NATURALLY HIGH PERFORMANCE INSULATION

isobio

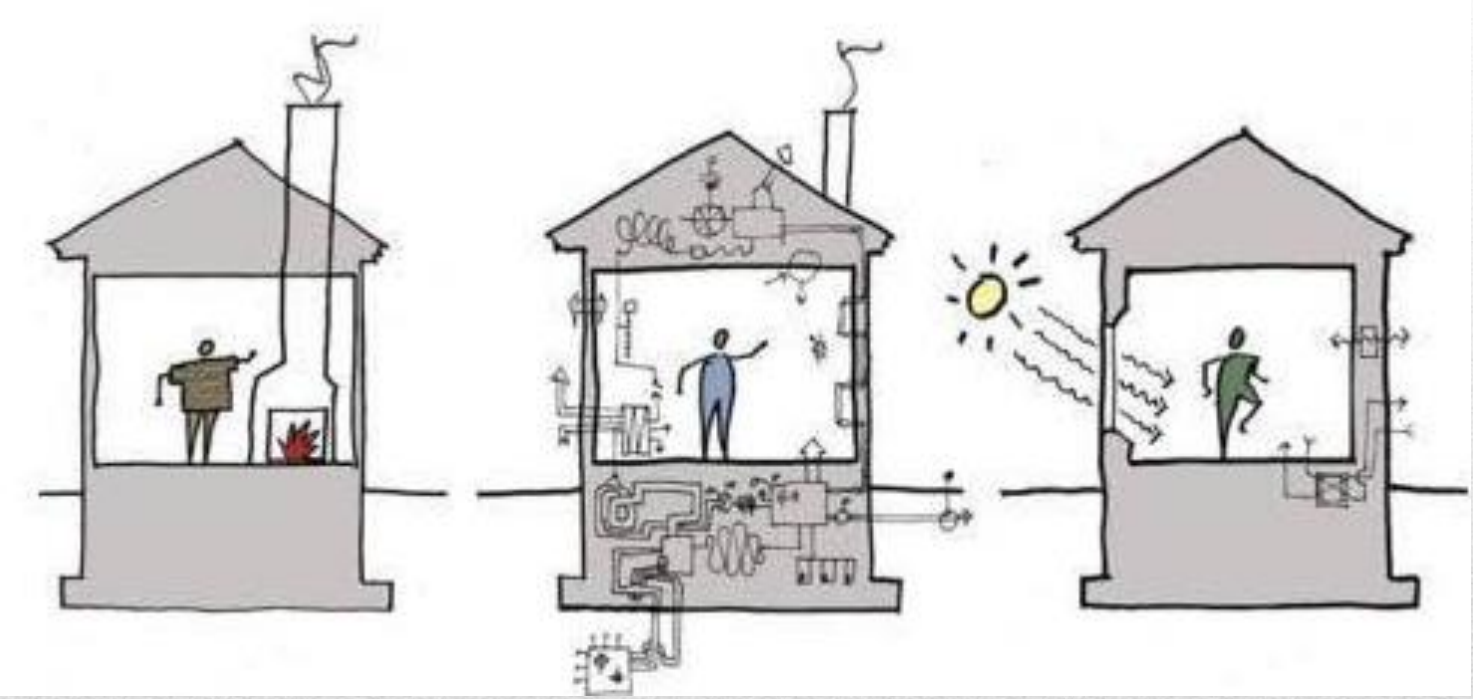
Incorporating bio-based materials into Passivhaus and nZEB designs

Oliver Style, Progetic

isobio

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Habitat over time



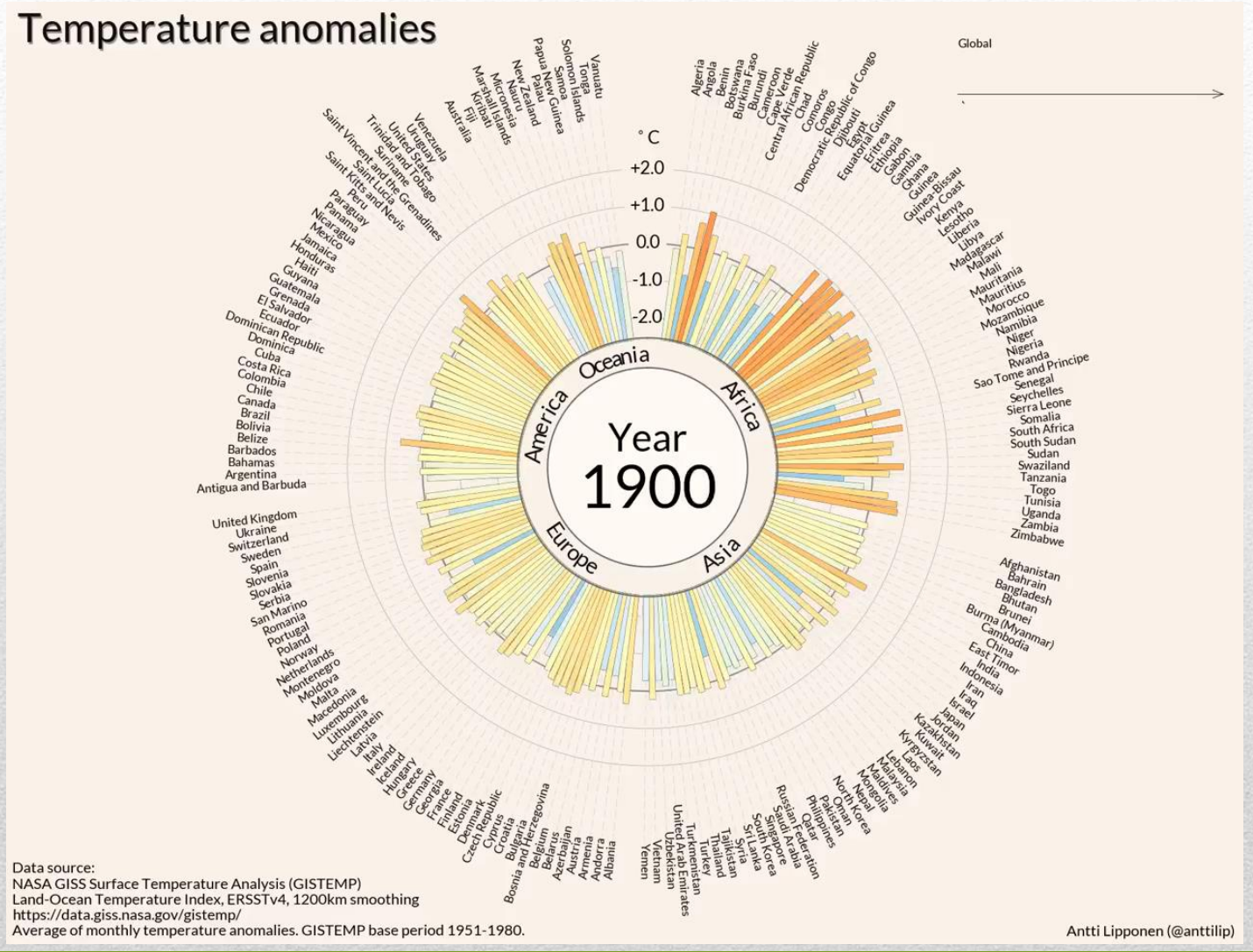
19th Century

20th Century

21st Century

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Designing for extreme climate scenarios



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

The tip of the iceberg

Construction cost

Environmental impact

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Operational energy + embodied energy

&

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

ISOBIO raw materials

Hemp shiv treated/ untreated with sol-gel

G7, G8, G12 and G14
4 treatments on G8

Hemp fine

Hemp fibre

Wheat shiv

G7, G8, G12 and G14

Rape shiv

G7, G8 and G14

Flax shiv

G7, G8, G12 and G14

Flax fine

Flax fibre

Corn cob

Corn cob residue

20 Raw Materials provided by CAVAC and 5 Raw Materials processed

Physical Characteristics	Mechanical Characteristics	Hygrothermal Characteristics	Chemical Characteristics

