

# Project documentation

## Rehabilitation of a “Cabaña Pasiega” in Cantabria (Spain)



### 1 Abstract



### 1.1 Data of building

Year of construction	2023	<b>Space heating</b>	<b>32</b> kWh/(m <sup>2</sup> a)
U-value external wall	0.24 W/(m <sup>2</sup> K)		
U-value basement ceiling	0,31 W/(m <sup>2</sup> K)	<b>Primary Energy Renewable (PER)</b>	61 kWh/(m <sup>2</sup> a)
U-value roof	0.27 W/(m <sup>2</sup> K)	<b>Generation of renewable energy</b>	- kWh/(m <sup>2</sup> a)
U-value window	1.06 W/(m <sup>2</sup> K)	<b>Non-renewable Primary Energy (PE)</b>	79 kWh/(m <sup>2</sup> a)
Heat recovery	81 %	Pressure test n <sub>50</sub> /	0.8 h-1
Special features			

## 1.2 Brief Description ...

### Rehabilitation of a "Cabaña Pasiega" in Selaya, Cantabria

This project addresses the rehabilitation of a traditional stone building from northern Spain in Cantabria. These constructions, known as "Cabañas Pasiegas," are very simple dry-stone volumes. They have historical protection, which does not allow any alteration of the exterior stone appearance. Therefore, the rehabilitation focuses on building an insulated and watertight "second skin" within the existing stone volume to meet the EnerPHit certification requirements.

The home is organized over two floors of approximately 45 m<sup>2</sup> each. The ground floor includes the living area, kitchen, and utility room, while the first floor has two bedrooms, each with its own bathroom.

### 1.3 Responsible project participants

Architect	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Implementation planning	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Building systems	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Structural engineering	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Building physics	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Passive House project planning	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Construction management	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>
Certifying body	VAND arquitectura <a href="https://vandarquitectura.info/">https://vandarquitectura.info/</a>
Certification ID	ID 43745
Database ID	ID7741
Author of project documentation	Juan Ramón Cristóbal / Mínima Arquitectura Sostenible <a href="http://www.minima.bio">http://www.minima.bio</a>

