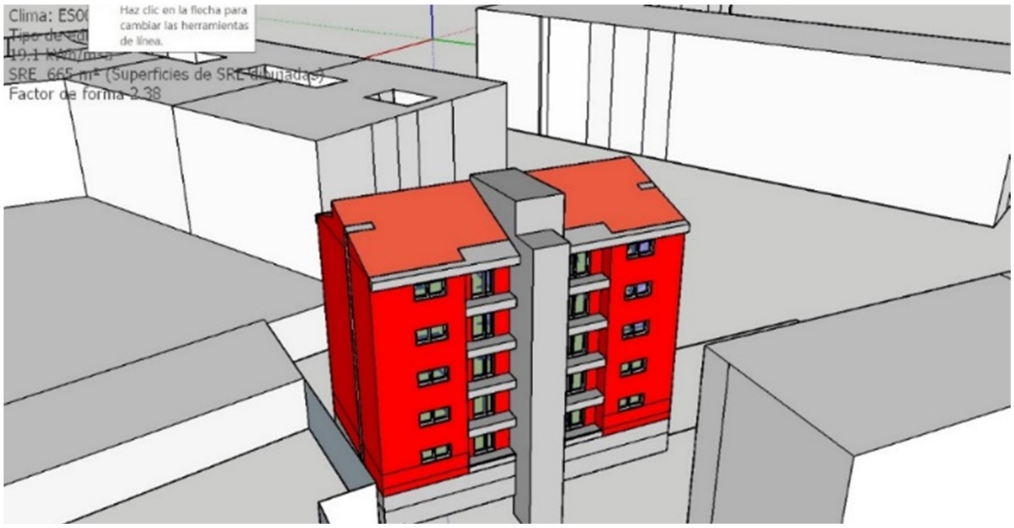
						Criterio	Criterios alternativos	¿Cumplido?[2]
	Superficie de referencia energética	m²	664,8					
Calefacción	Demanda de calefacción	kWh/(m²a)	29,0	≤		-	-	-
	Carga de calefacción	W/m²	14,8	≤		-	-	
Refrigeración	Demanda refrigeración & deshum.	kWh/(m²a)	1,1	≤		-	-	-
	Carga de refrigeración	W/m²	2,9	≤		-	-	
	Frecuencia de sobrecalentamiento (> 25 °C)	%	-	≤		-		-
	Frecuencia excesivamente alta humedad (> 12 g/kg)	%	0	≤		10		Sí
Hermeticidad	Resultado ensayo presión n_{50}	1/h	0,7	≤		1,0		Sí
Energía Primaria no renovable (EP)	Demanda EP	kWh/(m²a)	107	≤		118		Sí
	Project data imported fron Demanda PER	kWh/(m²a)	71	≤		-	-	-
Energía Primaria Renovable (PER)	Generación de Energía Renovable (en relación con área de la huella del edificio proyectado)	kWh/(m²a)	0	≥		-	-	

EnerPHit (modernización): Características de los componentes

Envolvente térmica en contacto con el aire exterior[1] (Valor-U)	W/(m²K)	0,17	≤	0,3		Sí
Envolvente térmica en contacto con el terreno[1] (Valor-U)	W/(m²K)	0,24	≤	0,25		Sí
Muro con aisl. interior en contacto con el aire exterior (Valor-U)	W/(m²K)	-	≤	0,5		-
Muro con aisl. interior en contacto con el terreno (Valor-U)	W/(m²K)	-	≤	0,46		-
Cubierta plana (IRS)	-	-	≥	-		-
Superficie externa inclinada y vertical (IRS)	-	46	≥	-		-
Ventanas/Puertas de entrada ($U_{V/P,instalada}$)	W/(m²K)	1,07	≤	1,09		Sí
Ventanas ($U_{V,instalada}$)	W/(m²K)	-	≤	1,14		-
Ventanas ($U_{V,instalada}$)	W/(m²K)	-	≤	1,24		-
Acristalamiento (valor-g)	-	0,45	≥	0,19		Sí
Acristalamiento/protección solar (carga solar máxima)	kWh/(m²a)	73	≤	-		-
Ventilación (Eficiencia efectiva del recuperador de calor)	%	83	≥	75		Sí
Ventilación (eficiencia de recuperación de humedad)	%	0	≥	-		-

[1] Sin ventanas, puertas y paredes exteriores con aislamiento por el interior

[2] Celda vacía: Falta dato; '-': Sin requerimiento



3.9. Predicted energy savings

In space heating demand:	406 -29 = 377 [kWh/(m²a)]
PER Demand:	789 – 107= 682 [kWh/(m²a)]

3.10. RES strategy

No RES in the building

4. Project challenges and opportunities

Prefabrication approach in retrofit is not common in Spain due to the lack of solutions available in the market and their high cost.