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

ISOBIO: Insulating core

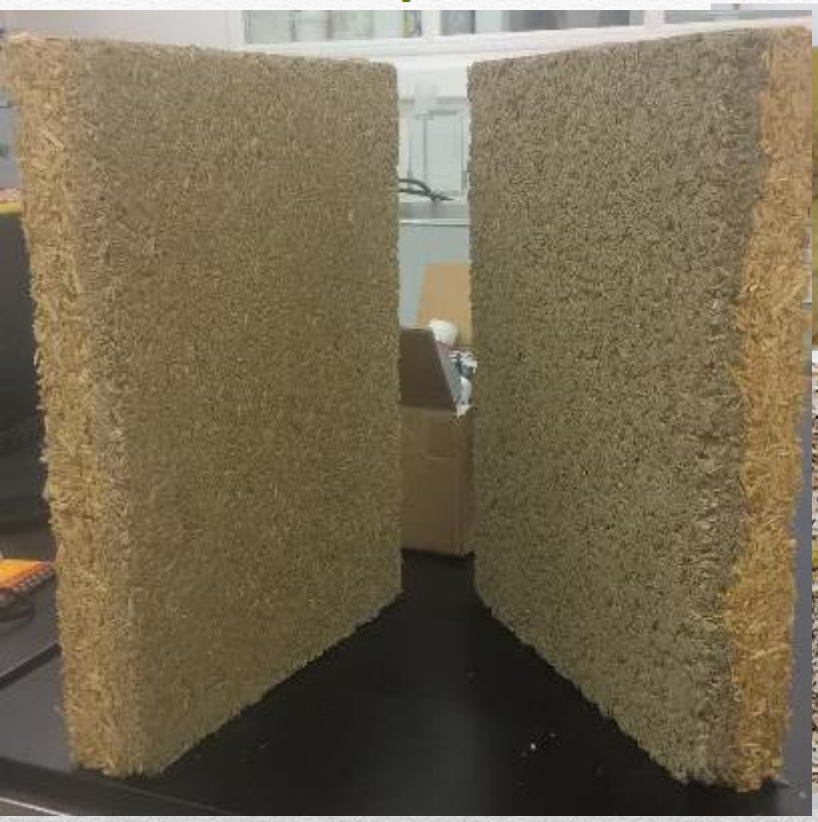
Hemp

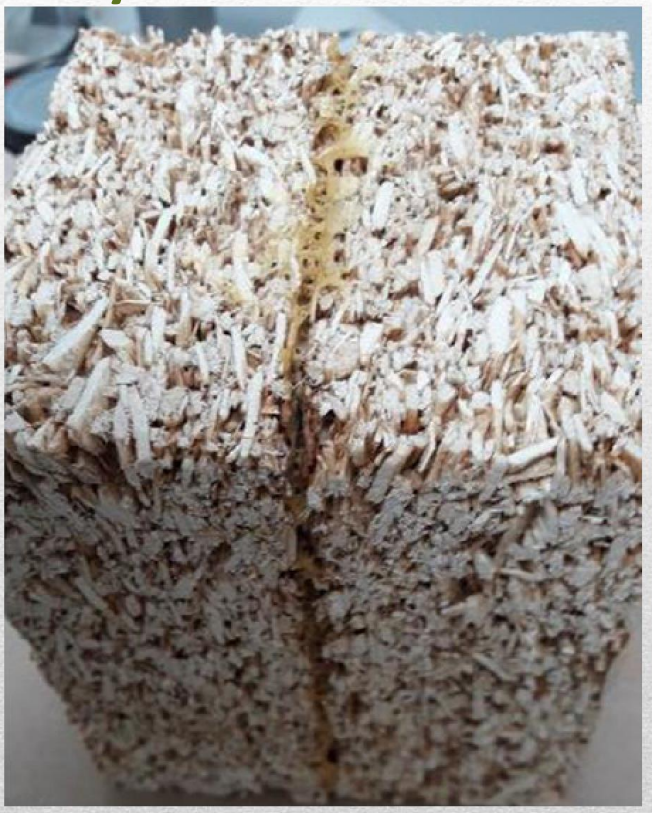
Straw

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

ISOBIO: Modified bio-based binder

Examples of uses : Lamination / multi-layer

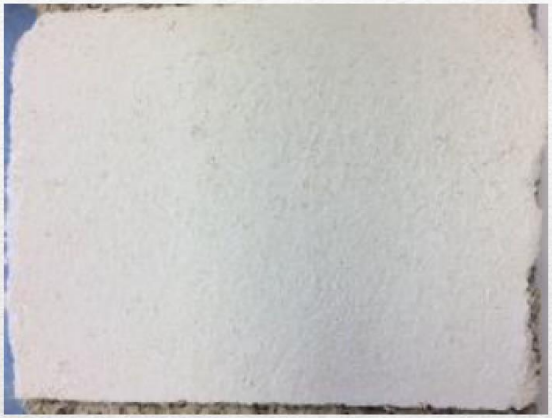


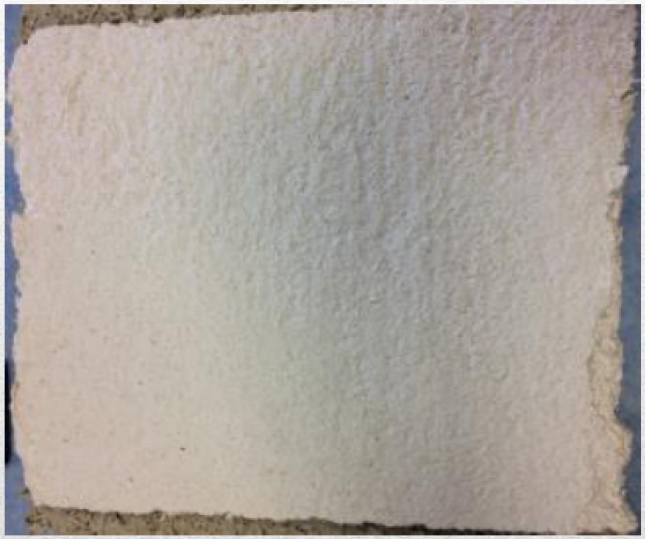


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

ISOBIO: Lime render/plaster + hemp

- Render (lime sp) + hemp





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

ISOBIO: Modified clay plasters

- Optimise fire resistance
- Maintain moisture buffering properties
- Maintain workability

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: straw & timber nZEB home

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: straw & timber nZEB home

- **Gross floor area:** 142 m2
- **Useful floor area:** 92 m2
- **Construction time:** 6 months
- **Construction cost:** € 153,782 ; € 1.083/m2
- **Architects:** Nacho Martí, Maria Molins & Oriol Martí
- **PHPP, Passivhaus design:** Oliver Style
- **Builder:** Farhaus
- **Developers:** Jordi Vinadé & Itziar Pagès

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: location

Source: Google Maps 2016

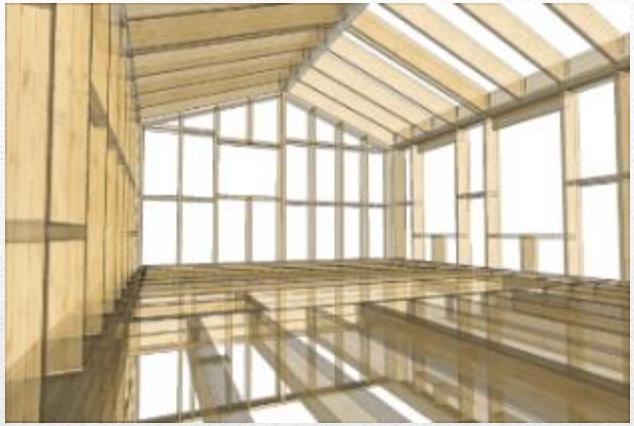
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: location

Source: Google Maps 2016

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: timber structure



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: materials, structure & envelope

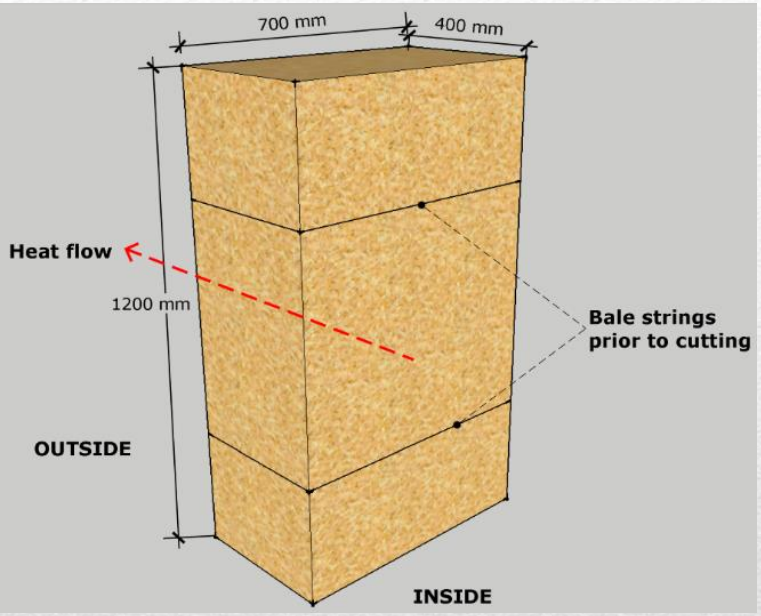


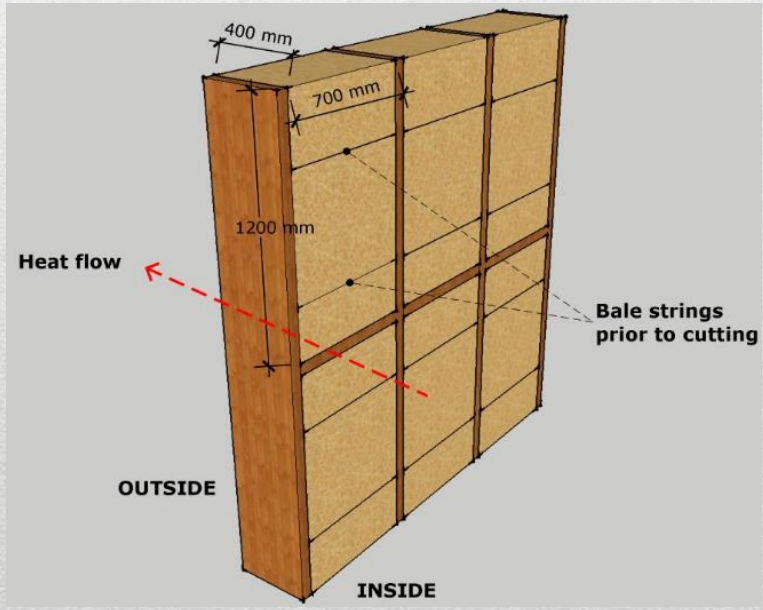




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

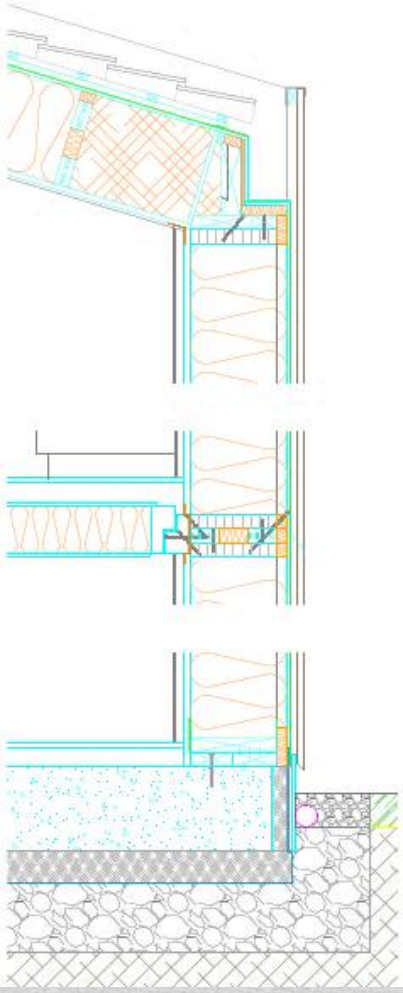
Larixhaus: straw insulation





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: thermal envelope



Wall build-up [in > out]:

- 12mm gypsum fibre board
- 35 mm service void
- 22mm OSB 4 [airtight layer & vapour barrier]
- 400mm straw insulation
- 16mm timber board [vapour permeable]
- 0,5mm membrane [vapour permeable]
- 35mm ventilated cavity
- 26mm larch rain screen cladding

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: straw insulation

Target density **δ = 90 <> 110 kg/m³**

Num.	Llargada (m)	Amplada (m)	Gruix (m)	*m3*	Pes (Kg)	Desnitat (kg/m3)
1	1,24	0,71	0,41	***0,36***	34,40	**95,30**
2	1,28	0,73	0,48	***0,45***	43,40	**96,76**
3	1,26	0,72	0,40	***0,36***	36,00	**99,21**
4	1,24	0,71	0,39	***0,34***	35,00	**101,94**
5	1,25	0,71	0,41	***0,36***	33,40	**91,79**
6	1,25	0,71	0,42	***0,37***	38,60	**103,55**
7	1,24	0,71	0,31	***0,27***	27,40	**100,39**
8	1,31	0,72	0,48	***0,45***	44,00	**97,19**
9	1,28	0,72	0,48	***0,44***	34,00	**76,86**
10	1,25	0,75	0,44	***0,41***	46,80	**113,45**
11	1,23	0,73	0,31	***0,28***	31,40	**111,37**
12	1,26	0,76	0,44	***0,42***	40,60	**96,36**
13	1,25	0,70	0,37	***0,32***	38,00	**117,37**
14	1,24	0,74	0,41	***0,38***	39,00	**103,66**
15	1,25	0,70	0,45	***0,39***	37,00	**93,97**
16	1,25	0,72	0,37	***0,33***	31,20	**93,69**
17	1,19	0,71	0,36	***0,30***	40,80	**134,14**
18	1,25	0,72	0,38	***0,34***	38,00	**111,11**
19	1,22	0,71	0,40	***0,35***	37,00	**106,79**
20	1,22	0,70	0,36	***0,31***	38,00	**123,60**
21	1,22	0,72	0,42	***0,37***	39,00	**105,71**
22	1,23	0,70	0,40	***0,34***	39,80	**115,56**

Measured average density **δ = 104 kg/m³**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: straw insulation

Target humidity $\varphi \leq 10\ \%$

Humitat i temperatura

	Humitat material	Tº ambient	Humitat ambiental
Proba 1	8,10	32	
Proba 2	10,00	32	
Proba 3	8,30	32	
Proba 4	4,00	32	
Proba 5	0,00	32	