Date, Signature  
18/11/2024

## 2. Photographs

### 2.1 Outside



North view



**South view**



**East view**



**West view**

## 2.1 Inside





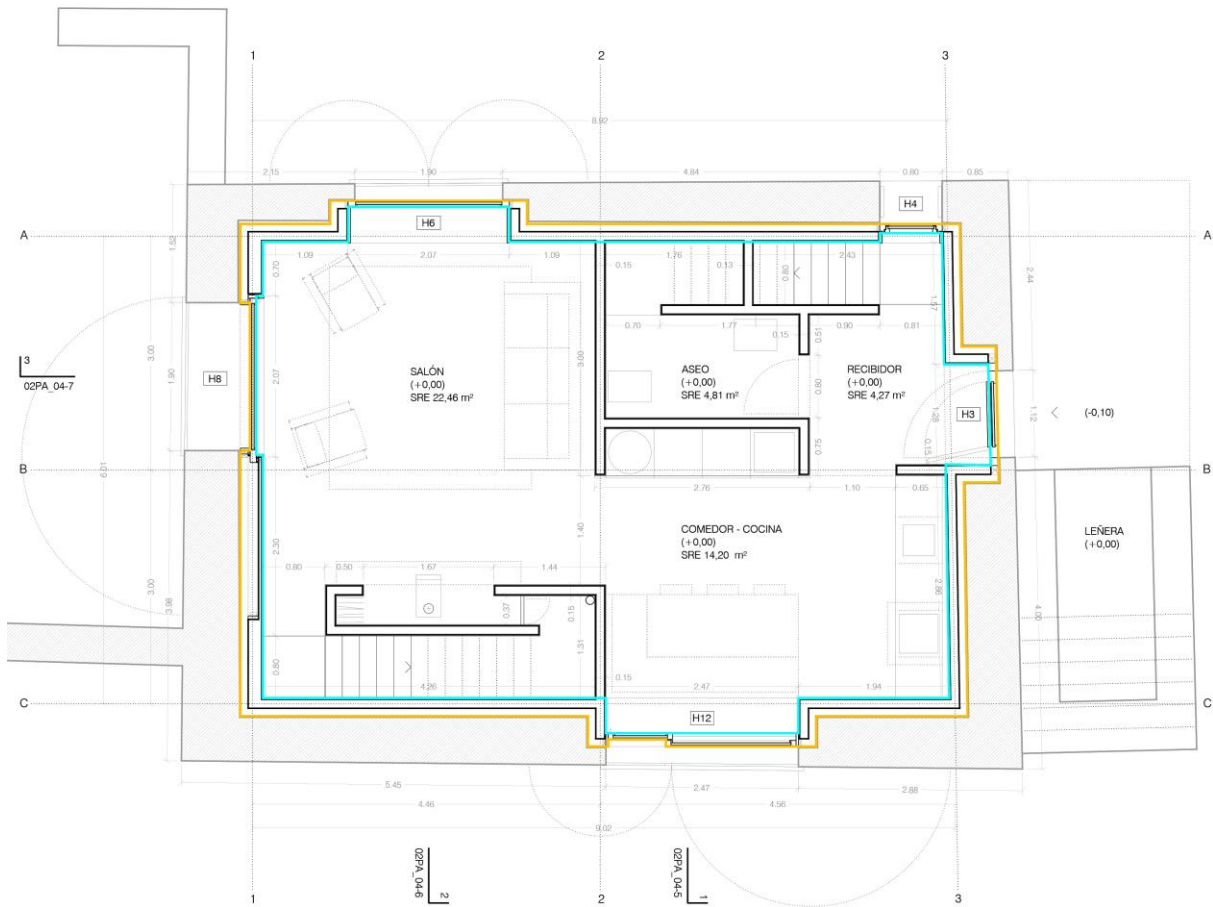
**Ground Floor**



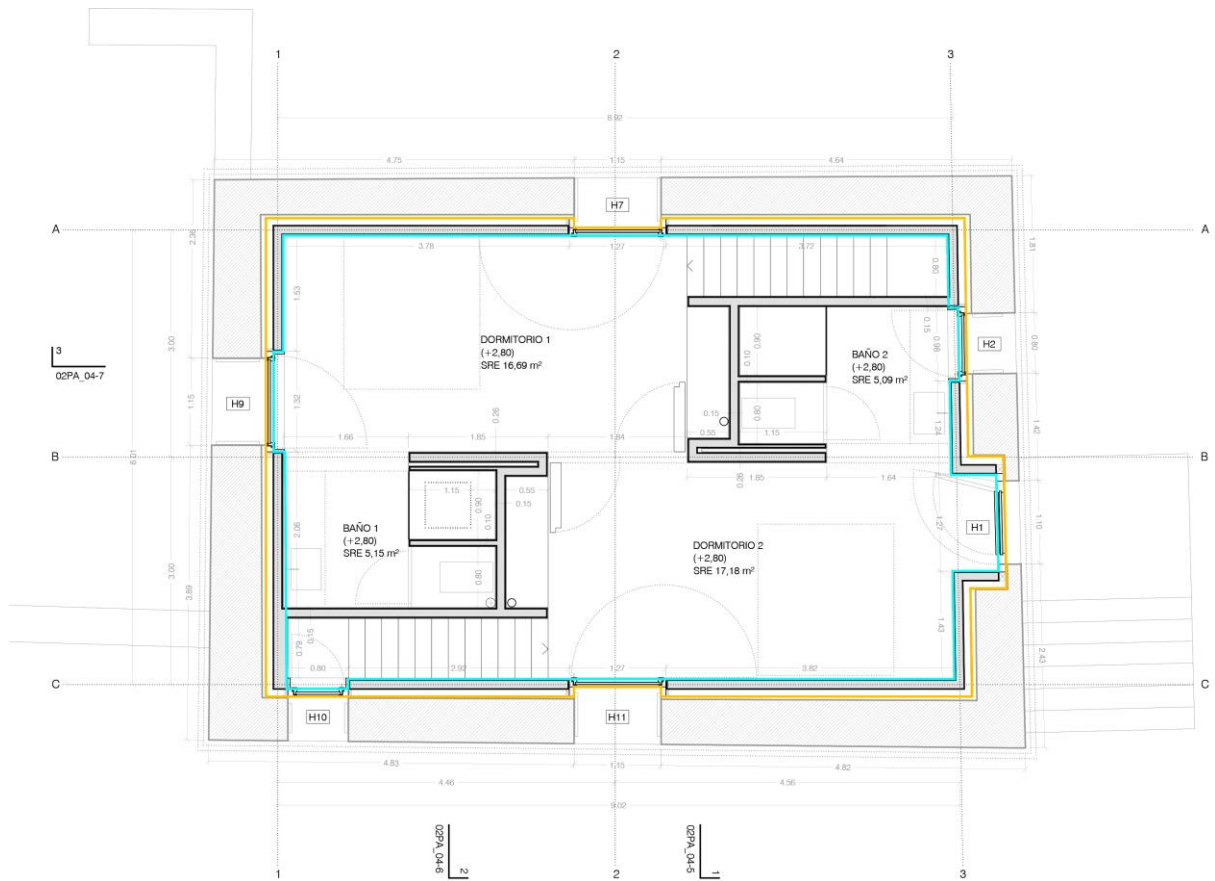
**Staircase and First Floor**

### 3. Plans

Thermal and airtightness envelope are shown in the following plans:

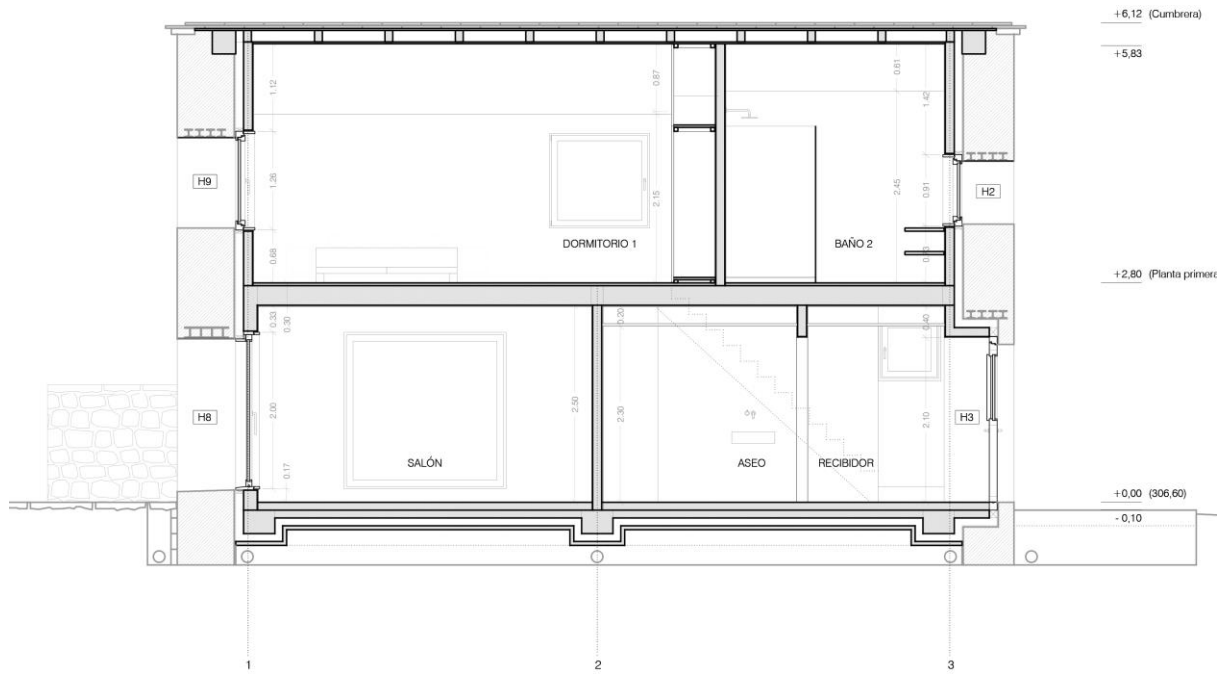
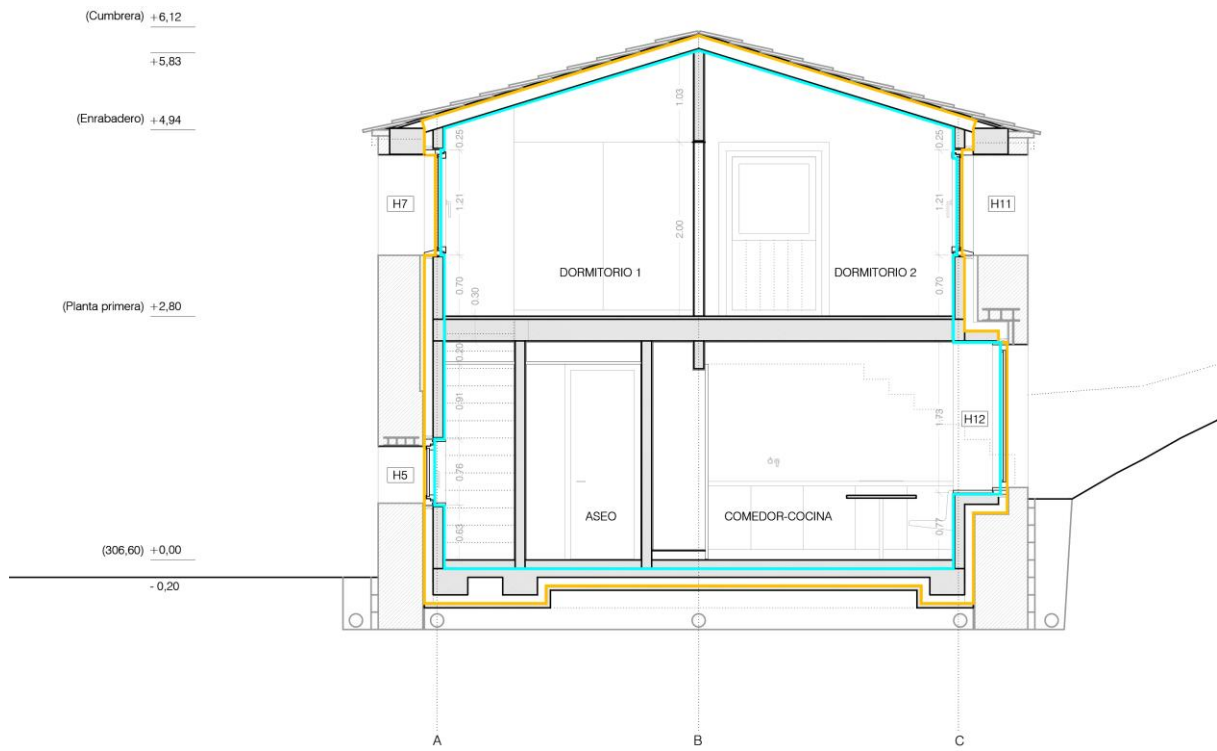