This project is a very interesting case study because this typology is quite common in Spain, and we can find thousends of similiar buildings in every city.

5. Current project status

Building construction works will finish in summer 2022. Enerphit certification is planned for November-December 2022.

Tenants will move into the new apartments in January 2023.

6. Lessons learnt and guidelines for replication

Not available yet

7. Pre-Monitoring description (if applicable)

Number of apartments: 1

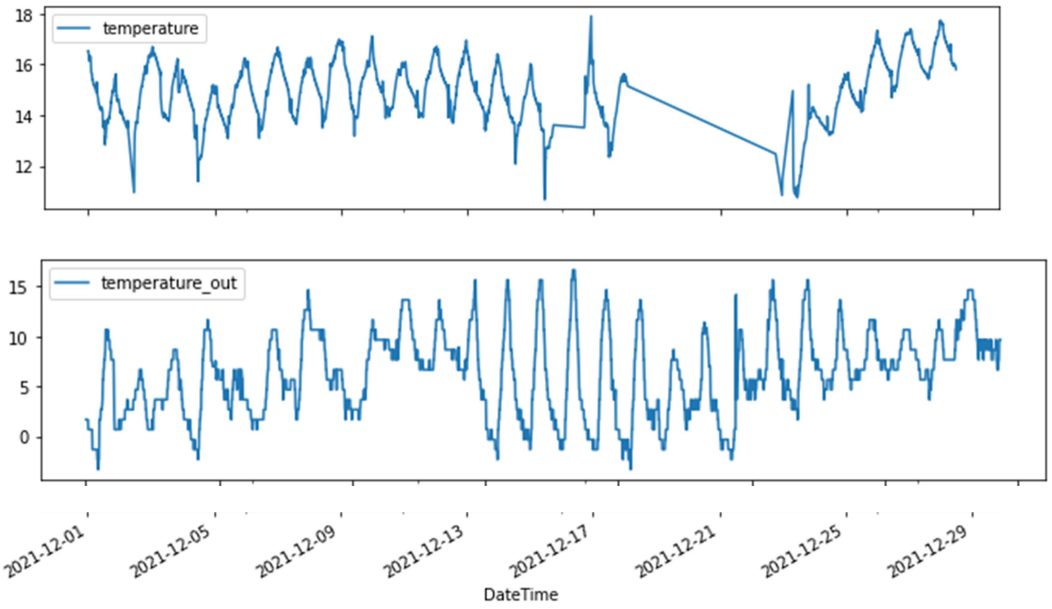
Period of pre-monitoring: June.2021 – June.2022

As far as the building was already empty when the Outphit project began, the monitoring of the original situation has been done in one of the clone buildings of the colony (same orientation, construction system, building service) We started the monitoring in two apartments but we could only complete one of them because the second family decided to retire the devices after one month.

The results of our pre-monitoring works show the poor conditions of the original apartments: lack of comfort, very low temperatures in interior surfaces in winter, mould growth even visible in corners.

The following diagrams show the results of the comfort monitoring from December 2021

Temperature:



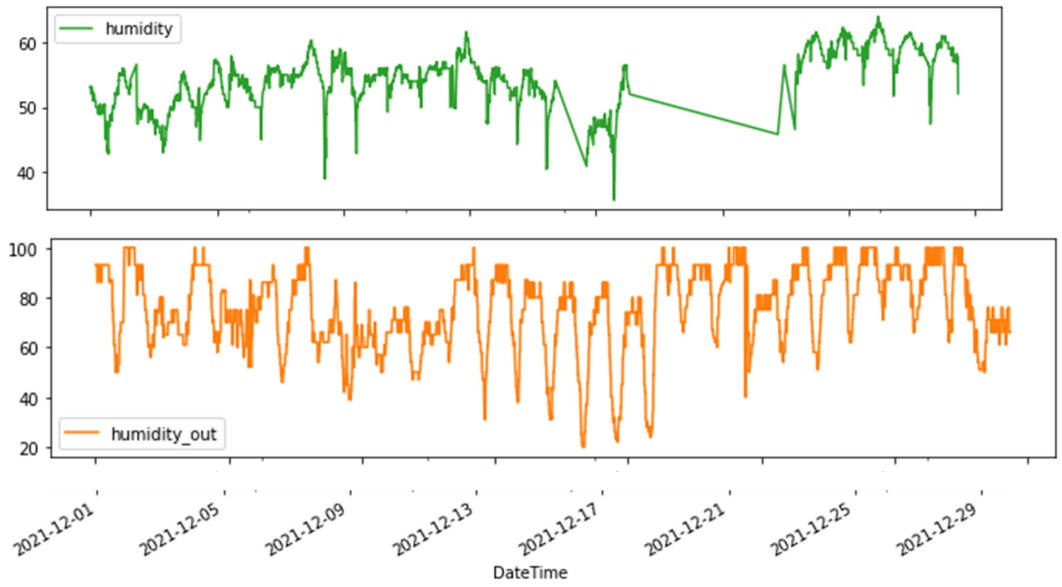
Even with outside temperatures close to 15 degrees in the warmer hours of the day, inside air temperature is always below 18 degrees.