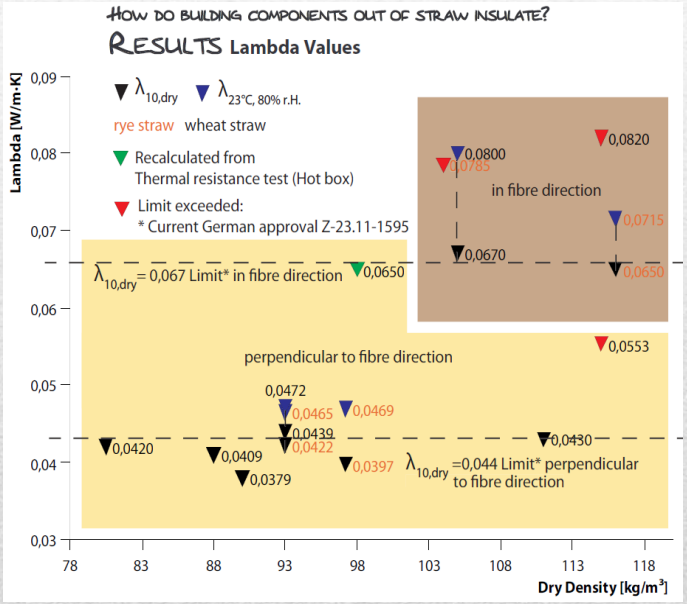
Measured average humidity $\varphi = 6\ \%$

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: straw insulation

Estimated thermal conductivity

λ_R = **0.052***0.75 + **0.08***0.25 = 0.059 W/m·K

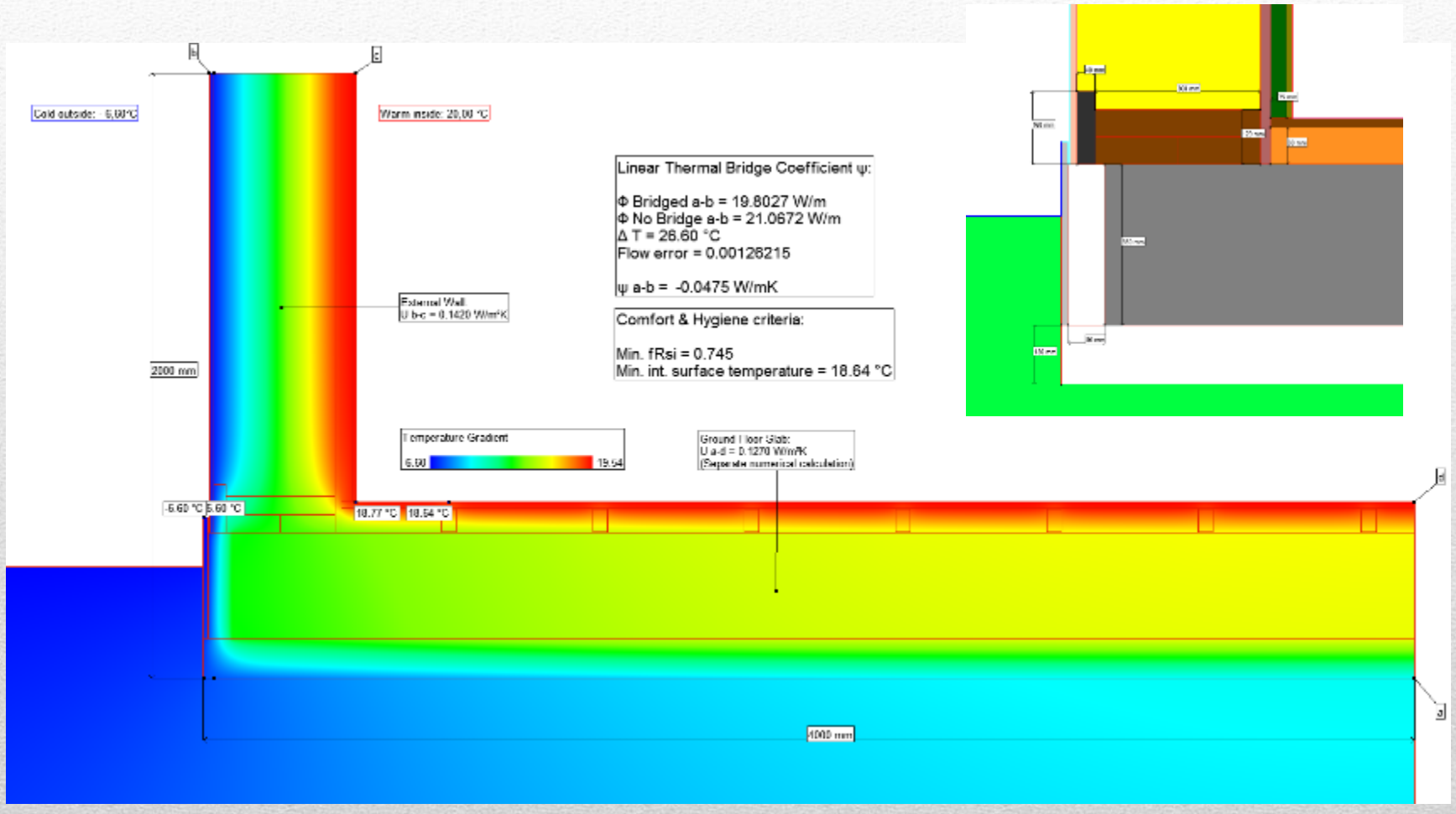


Source: FASBA 2009

Thermal conductivity **λ = 0.059 W/m·K**

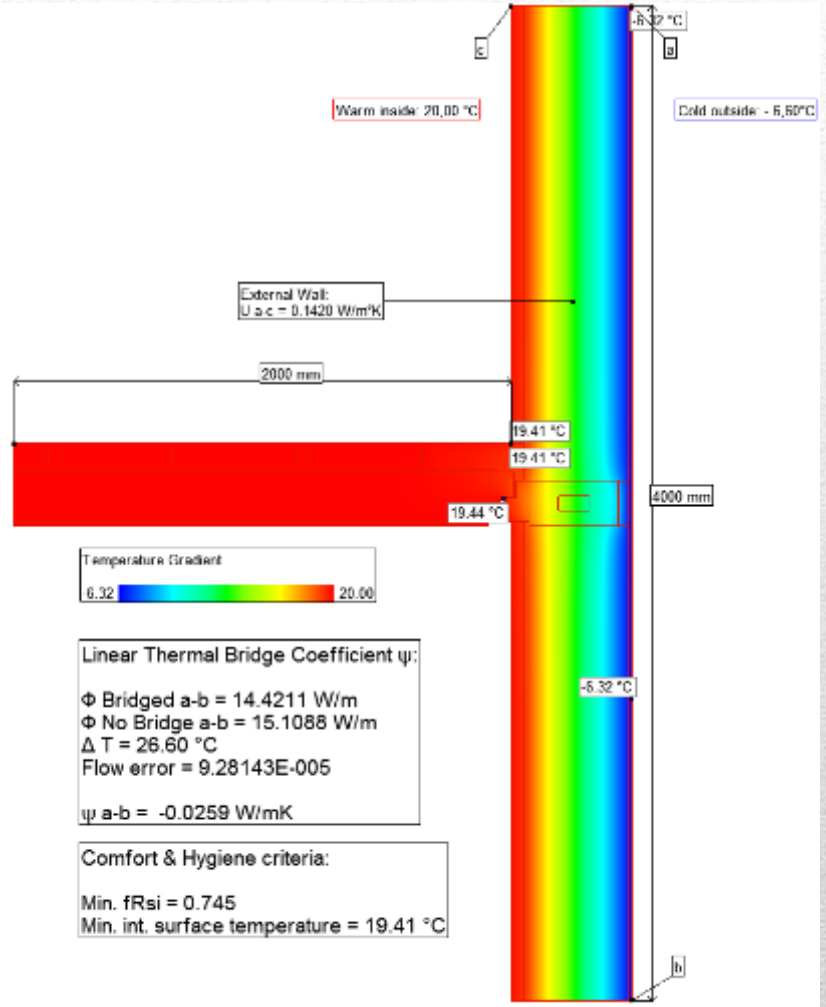
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