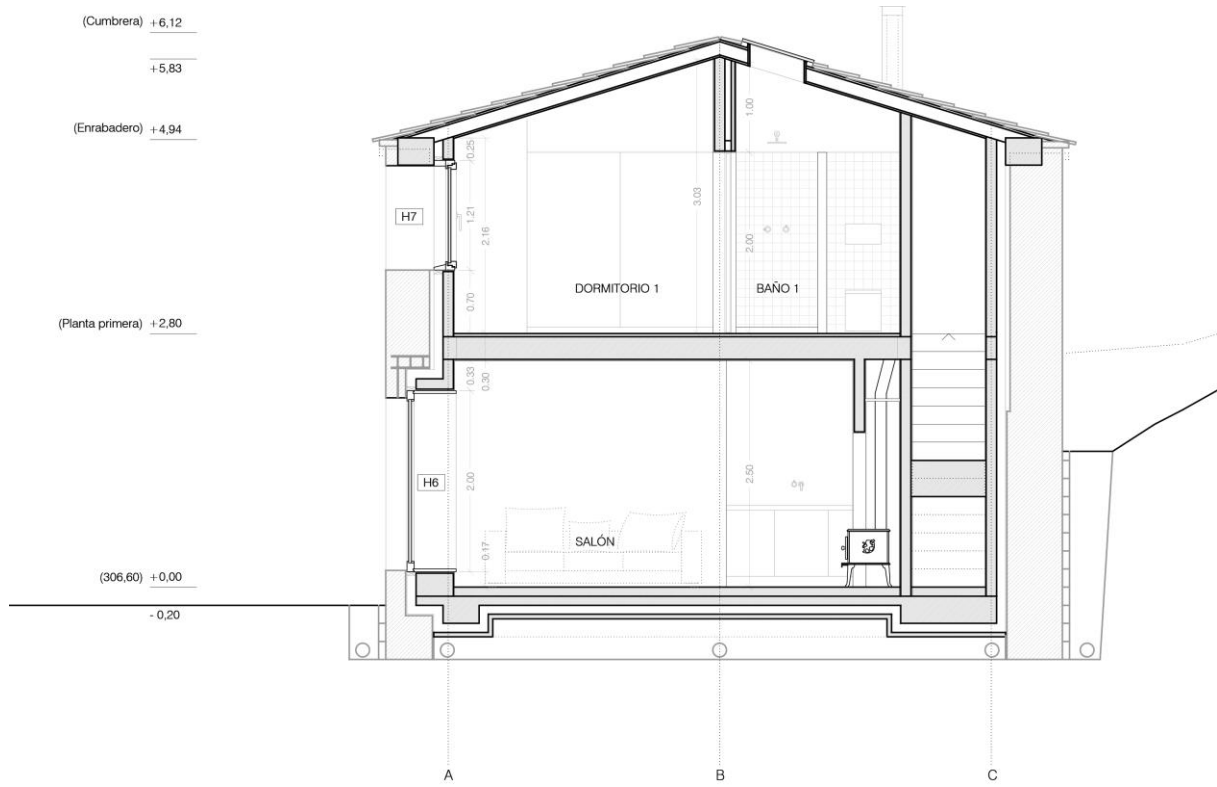
Ground floor



**First floor**

# Sections





## 4. Technical details of the construction

### 4.1 Wall, floor and roof

#### DETAIL 1: WALL SECTION ( $U = 0,242 \text{ W/mK}$ )

From inside to outside:

1. 15mm. Lime plaster ( $\lambda = 1 \text{ W/mK}$ )
2. 115mm. Perforated brick factory ( $\lambda = 0,54 \text{ W/mK}$ )
3. 100mm. Insulation ( $\lambda = 0,03 \text{ W/mK}$ )
4. 40mm. Lime plaster ( $\lambda = 1 \text{ W/mK}$ )
5. 500mm. Original stone wall ( $\lambda = 1,4 \text{ W/mK}$ )

#### DETAIL 2: FLOOR SECTION ( $U = 0,313 \text{ W/mK}$ )

From inside to outside:

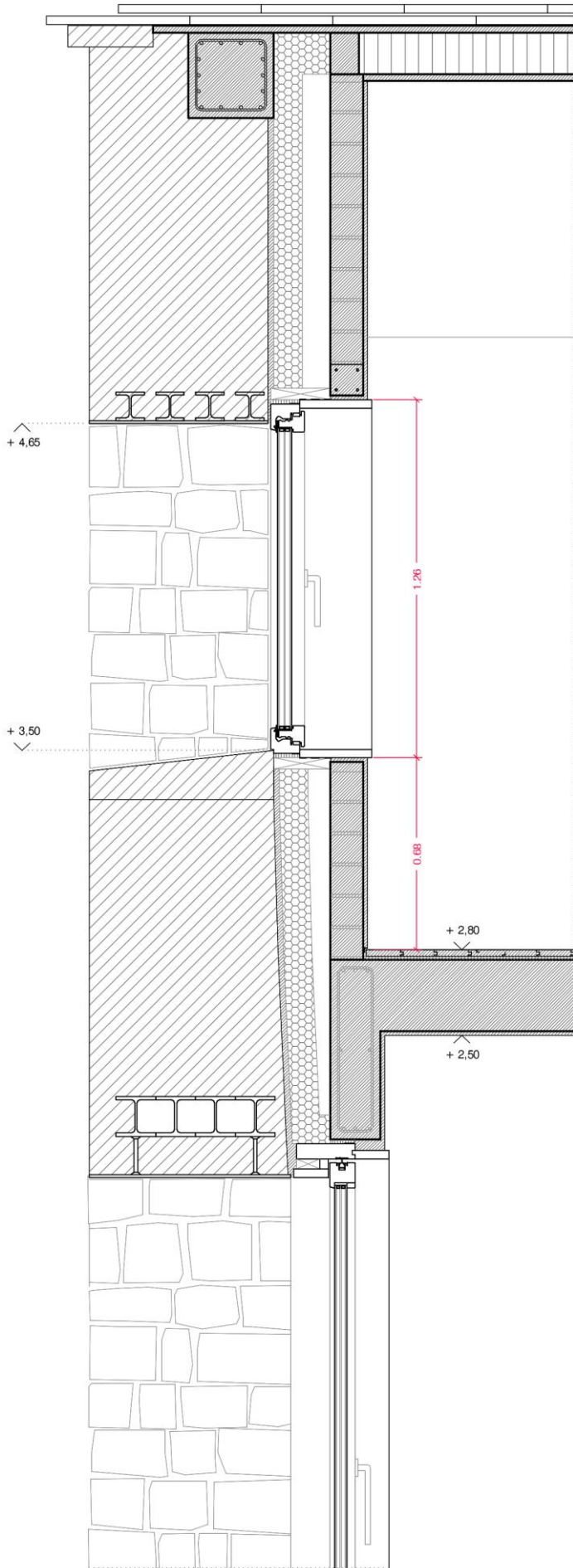
1. 70mm. Continuous lime-based pavement ( $\lambda = 2 \text{ W/mK}$ )
2. 100mm. Insulation ( $\lambda = 0,034 \text{ W/mK}$ )
3. 100mm. Concrete slab ( $\lambda = 2,1 \text{ W/mK}$ )