This is a social housing building for low income families. Using regulary the heating system is a cost that they usually cannot afford.

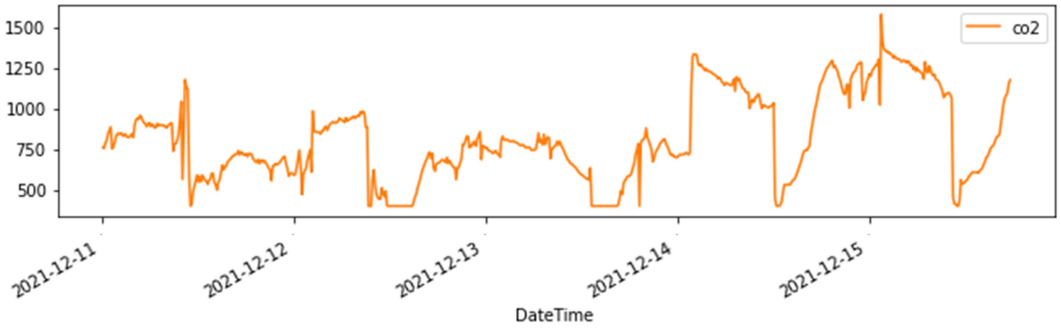
CS17_PARQUE MAQUINARIA_TERUEL

Renovation Approach Description

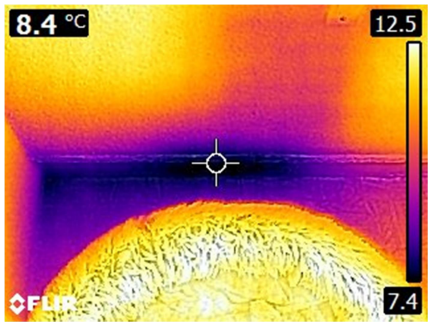
Humidity:



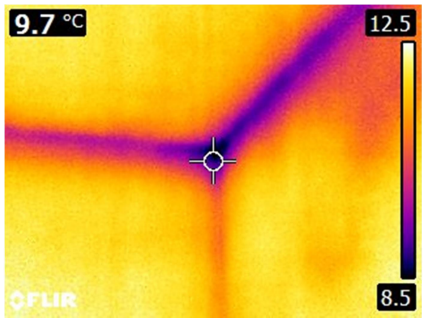
CO2 concentration:



Infrared thermography:

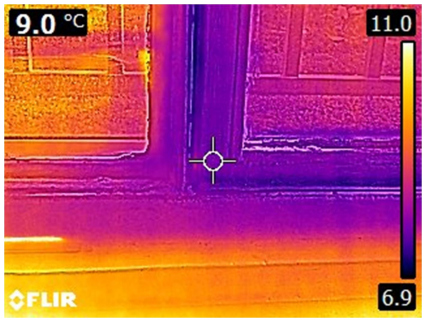


Connexion between wall and ground floor (north façade) @ VAND arquitectura



Corners (north façade) @ VAND arquitectura

North façade @ VAND arquitectura



Window frame @ VAND arquitectura

Air quality measurement:

The samples were taken on 24th January 2022. Conclusions are not available yet.

Artículo: Placa rodac (SAS) (100 L) (C.02)
Punto de toma: Comedor
Volumen muestreado: 100 L
Fecha de toma: 11/02/2022
Cantidad de Muestra: 2 placas
Observaciones: Edificio: C/Señorío Amocain, 1

Pruebas/Ensayos	Resultados(#)	Unidad Medida	Metodología/PNT	Legislación	Ficha Técnica
Recuento de microorganismos a 37ºC	23	ufc/placa	SU/10-Rev.3		
* Cálculo para expresión por m³	240	ufc/m³	Cálculo		
Mohos y levaduras	12	ufc/placa	SU/11-Rev.4		
* Cálculo para expresión por m³	120	ufc/m³	Cálculo		

Observaciones:

Información analítica:
Identificación micológica (resultados ufc/m³):
Aspergillus sp: No se detecta
Fusarium sp: No se detecta
Mucor sp: No se detecta
Rhizopus sp: No se detecta
Penicillium sp: 4
Scedosporium sp: 6
Alternaria sp: No se detecta
Nocardia sp: No se detecta
Levaduras: No se detecta
Otros: 2

User satisfaction questionnaires

Conclusions are not available yet.