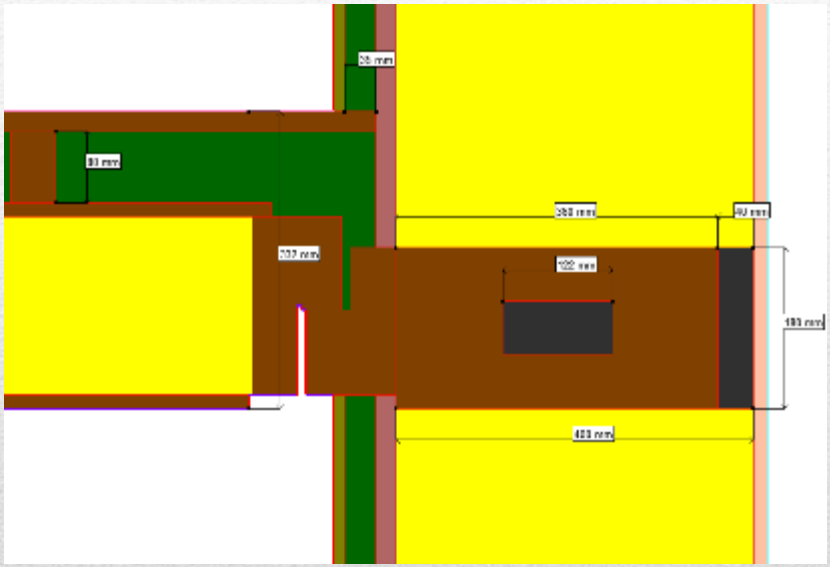
Larixhaus: thermal-bridge free envelope



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

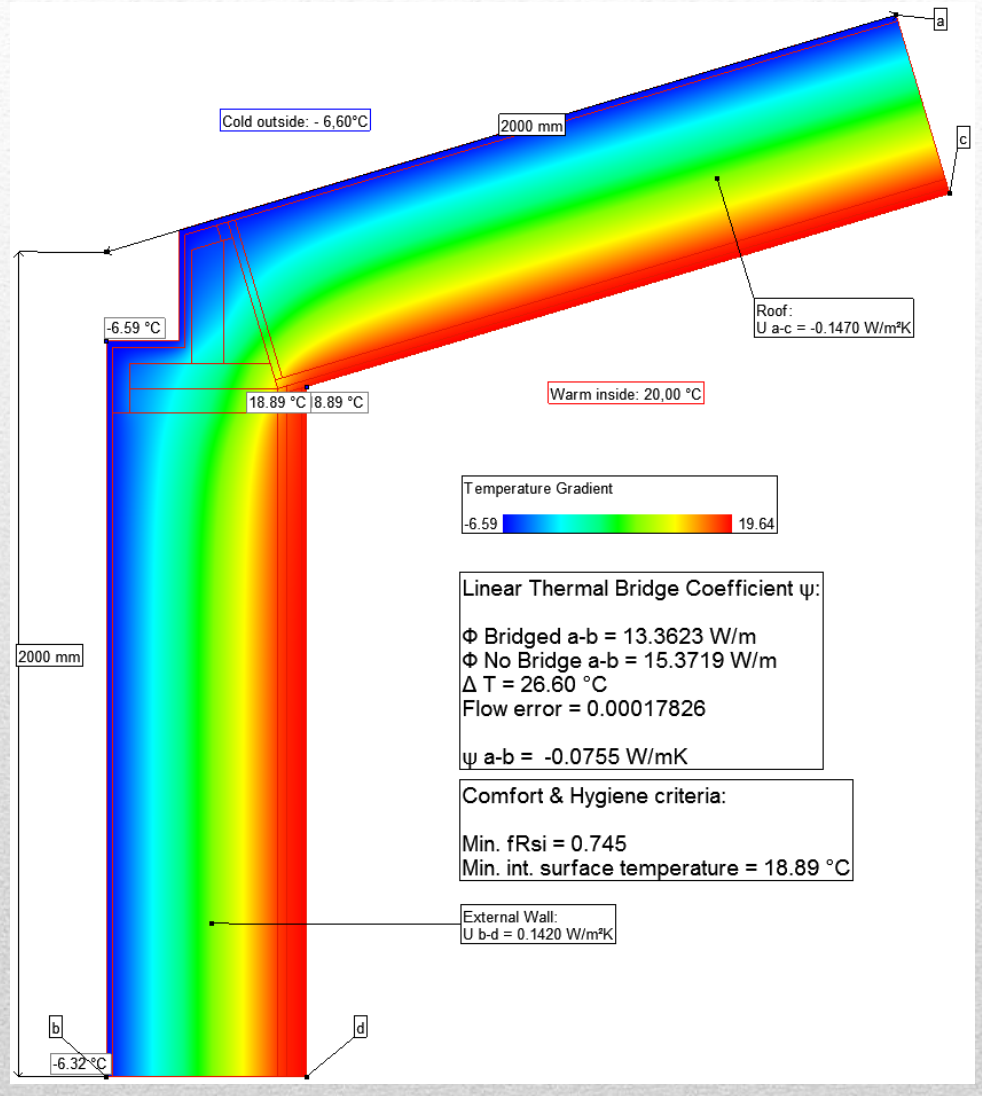
Larixhaus: thermal-bridge free envelope

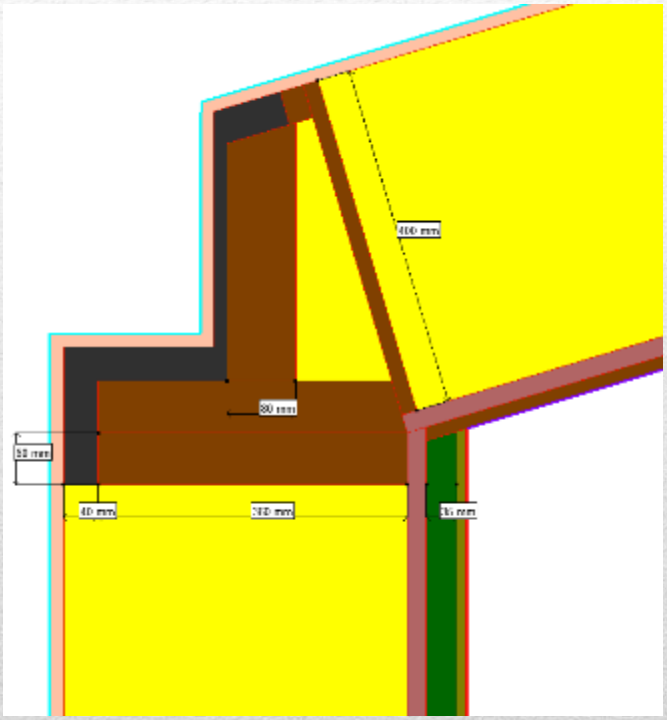




This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: thermal-bridge free envelope





This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: prefabrication






This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: on-site assembly






This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: air tightness

Certificate

about the BlowerDoor Test

Object:

Larixhaus

C/Ponent 18

Collsuspina 08178

Test Date: 30.9.2013

Air change rate (n50) at 50 Pascal

according to EN 13829

n50	=	0,32 1/h

Regulation complied with: Passivhaus standard

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

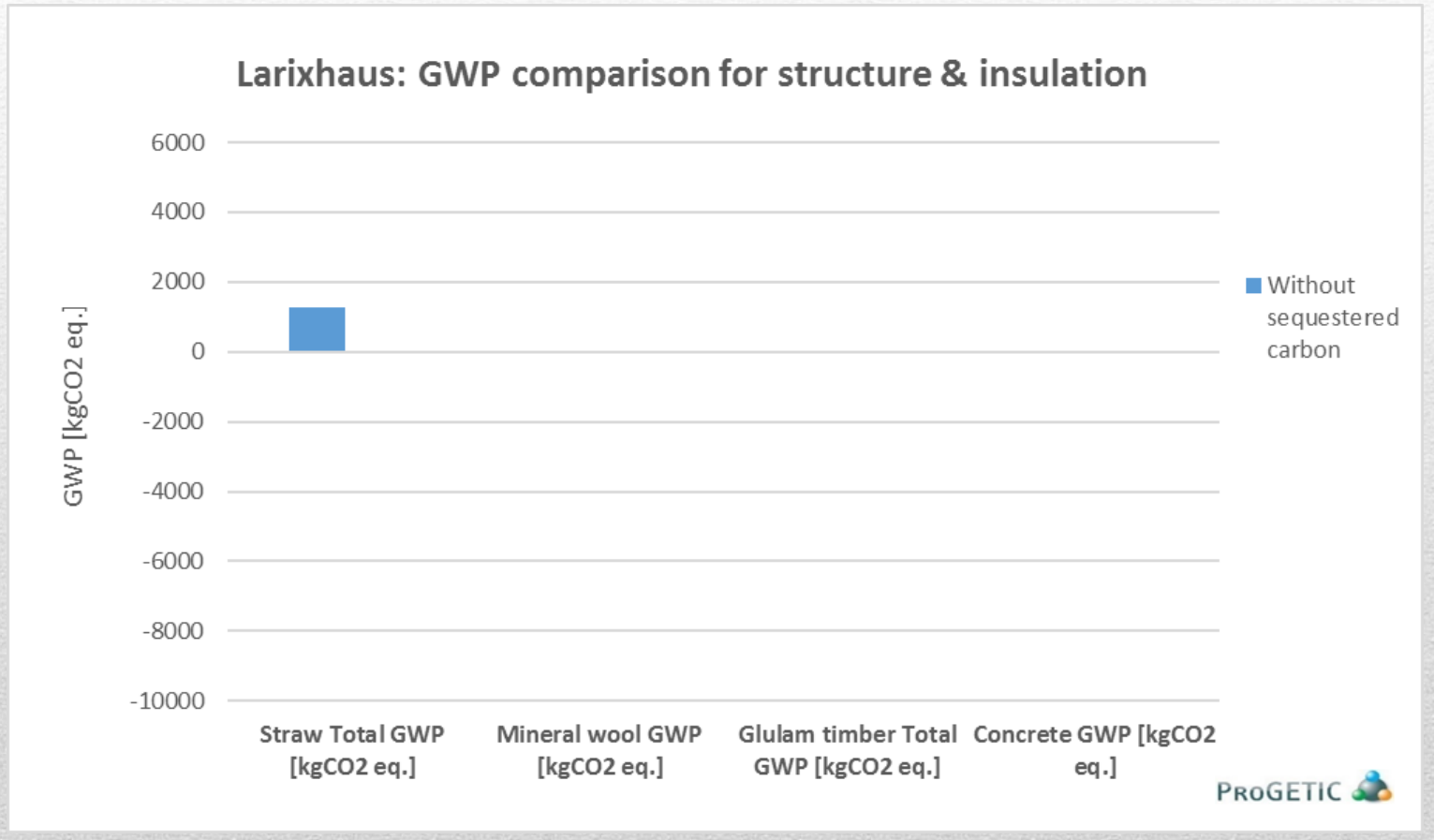
Larixhaus: mechanical & electrical systems

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: completed & certified building

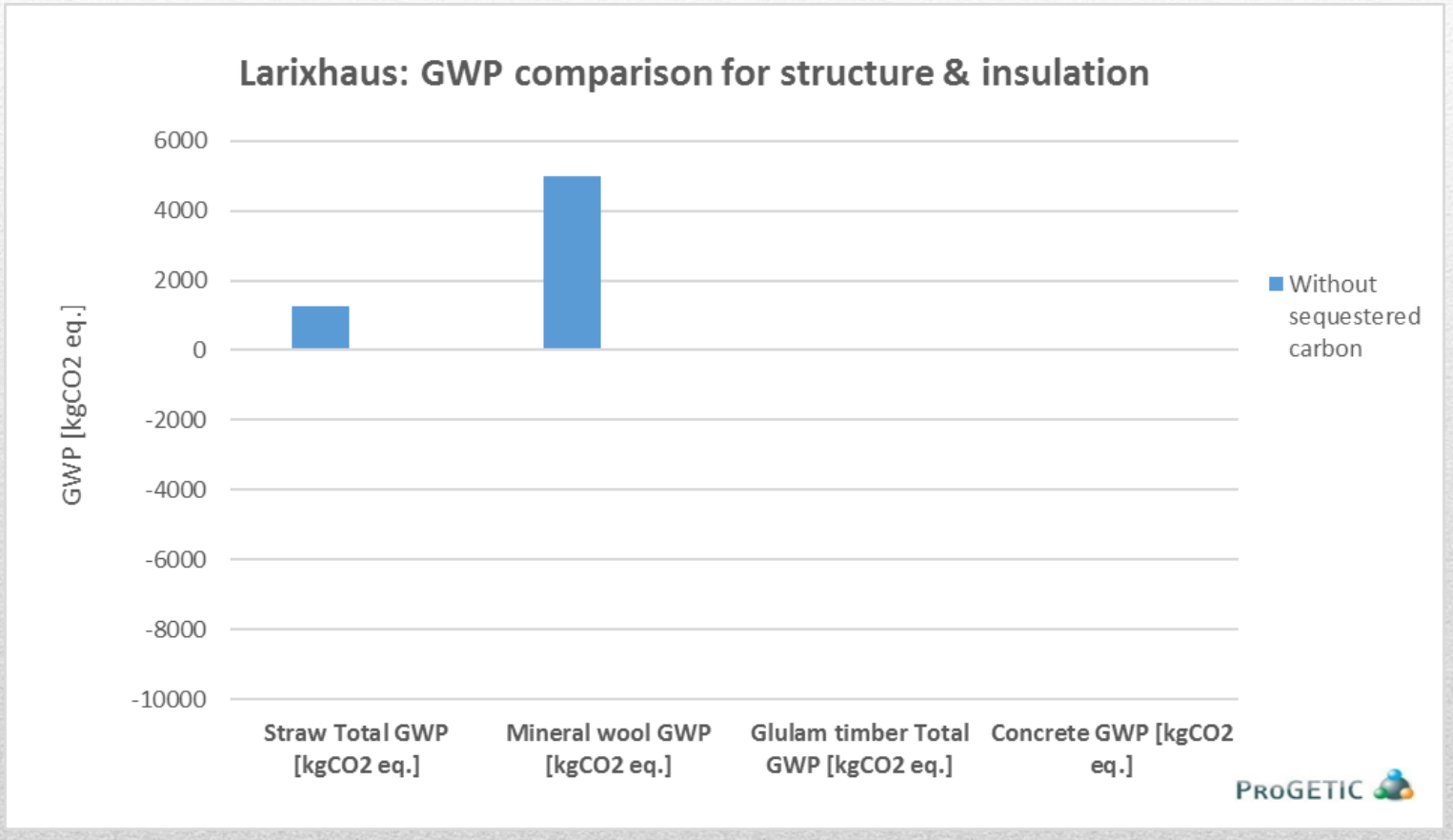
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