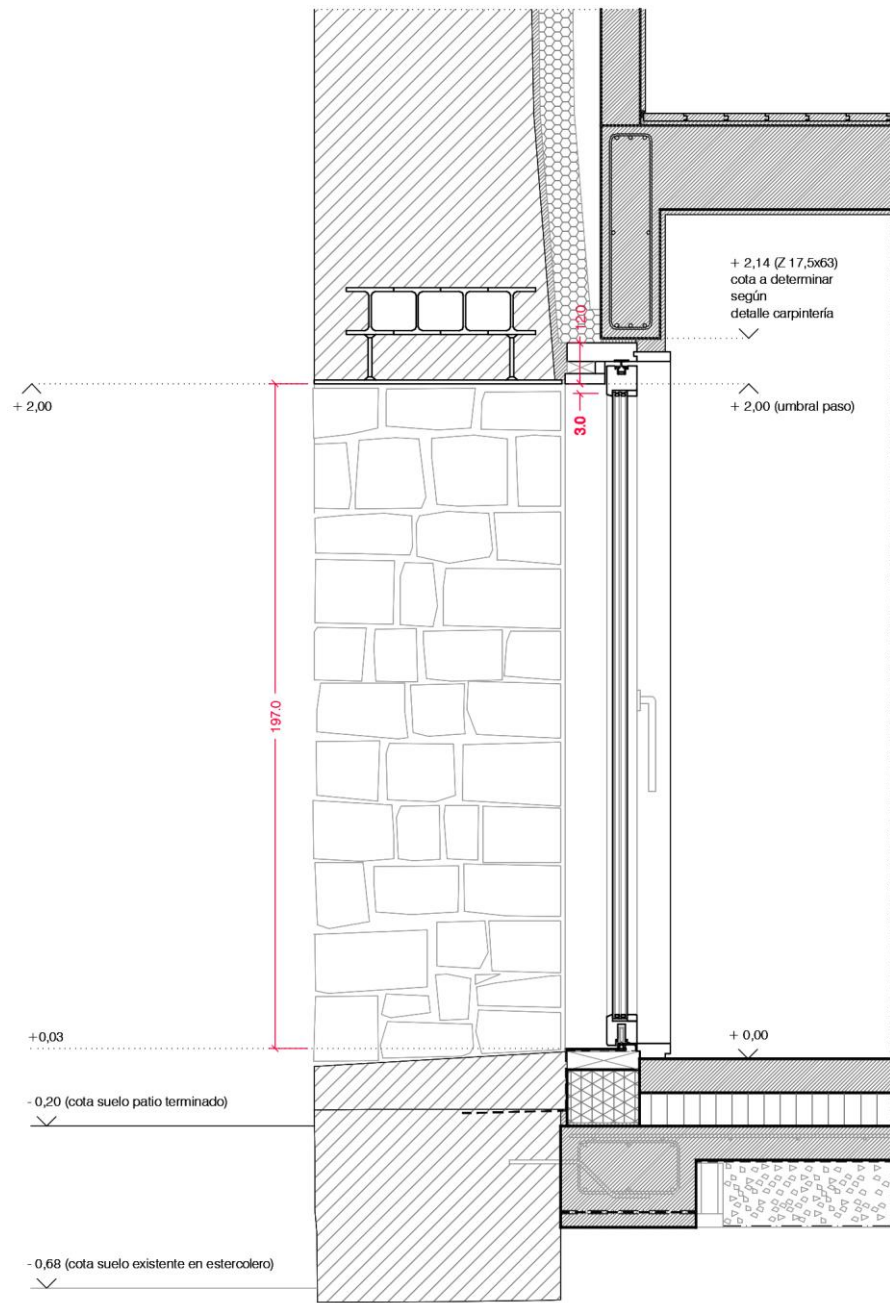
#### DETAIL 3: ROOF SECTION ( $U = 0,275 \text{ W/mK}$ )

From inside to outside:

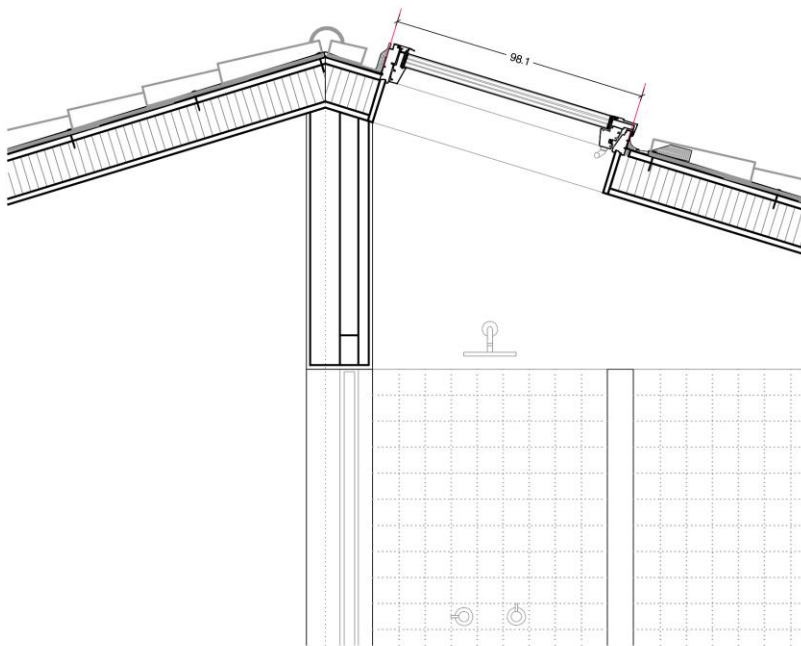
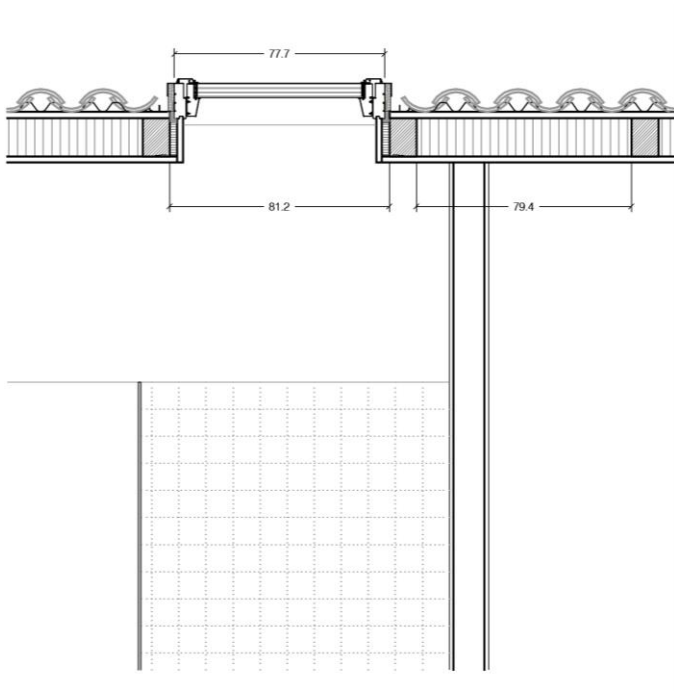
1. 22mm. Oriented strand board (OSB) ( $\lambda = 0,13 \text{ W/mK}$ )
2. 140mm. Wood beam + Insulation ( $\lambda_{eq} = 0,18 \text{ W/mK}$ )
3. 24mm. Plywood board ( $\lambda = 0,24 \text{ W/mK}$ )
4. Bituminous sheet
5. Clay tile







**Detail 2**



**Detail 3**

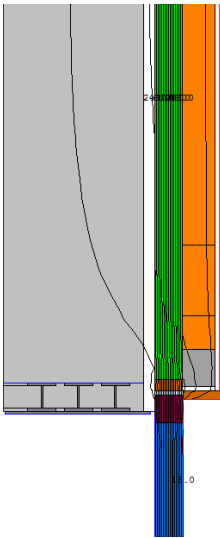
## 4.2 Windows

### 4.2.1 Window frame

- **Passivhaus certified Wooden frames Cosisven LUX MX92 have been installed in walls.**

$U_f = 1,02 \text{ W/mK}$

Typical installation detail and calculation:  $\psi = 0,045$



	U-factor W/m <sup>2</sup> K	delta T C	Length mm	Rotation	Heat Flow W	Heat Flux W/m <sup>2</sup>
EXTERIOR	0.2738	20.0	5157.43	N/A	28.2423	5.4760
INTERIOR	0.3760	20.0	3755.72	N/A	28.2419	7.5197

Display  
 U-factor  
 R-value

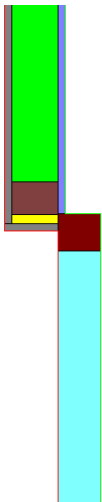
% Error Energy Norm 2.39%

Export  
OK

- **Passivhaus certified Wooden and aluminium frame FAKRO PP FTTU8 THERMO 2012 have been used for rooflights.**

$U_f = 1,10 \text{ W/mK}$

Typical installation detail and calculation:  $\psi = 0,070$



	U-factor W/m <sup>2</sup> K	delta T C	Length mm	Rotation	Heat Flow W	Heat Flux W/m <sup>2</sup>
EXTERIOR	0.4215	20.0	2607.04	N/A	21.9778	8.4302
INTERIOR	0.4127	20.0	2663.05	N/A	21.9784	8.2531