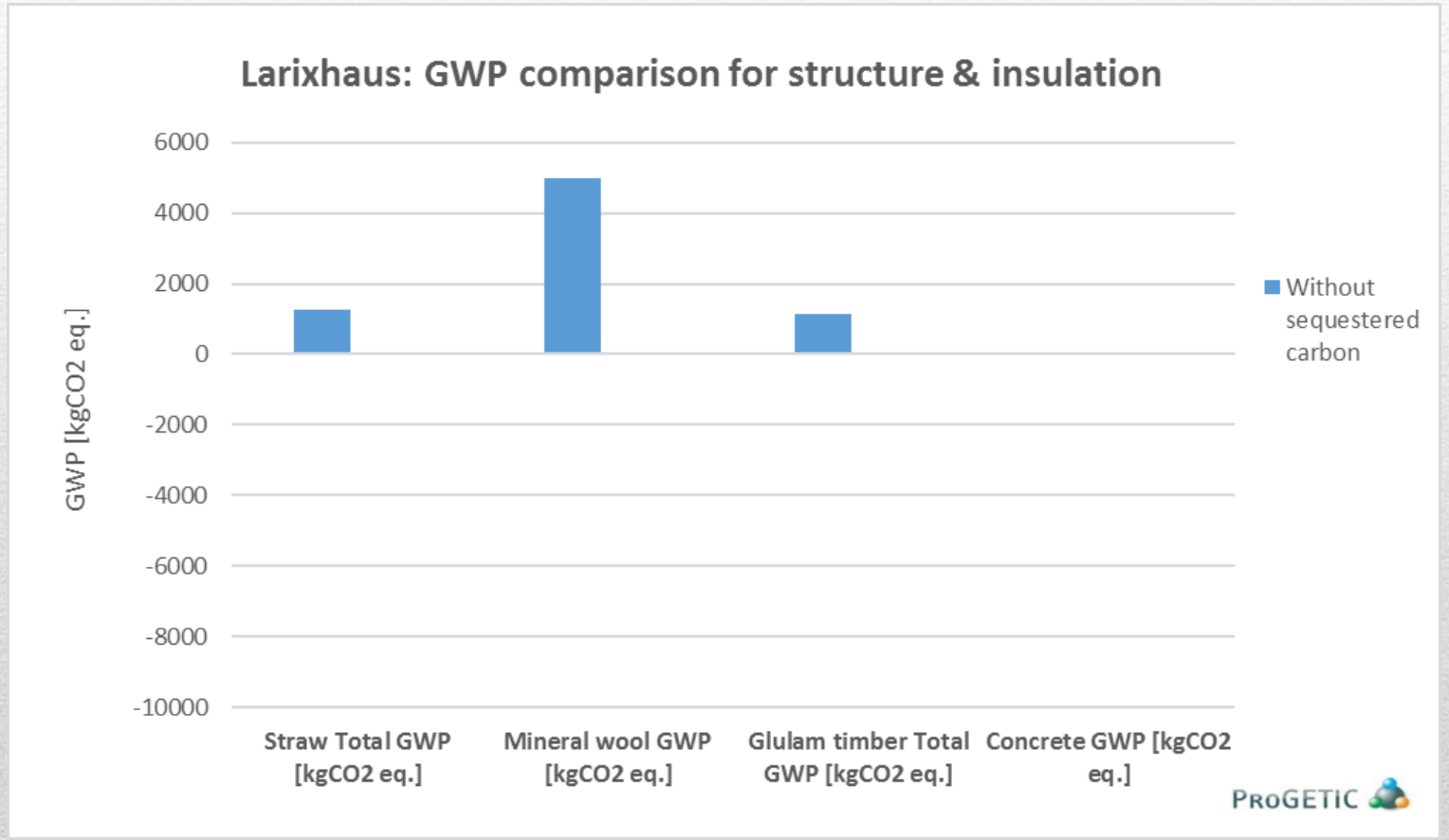
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



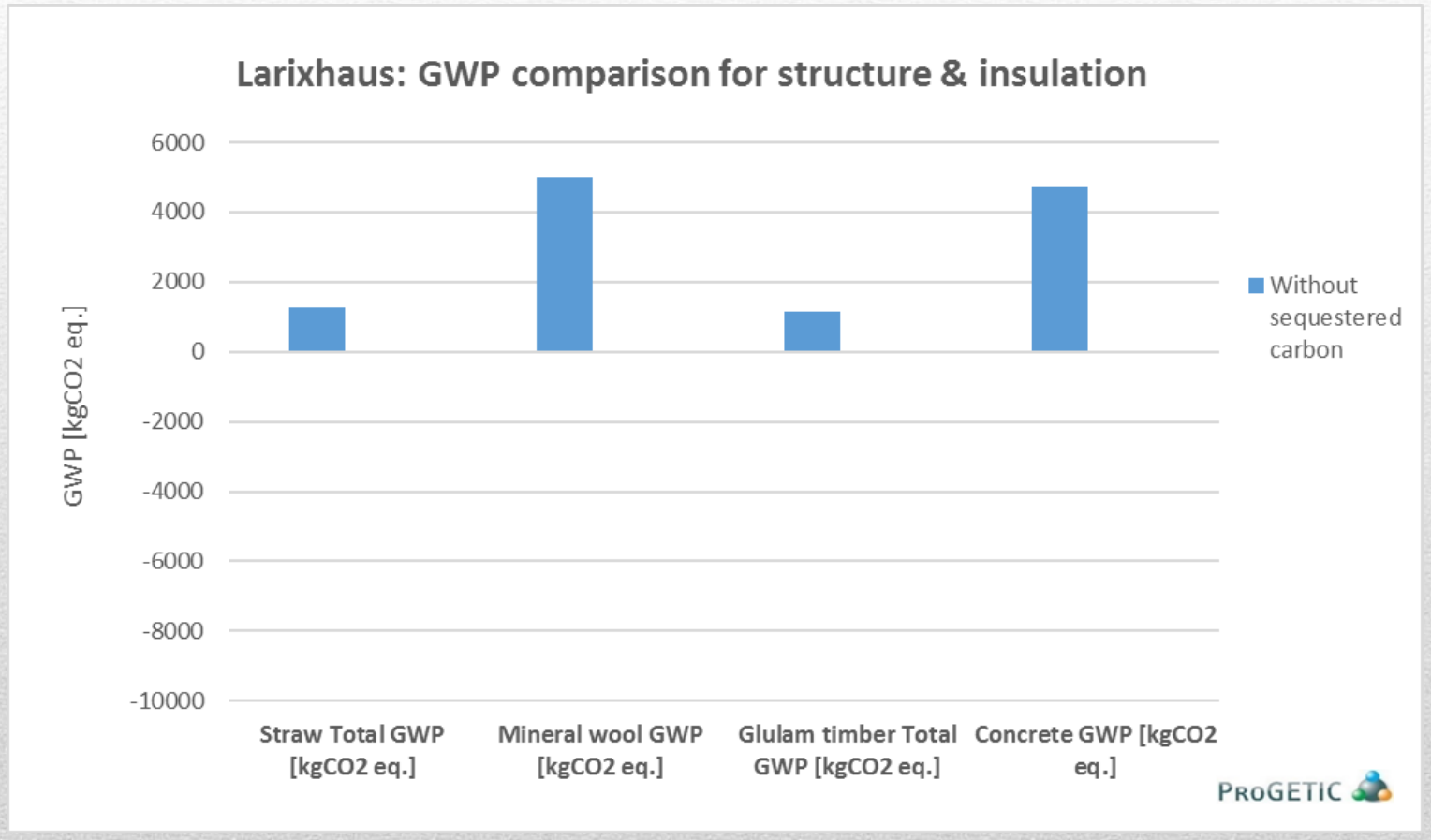
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



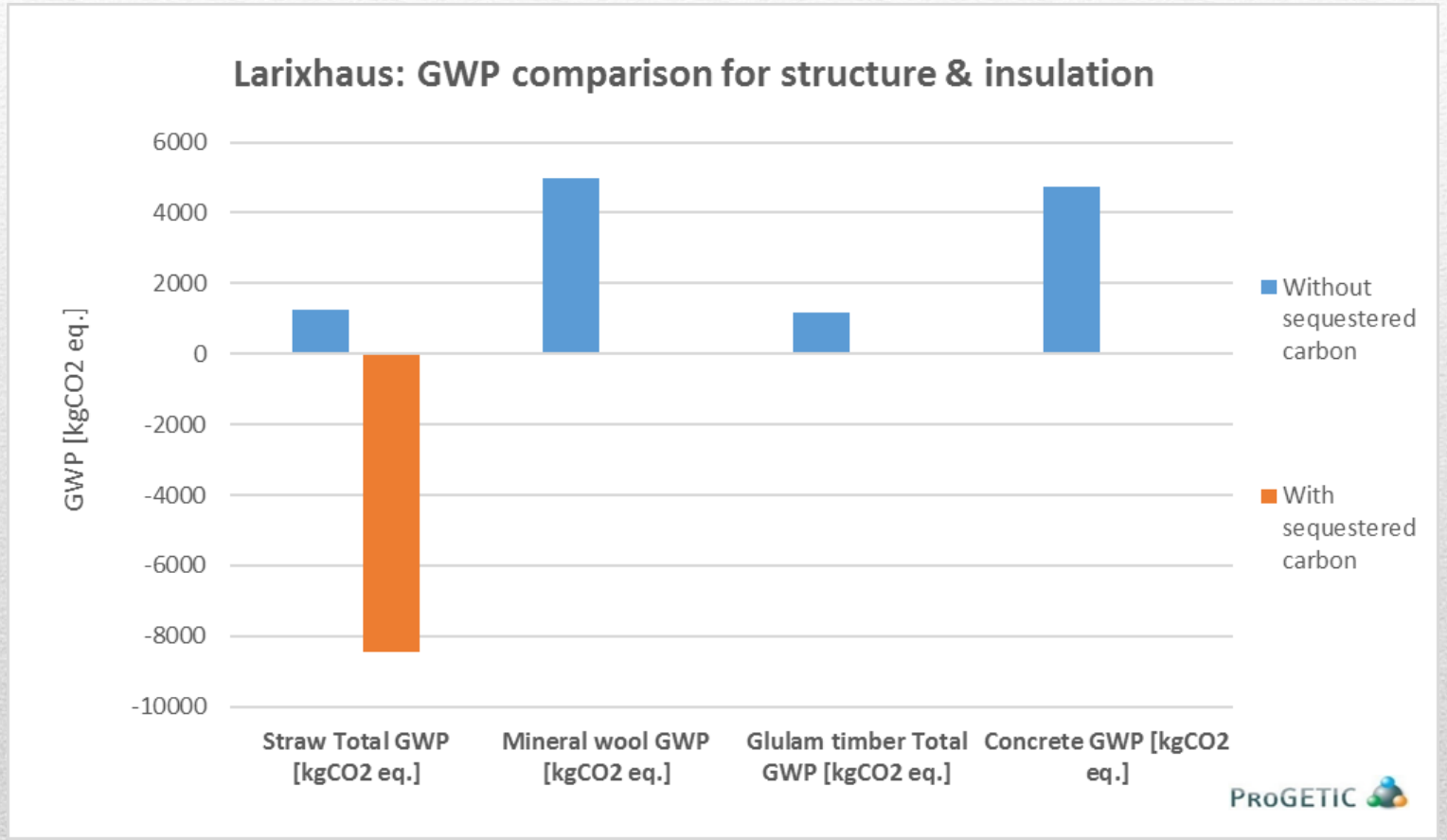
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