Display  
 U-factor  
 R-value

% Error Energy Norm 6.17%

Export  
OK

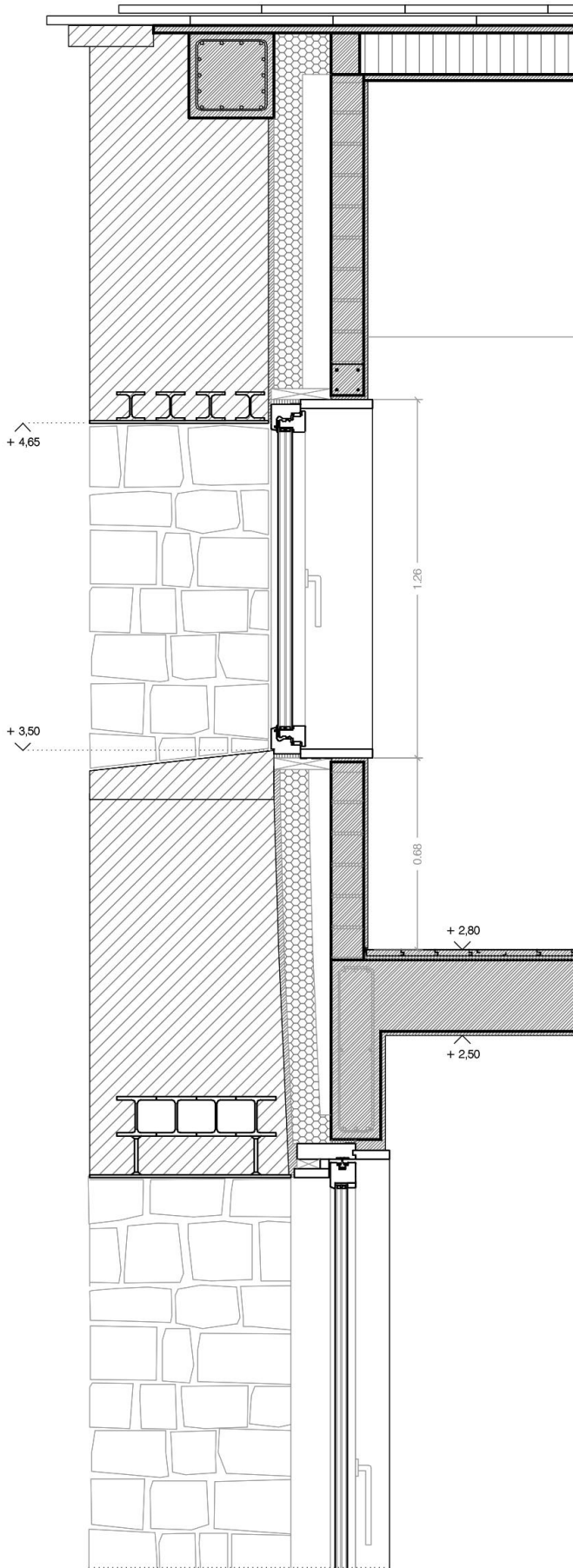
## **4.2.2 Glass**

Type: 4+4 / 16 Argon / 3+3

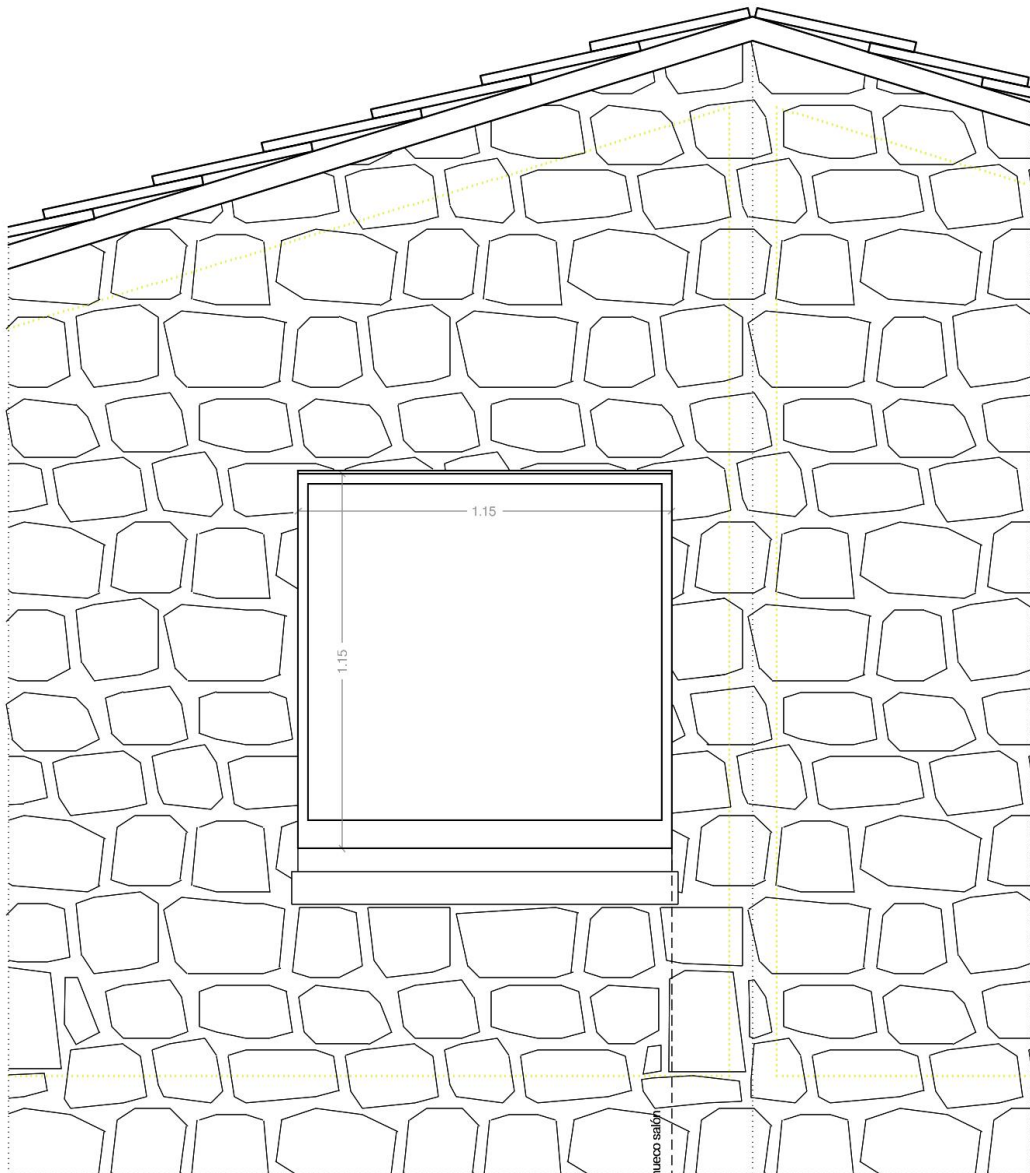
Ug: 0,574

Gvalue: 0,526

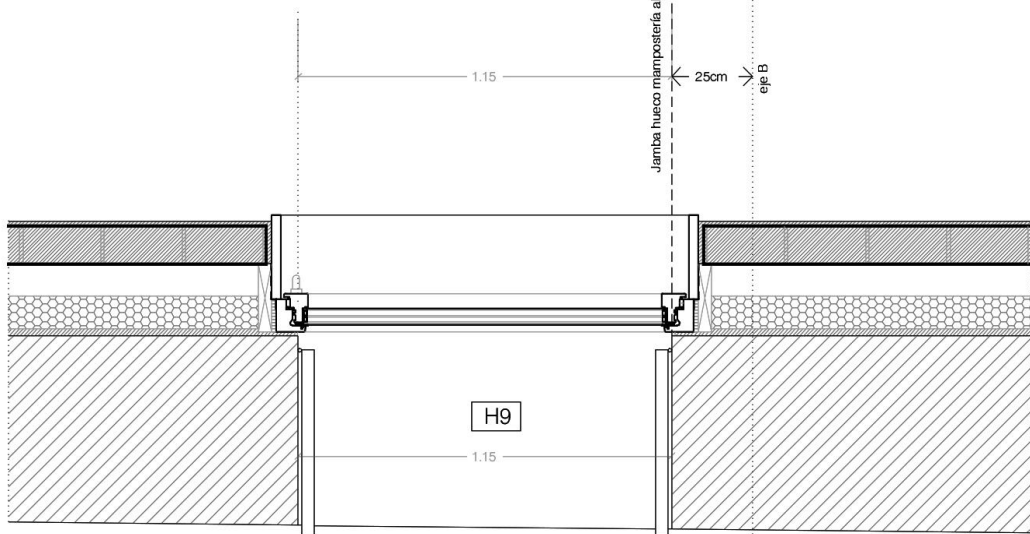
## **4.2.3 Window instalation detail**



SECCIÓN HUECO DORMITORIO 1 (H9)



ALZADO EXTERIOR HUECO DORMITORIO 1 (H9)



PLANTA HUECO DORMITORIO 1 (H9)

## 5. Construction phase



**Basement floor insulation**



**Wall and roof insulation**



**Roof airtightness**



**Floor and wall airtightness**



**Window installation**

## 5.1 Airtightness. Basic approach

### • Roof

For the roof, air-tightness has been achieved using INTELLO PLUS sheets, joined with TESCON VANA airtight tapes.



### • Walls

In the walls, air-tightness has been achieved through the use of a lime plaster with a minimum thickness of 2 cm. Joints or material transitions have been sealed with the application of Blower Proof.



### • Exterior windows and doors

For the airtight installation of the frames, Flexifoam foam has been used, complemented with CONTEGA airtight tapes.



## 5.2 Blower Door test results

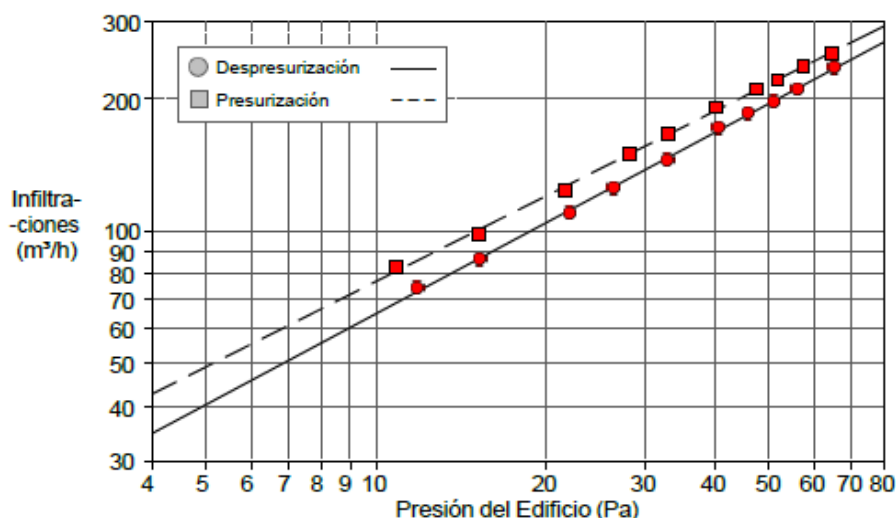


**BlowerDoor GmbH**  
MessSysteme für Luftdichtheit

### TEST DE INFILTRACIONES DEL EDIFICIO

Fecha del Test: 12/01/2024 Archivo de Test: Selaya2  
 Técnico: CESAR BLANCO Y ANTONIO VIEJO  
 Número de proyecto: CABAÑA PISUEÑA ENERPHIT  
 Cliente: JUAN RAMON CRISTOBAL MAYORAL Dirección del Edificio: CABAÑA PASIEGA  
 PISUEÑA CABAÑA PASIEGA  
 CANTABRIA - SELAYA RC. 39082A005003940000OM  
 Teléfono: 637-93-76-00 parcela 394 del pol.nº5 barrio PISUEÑA  
 Fax: CANTABRIA - 5394 SELAYA  
 e-mail: estudio@minima.bio

Resultados del test a 50 Pa:	Despresurización	Presurización	Media
q <sub>50</sub> : m <sup>3</sup> /h (Caudal de Aire)	195 (+/- 1.1 %)	216 (+/- 1.5 %)	206
<b>n<sub>50</sub>: 1/h (Tasa de Renovación de Aire)</b>	<b>0.80</b>	<b>0.89</b>	<b>0.84</b>
qF <sub>50</sub> : m <sup>3</sup> /(h·m <sup>2</sup> Área del Suelo)	2.17	2.41	2.29
qE <sub>50</sub> :			
<b>Áreas de Infiltraciones:</b>			
ELA 50: m <sup>2</sup>	0.0059 (+/- 1.5 %)	0.0066 (+/- 1.5 %)	0.0063
ELA F50: m <sup>2</sup> /m <sup>2</sup>	0.0000662	0.0000733	0.0000697
ELA E50:			
<b>Curva de Infiltraciones del Edificio:</b>			
Coefficiente de Caudal de Aire (C <sub>env</sub> ) m <sup>3</sup> /(h·Pa <sup>n</sup> )	13.4 (+/- 5.5 %)	17.6 (+/- 7.2 %)	
Coefficiente de Infiltraciones (CL) m <sup>3</sup> /(h·Pa <sup>n</sup> )	13.4 (+/- 5.5 %)	17.5 (+/- 7.2 %)	
Exponente (n)	0.684 (+/- 0.016)	0.643 (+/- 0.020)	
Coefficiente de Determinación (R <sup>2</sup> )	0.99922	0.99848	
Norma del Test:	ISO 9972		
Modo del Test:	Despresurización y Presurización		
Método del Test:	Método 3 - tes del edificio para un objetivo específico		
Objetivo del test:	comprobación de hermeticidad del edificio terminado n <sub>50</sub> ≤ 1 1/h		



TEST DE INFILTRACIONES DEL EDIFICIO Página 2 of 5

Fecha del Test: 12/01/2024 Archivo de Test: Selaya2

Información del Edificio

Volumen interno, V (m³) (De acuerdo a ISO)	243.6
Superficie neta, A <sub>F</sub> (m²) (De acuerdo a ISO)	89.9
Área de la Envolvente, A <sub>E</sub> (m²) (De acuerdo a ISO)	
Altura (m)	
Incertidumbre de las dimensiones (%)	1
Año de Construcción	2023
Tipo de calefacción	bomba de calor y estufa de leña estanca
Tipo de aire acondicionado	
Tipo de ventilación	Ninguno
Exposición al viento del edificio	Edificio parcialmente expuesto
Tipo de viento	Calma

Información del equipo

Tipo	Fabricante	Modelo	Número de Serie	Fecha de calibración
Ventilador	Energy Conservatory	Modelo 4 (230V)	1376	25/10/2021
Micromanómetro	Energy Conservatory	DG1000	1376	13/11/2023



TEST DE INFILTRACIONES DEL EDIFICIO Página 3 of 5

Fecha del Test: 12/01/2024 Archivo de Test: Selaya2

Test de Despresurización 1:

Datos Climáticos

Temperatura Interior (°C)	Temperatura Exterior (°C)	Presión Barométrica (Pa)
17.0	8.0	97660.7

Pre-test			Presión diferencial natural			Post-test		
$\Delta p_{0,1-}$	$\Delta p_{0,1+}$	$\Delta p_{0,1}$	$\Delta p_{0,2-}$	$\Delta p_{0,2+}$	$\Delta p_{0,2}$			
-1.0	0.1	-0.9	-1.0	0.0	-1.0			

Puntos de Datos - Test Automático (TTE 5.1.8.5)

Presión Nominal del Edificio (Pa)	Presión del edificio ajustada (Pa)	Presión del Ventilador (Pa)	Caudal Nominal $q_r$ (m³/h)	Caudal de Aire Ajustado $q_{env}$ (m³/h)	Caudal de Aire Ajustado $q_L$ (m³/h)	% Error	Diafragma
-0.9	---	---					
-66.0	-65.1	132.1	239	235	235	0.7	Diafragma C
-57.1	-56.1	106.4	214	210	210	-0.4	Diafragma C
-51.9	-50.9	94.1	201	197	198	-0.1	Diafragma C
-46.8	-45.9	83.0	188	185	185	0.7	Diafragma C
-41.5	-40.6	71.3	174	171	171	1.2	Diafragma C
-34.0	-33.1	51.8	148	145	145	-1.2	Diafragma C
-27.4	-26.4	38.9	127	125	125	-0.7	Diafragma C
-23.0	-22.1	30.4	112	110	110	-1.3	Diafragma C
-16.3	-15.3	18.9	88	86	86	-0.8	Diafragma C
-12.8	-11.9	37.0	76	74	74	2.0	Diafragma D
-1.0	---	---					