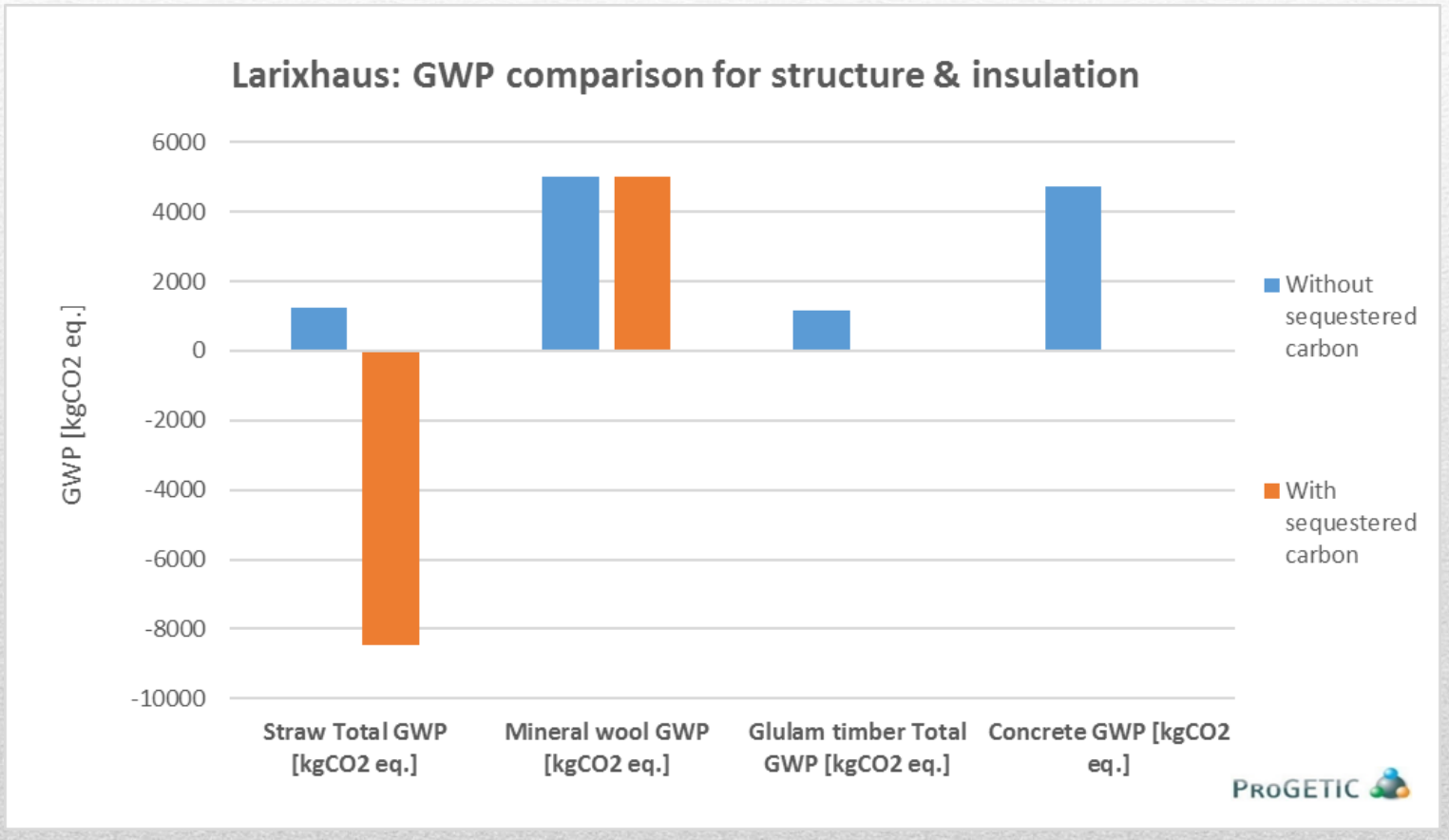
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



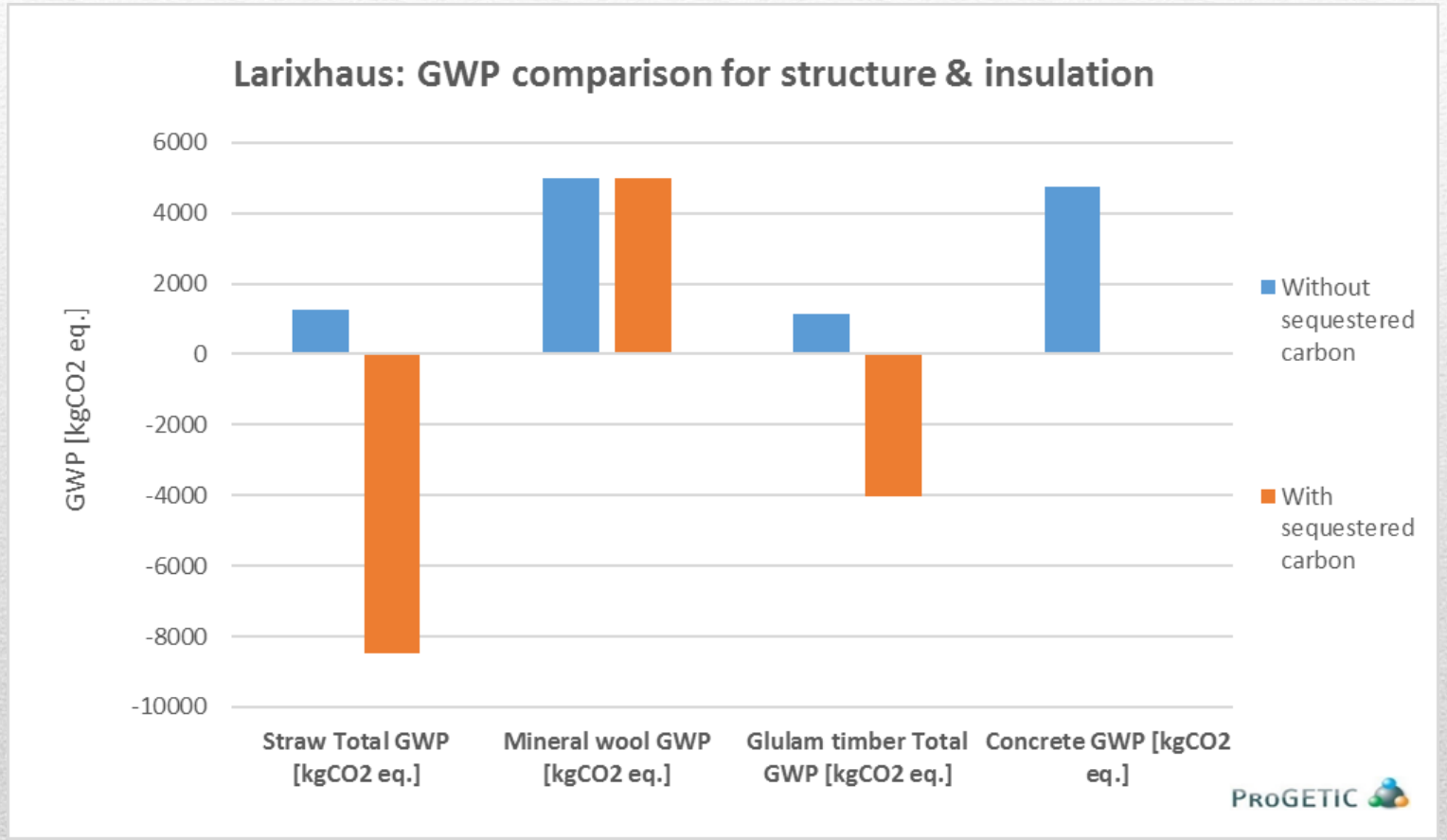
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



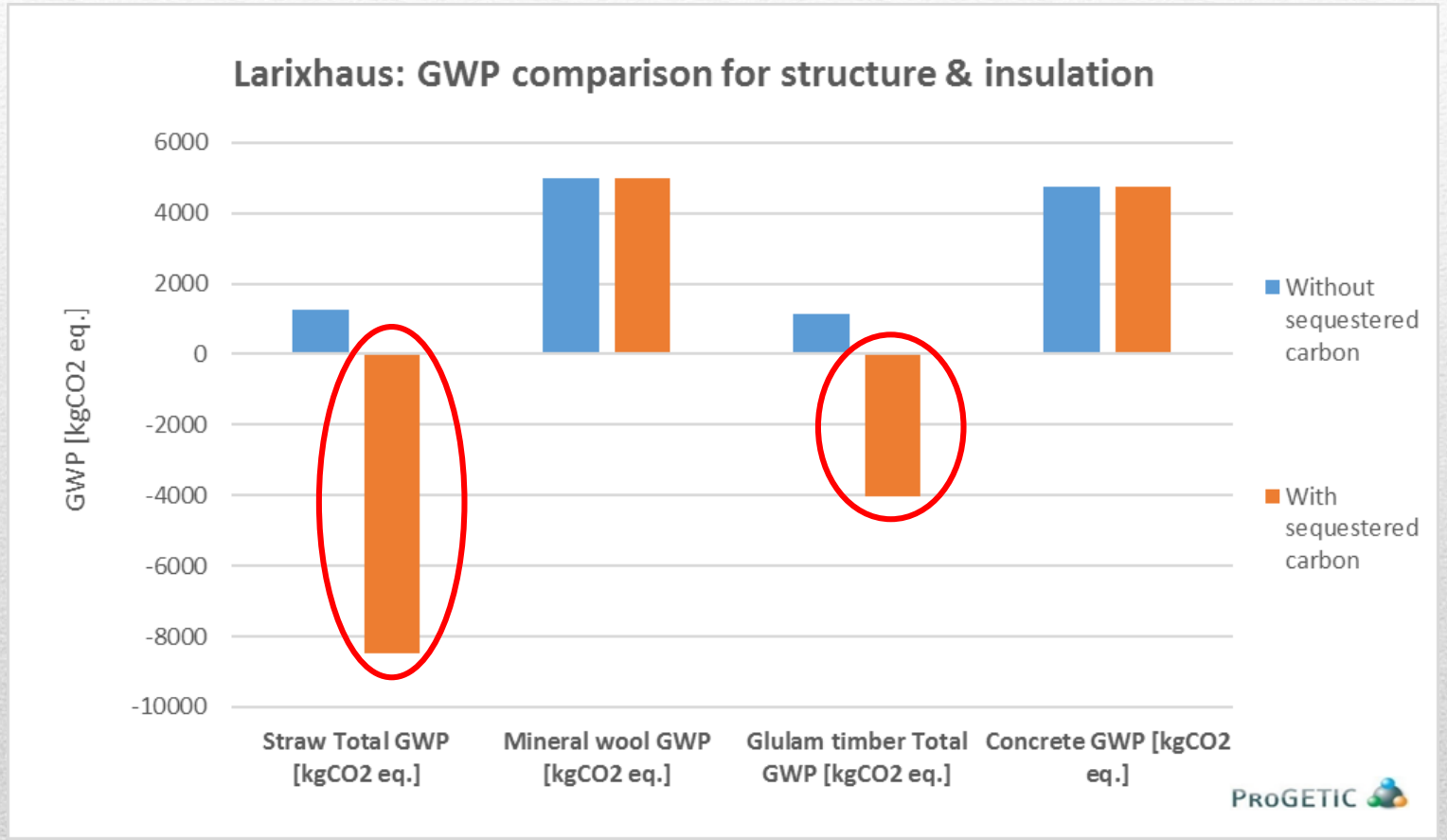
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: embodied energy

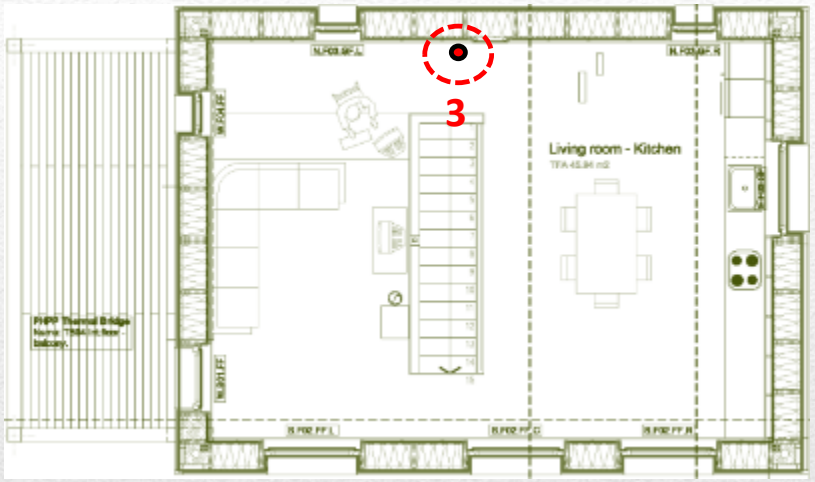


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

Ground Floor

First Floor



1

Outdoor Temp. & RH sensor

2

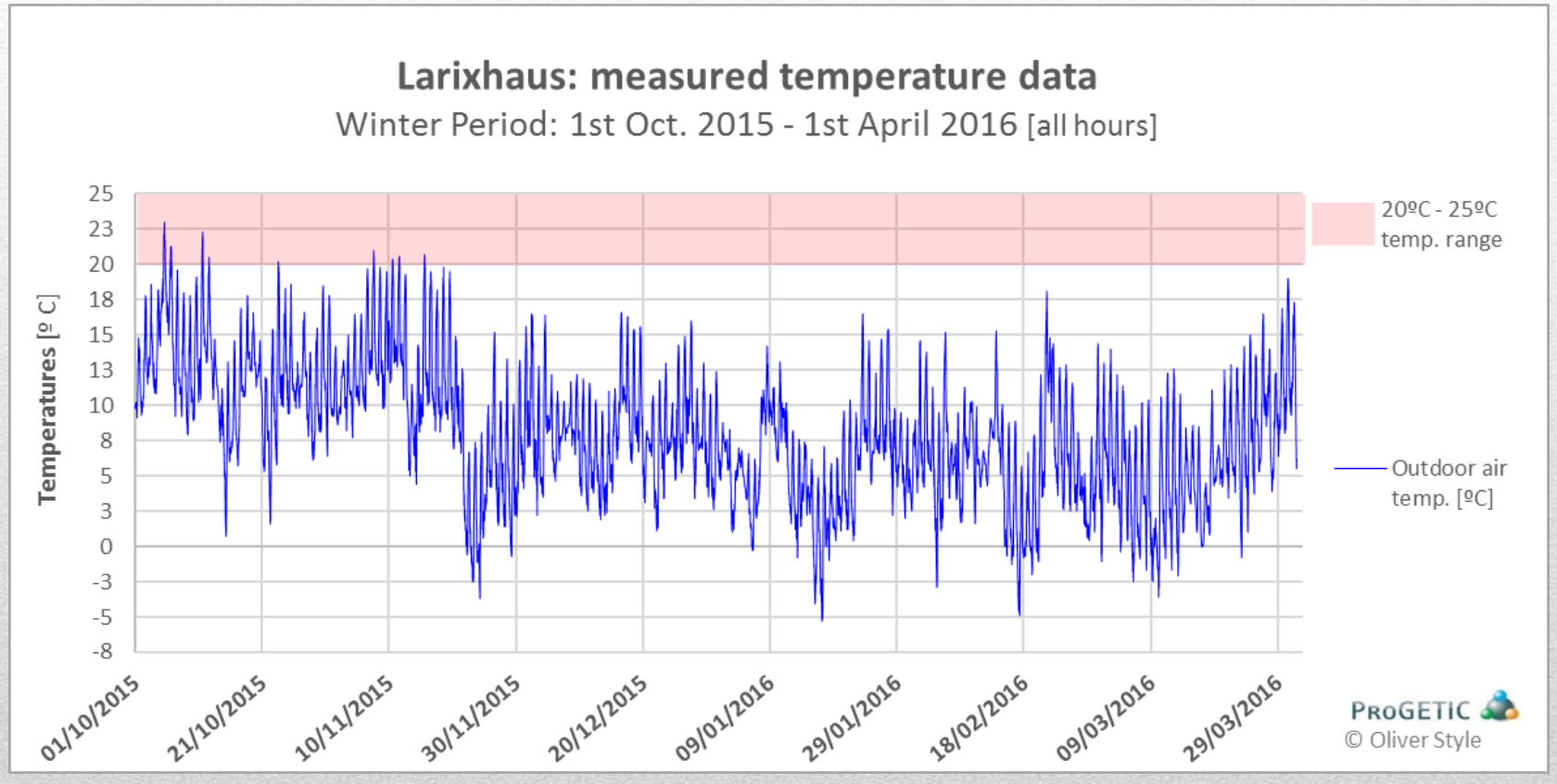
3

Indoor Temp.. RH & CO2 sensors

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

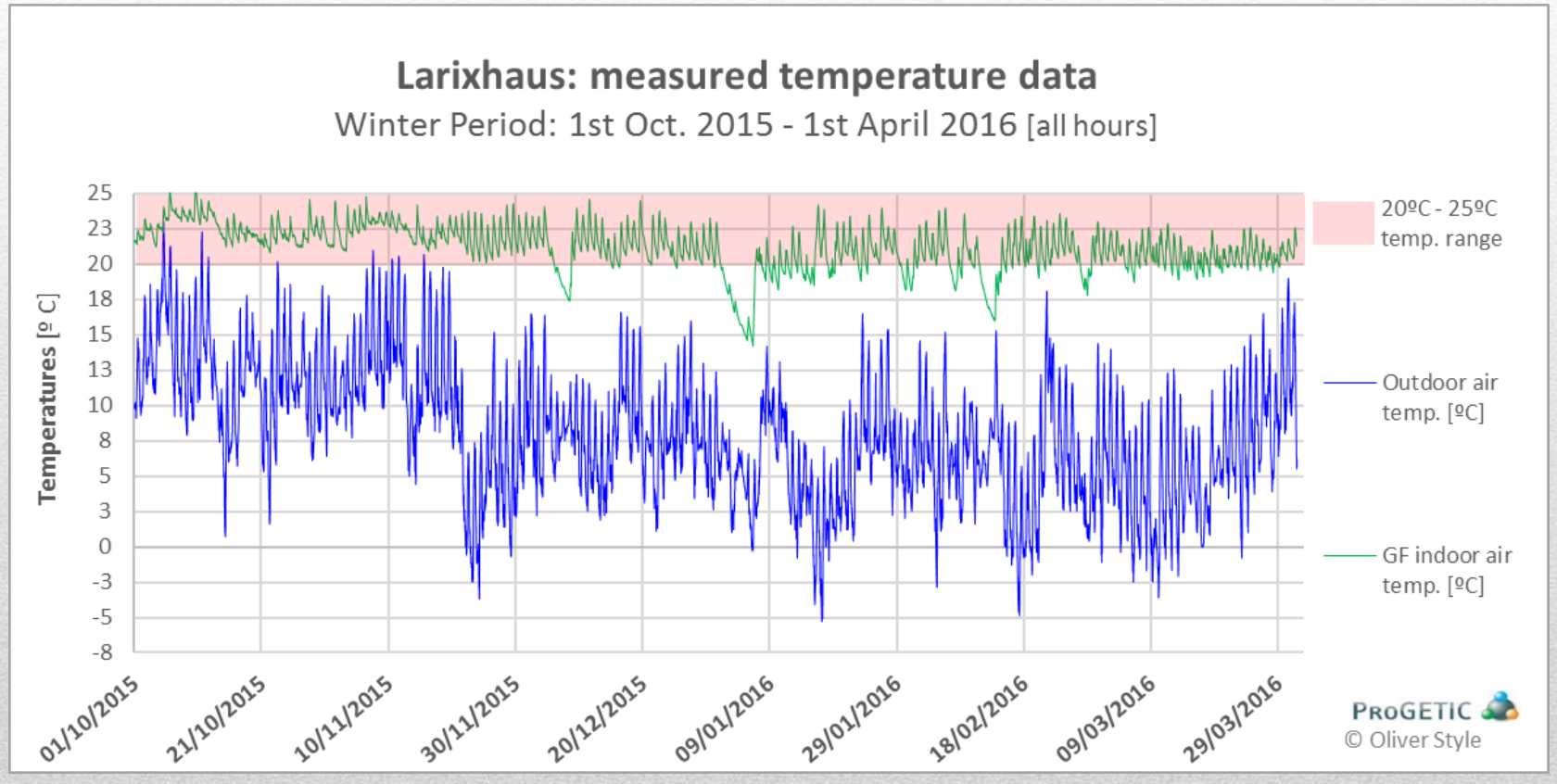
Winter



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