Información – Datos de la medición

Ninguno



TEST DE INFILTRACIONES DEL EDIFICIO Página 4 of 5

Fecha del Test: 12/01/2024 Archivo de Test: Selaya2

Test de Presurización 1:

Datos Climáticos

Temperatura Interior (°C)	Temperatura Exterior (°C)	Presión Barométrica (Pa)
17.0	8.0	97660.7

Pre-test			Presión diferencial natural			Post-test		
$\Delta p_{0,1-}$	$\Delta p_{0,1+}$	$\Delta p_{0,1}$	$\Delta p_{0,2-}$	$\Delta p_{0,2+}$	$\Delta p_{0,2}$			
-0.9	0.0	-0.9	-0.4	0.0	-0.4			

Puntos de Datos - Test Automático (TTE 5.1.8.5)

Presión Nominal del Edificio (Pa)	Presión del edificio ajustada (Pa)	Presión del Ventilador (Pa)	Caudal Nominal $q_r$ (m³/h)	Caudal de Aire Ajustado $q_{env}$ (m³/h)	Caudal de Aire Ajustado $q_L$ (m³/h)	% Error	Diafragma
-0.9	—	—					
63.9	64.6	141.6	248	255	253	-0.7	Diafragma C
56.8	57.5	124.7	232	239	237	0.2	Diafragma C
51.1	51.7	108.7	217	223	221	-0.1	Diafragma C
46.8	47.5	98.6	206	212	210	0.4	Diafragma C
39.6	40.3	82.1	187	193	191	1.5	Diafragma C
32.3	33.0	62.9	163	168	167	0.6	Diafragma C
27.5	28.2	51.4	147	152	150	0.4	Diafragma C
21.0	21.7	35.2	121	125	123	-2.3	Diafragma C
14.5	15.2	22.7	96	99	98	-2.3	Diafragma C
10.2	10.8	42.6	81	84	83	2.5	Diafragma D
-0.4	—	—					

Información – Datos de la medición

Ninguno



## 6 Ventilation

For ventilation we used a compact ventilation unit (Orkli PKOM 4). This unit incorporates ventilation function with a heat pump that heats the ventilation air and a 100l tank for hot domestic water.

# Certificate

**Passive House Suitable Component**  
For cool temperate climates, valid until 31. December 2022

Category: **Compact Heat Pump System**  
Manufacturer: **Pichler G.m.b.H.**  
**9021 Klagenfurt, AUSTRIA**

Product name: **PKOM 4**

This certificate was awarded based on the following criteria (limit values\*):

Thermal Comfort:  $\theta_{\text{supply air}} \geq 16.5^\circ\text{C}$   
Heat Recovery of ventilation system:  $\eta_{\text{WRG,eff}} \geq 75\%$   
Electric efficiency ventilation system:  $P_{\text{el}} \leq 0.45 \text{ Wh/m}^3$   
Air tightness (internal/external):  $V_{\text{Leakage}} \leq 3\%$   
Total Primary Energy Demand (\*\*):  $PE_{\text{total}} \leq 55 \text{ kWh}/(\text{m}^2\text{a})$   
Control and calibration (\*)  
Air pollution filters (\*)  
Anti freezing strategy (\*)  
Noise emission and reduction (\*)

**Measured values to be used in PHPP**  
useful air flow rates 121 to 192 m<sup>3</sup>/h

		Test point 1	Test point 3	Test point 3	Test point 4		
<b>Heating</b>	Outside Air Temperature	$T_{\text{amb}}$	-15	-7	2	7	°C
	Thermal Output Heating Heat Pump	$P_{\text{WP,heiz}}$	0.612	0.933	0.771	0.776	kW
	COP number Heating Heat Pump	$\text{COP}_{\text{heiz}}$	1.53	2.61	3.15	3.86	-
	Maximum available supply air temperature with Heat Pump only(*)		33				°C
<b>Hot water</b>	Outside Air Temperature	$T_{\text{amb}}$	-7	2	7	20	°C
	Thermal Output Heat Pump for heating up storage tank.	$P_{\text{DHW heating up}}$	0.84	1.15	1.38	1.67	kW
	Thermal Output Heat Pump for reheating storage tank	$P_{\text{DHW reheating}}$	0.80	1.19	1.35	1.66	kW
	COP Heat Pump for heating up storage tank	$\text{COP}_{\text{DHW heating up}}$	2.28	2.97	3.34	3.94	-
	COP Heat Pump for reheating storage tank	$\text{COP}_{\text{DHW reheating}}$	2.02	2.88	3.10	3.76	-
	Average storage tank temperature		45				°C
	Specific storage heat losses		1.51				W/K
Exhaust air addition (if applicable)		200				m <sup>3</sup> /h	

(\*) detailed description of criteria and key values see attachment.  
(\*\*) for heating, domestic hot water (DHW), ventilation, auxiliary electricity in the reference building, explanation see attachment.  
(\*\*\*) All key values of heat pump were measured with enthalpy (humid) heat exchanger. The dry heat recovery was measured, too and is shown here alternatively.  
All other key values are valid respectively for dry heat recovery, too.

0875ch03

[www.passivehouse.com](http://www.passivehouse.com)

Passivhaus Institut  
Dr. Wolfgang Feist  
64283 Darmstadt  
GERMANY

**Heat Recovery by enthalpy heat exchanger(\*\*\*)**  
 $\eta_{\text{WRG,eff}} = 85\%$

alternative:  
**Dry Heat Recovery by heat exchanger(\*\*\*)**  
 $\eta_{\text{WRG,eff}} = 88\%$

**Electric efficiency**  
0.33 Wh/m<sup>3</sup>

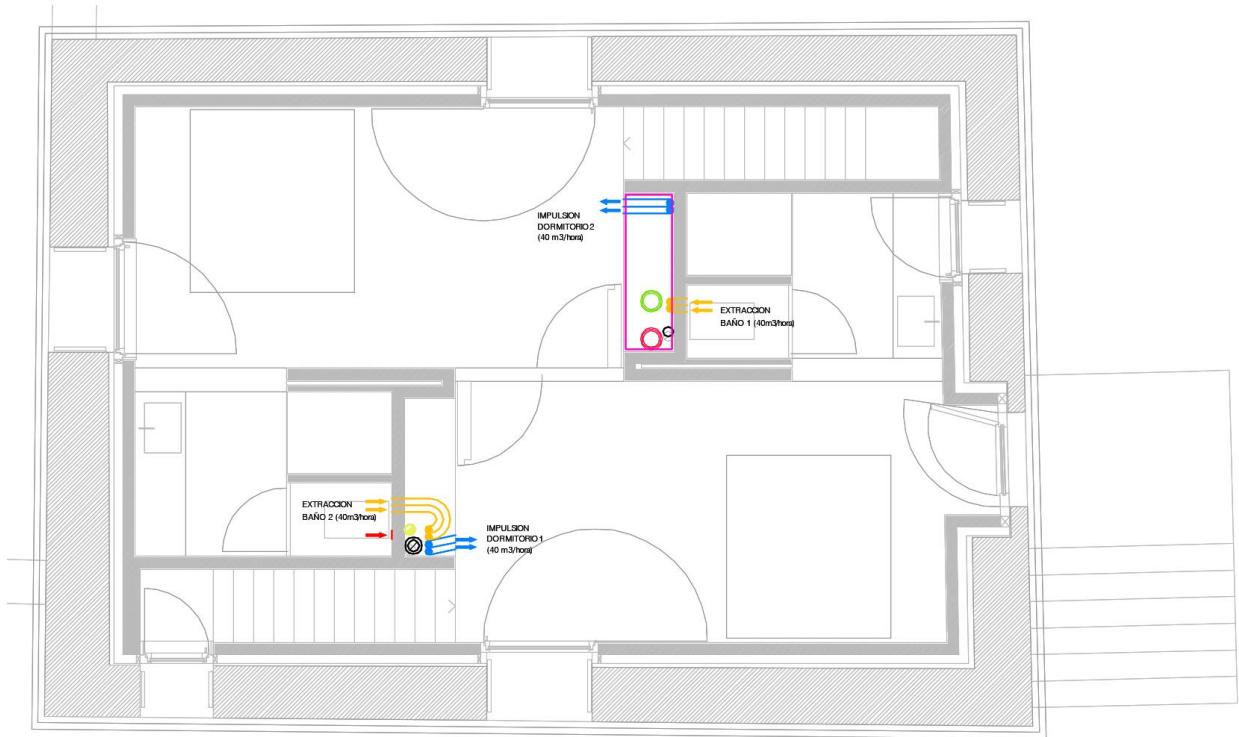
**Air tightness**  
 $V_{\text{leak, internal}} = 0.8\%$   
 $V_{\text{leak, external}} = 1.4\%$

**Frost protection**  
down to -15 °C

**Total Primary Energy Demand (\*\*)**  
**45 kWh/(m<sup>2</sup>a)**

**CERTIFIED COMPONENT**  
Passive House Institute

### 6.1 Ventilacion planning

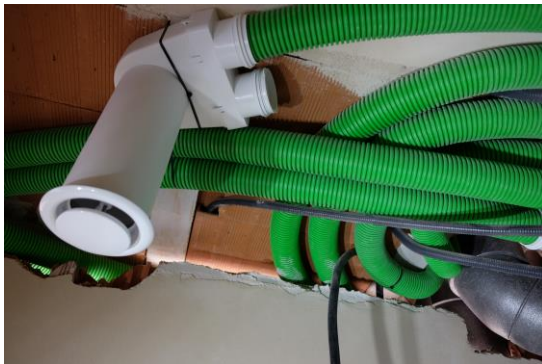


**First floor**



**Ground floor**

## 6.2 Construction phase



Average air flow rate m <sup>3</sup> /h	Average air change rate 1/h	Heat recovery efficiency	Effective heat recovery efficiency unit	Specific power input Wh/m <sup>3</sup>
93 m <sup>3</sup> /h	0.41 /h	88%	80,6%	0,33



## **7 Building services**

### **7.1 Heating / Cooling**

To heat the home we use the same compact ventilation unit described in the previous point (Orkli PKOM 4). This unit incorporates a heat pump that heats the ventilation air. We complement this with a small wood stove for the coldest days.




No active cooling system is planned.

### **7.2 Domestic hot water**

Domestic hot water is supplied by the same compact machine described in the previous point (Orkli PKOM 4), which incorporates a 100l tank.

## 8 PHPP results

### EnerPHit Comprobación



Edificio: **Cabaña**

Calle:

CP / Ciudad:

Provincia/Pais: **Cantabria** **ES-España**

Tipo de edificio: **Vivienda unifamiliar**

Datos climáticos: **ES0032a-Santander**

Zona climática: **4: Cálida-templada** Altitud de la localización: **292 m**

Propietario / cliente: **Helena Aguilar**

Calle:

CP / Ciudad: **28200** **San Lorenzo de el Escorial**

Provincia/Pais: **Madrid** **ES-España**

Construtor: **Sorribero**

Calle:

CP / Ciudad: **39470** **Rededo de Piélagos, Cantabria**

Provincia/Pais: **Cantabria** **ES-España**

Certificación: **Vand arquitectura**

Calle:

CP / Ciudad: **28029**

Provincia/Pais: **Madrid** **1-Estándar (sólo para edificios re**

**Arquitectura:** **Estudio Mínima**

Calle:

CP / Ciudad: **28200** **San Lorenzo de el Escorial, Madrid**

Provincia/Pais: **Madrid** **ES-España**

**Consult. energética:** **Estudio Mínima**

Calle:

CP / Ciudad: **28200** **San Lorenzo de el Escorial, Madrid**

Provincia/Pais: **Madrid** **ES-España**

Año construcción: **2023**

Nr. de viviendas: **1**

Nr. de personas: **2.2**

Temp. interior invierno [°C]: **20,0**

Temp. interior verano [°C]: **25,0**

Ganancias internas de calor (GIC): caso calefacción [W/m²]: **2,7**

GIC caso refriger. [W/m²]: **3,3**

Capacidad específica [Wh/K por m² de SRE]: **204**

Refrigeración mecánica:

**Cálculo de la demanda eléctrica / ganancias internas de calor**

Tipo de edificio: **1-Edificio residencial**

**Ganancias internas de calor (GIC)**

Tipo de uso: **10-Vivienda**

Valores: **2-Estándar**

**Ocupación**

**1-Estándar (sólo para edificios residenciales)**

Clima seleccionado: **ES0032a-Santander**

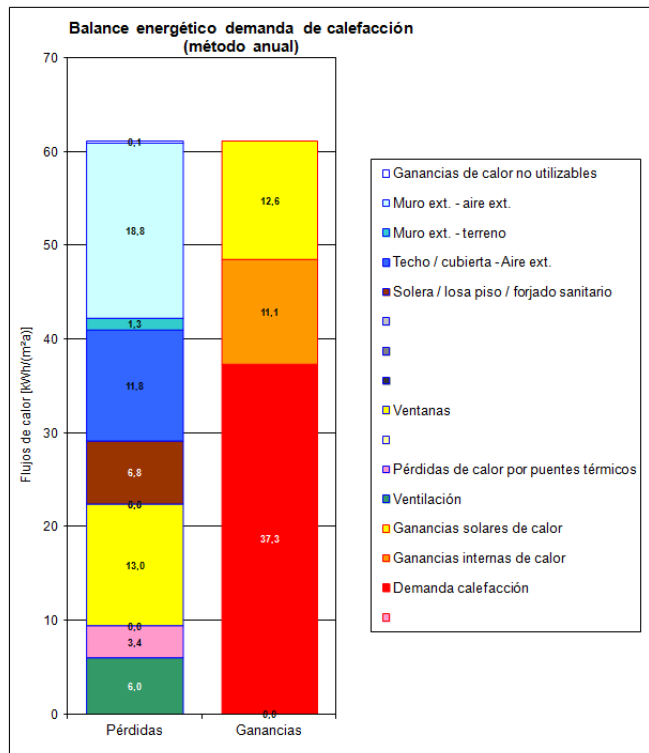
**1-Factores EP (no-renovable) Certificación PHI**

(Factores de energía primaria seleccionados para el cálculo de la demanda EP)

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

Criterio	Unidad	Valor	Relación	Criterios alternativos		¿Cumplido?²	
				-	-		
Calefacción	Superficie de referencia energética	m²	89,9				
	Demanda de calefacción	kWh/(m²a)	33	≤	-	-	-
	Carga de calefacción	W/m²	16	≤	-	-	-
Refrigeración	Demanda refrigeración & deshum.	kWh/(m²a)	-	≤	-	-	-
	Carga de refrigeración	W/m²	-	≤	-	-	-
	Frecuencia de sobrecalentamiento (> 25 °C)	%	1	≤	10		Si
	Frecuencia excesivamente alta humedad (> 12 g/kg)	%	10	≤	20		Si
Hermeticidad	Resultado ensayo presión n <sub>50</sub>	1/h	1,0	≤	1,0		Si
Energía Primaria no renovable (EP)	Demanda EP	kWh/(m²a)	80	≤	121		Si
Energía Primaria Renovable (PER)	Demanda PER	kWh/(m²a)	62	≤	-	-	-
	Generación de Energía Renovable (en relación con área de la huella del edificio)	kWh/(m²a)	-	≥	-	-	-

## Energy balance heating



## Energy balance cooling