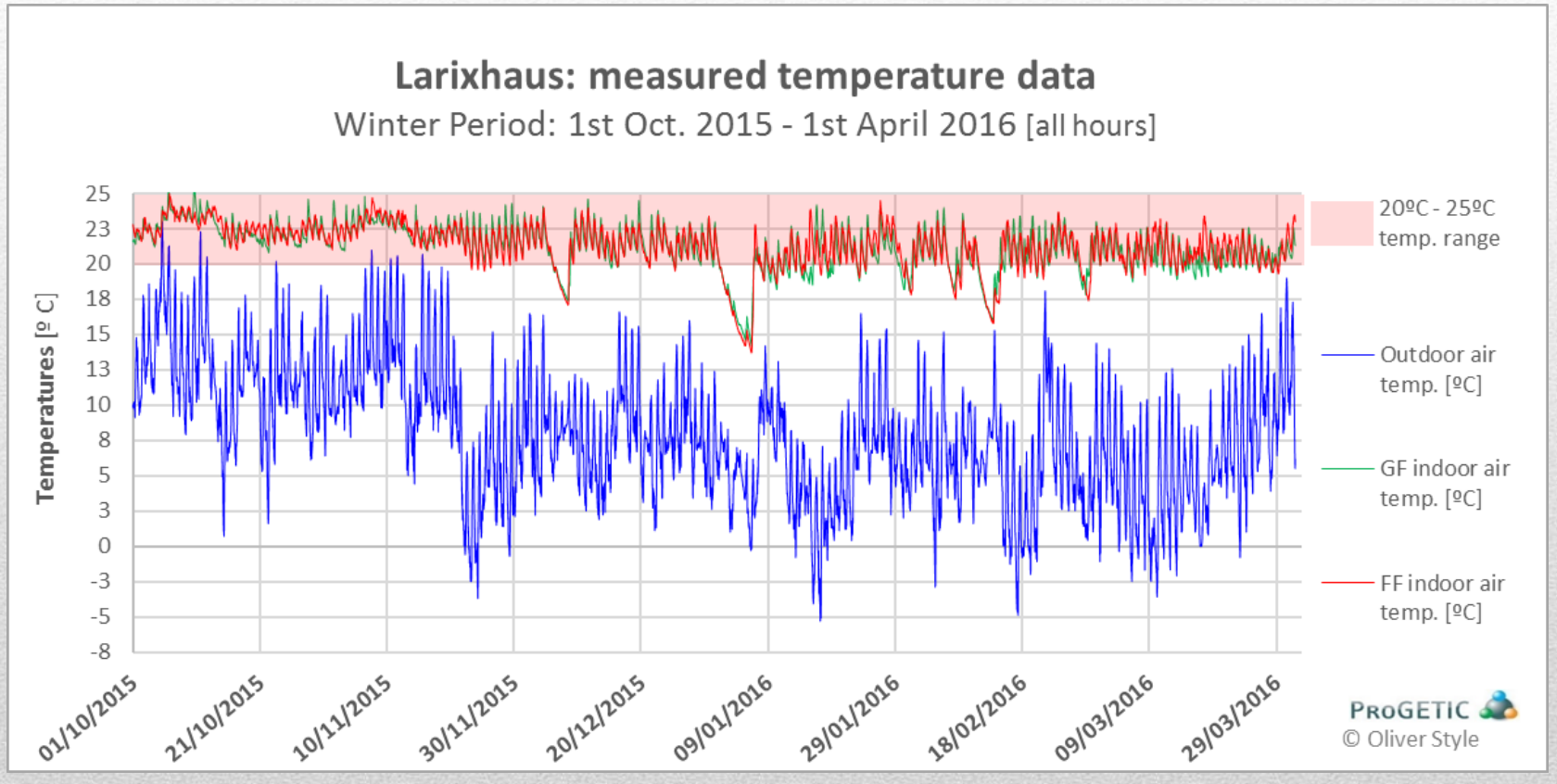
Winter



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

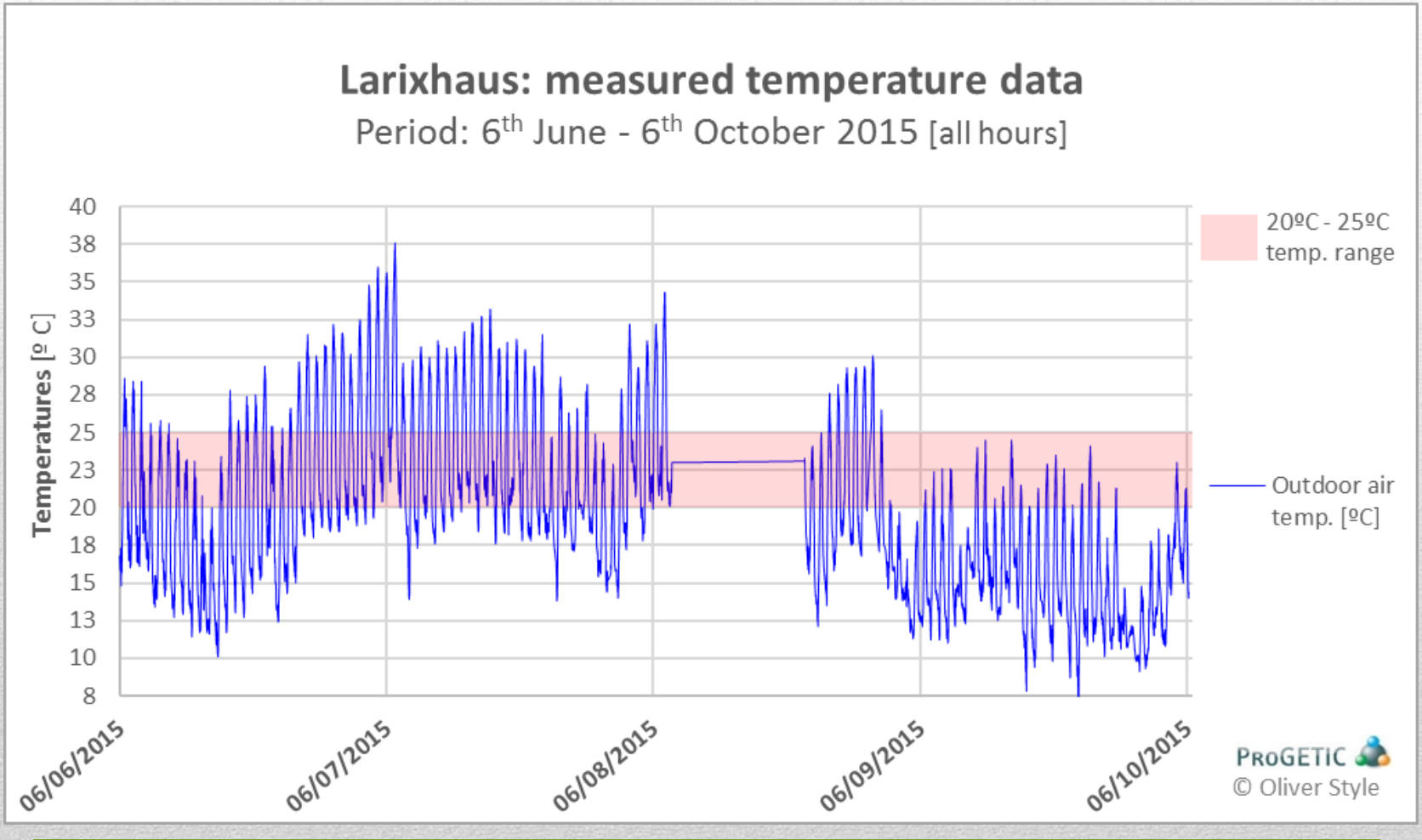
Winter



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

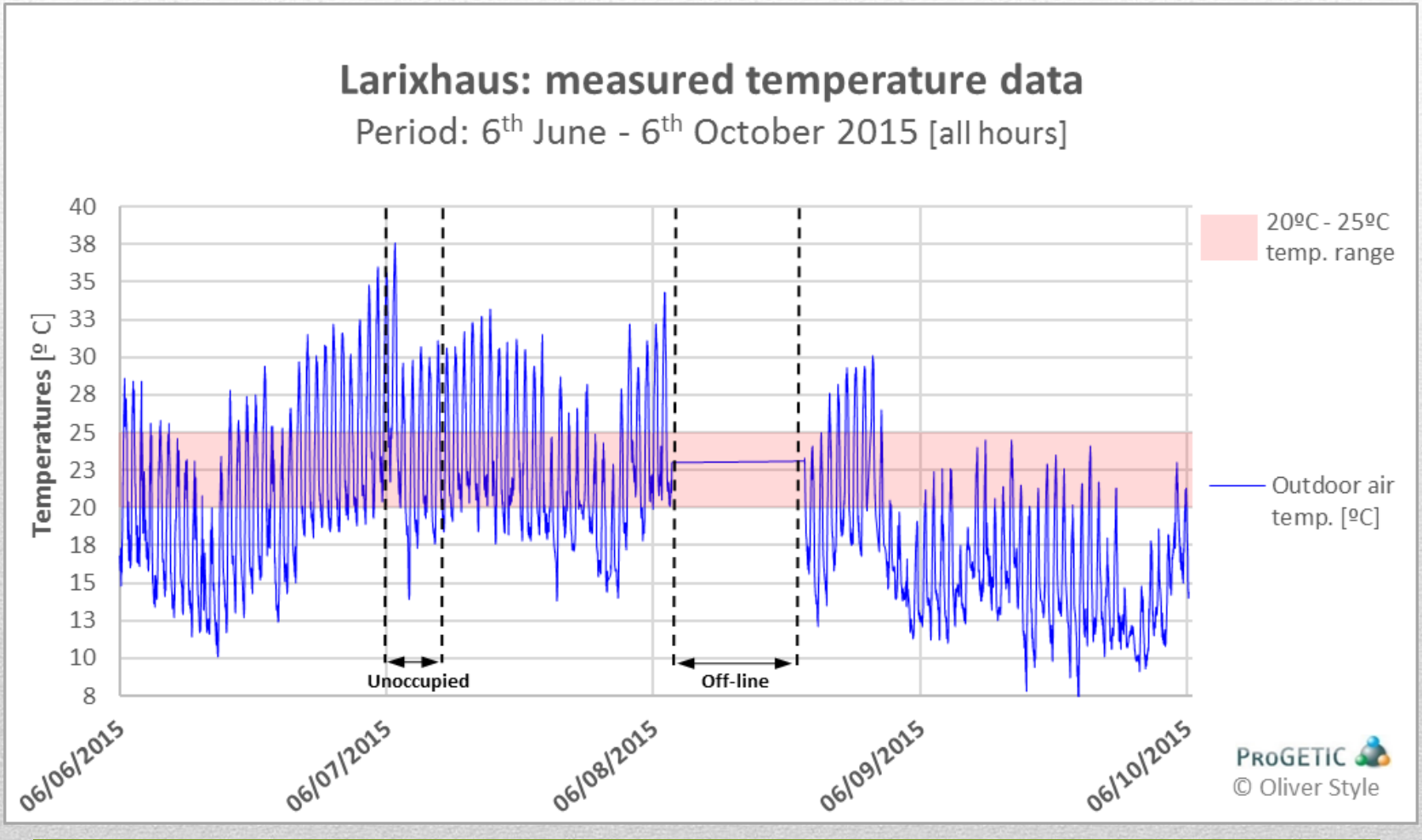
Summer



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

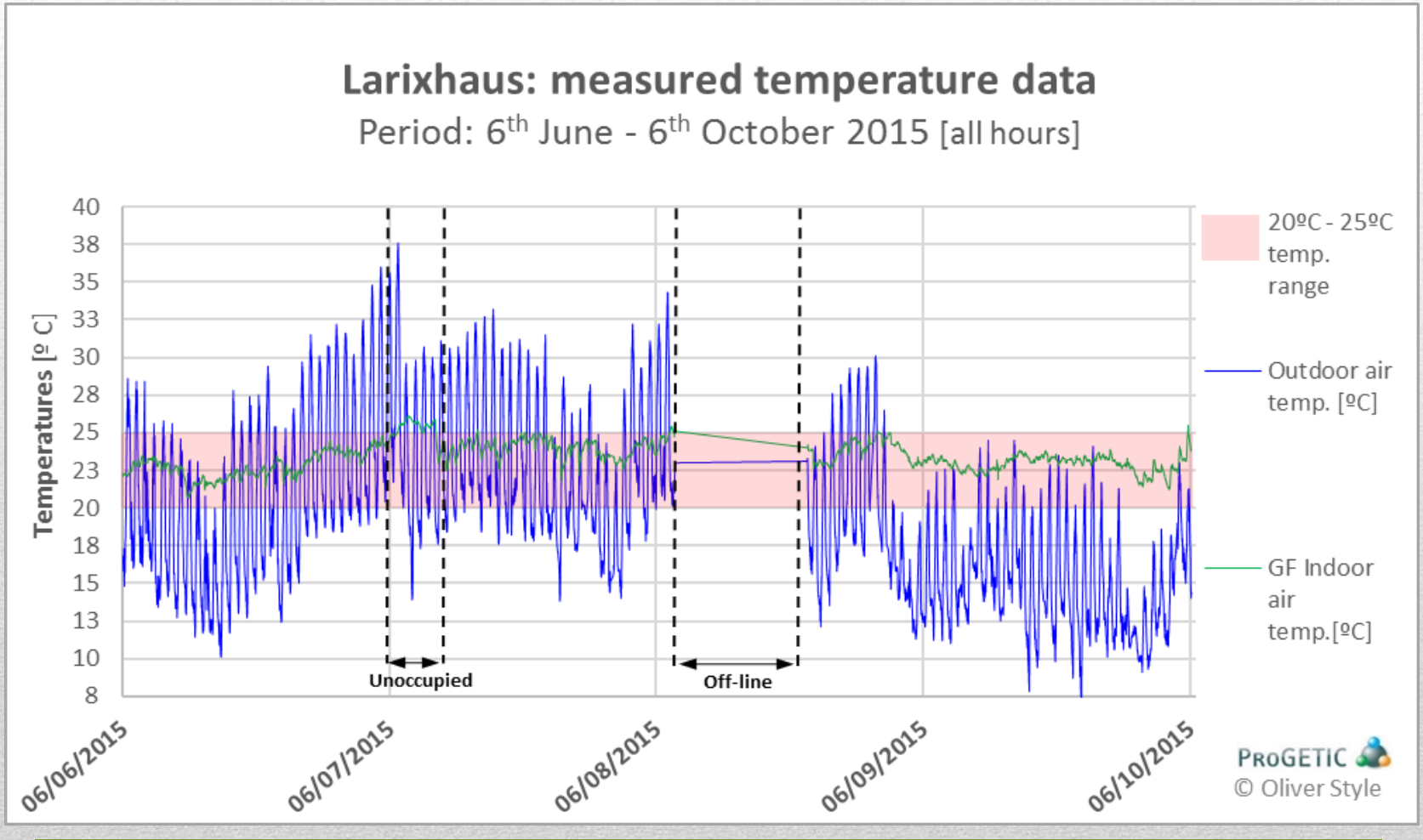
Summer



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

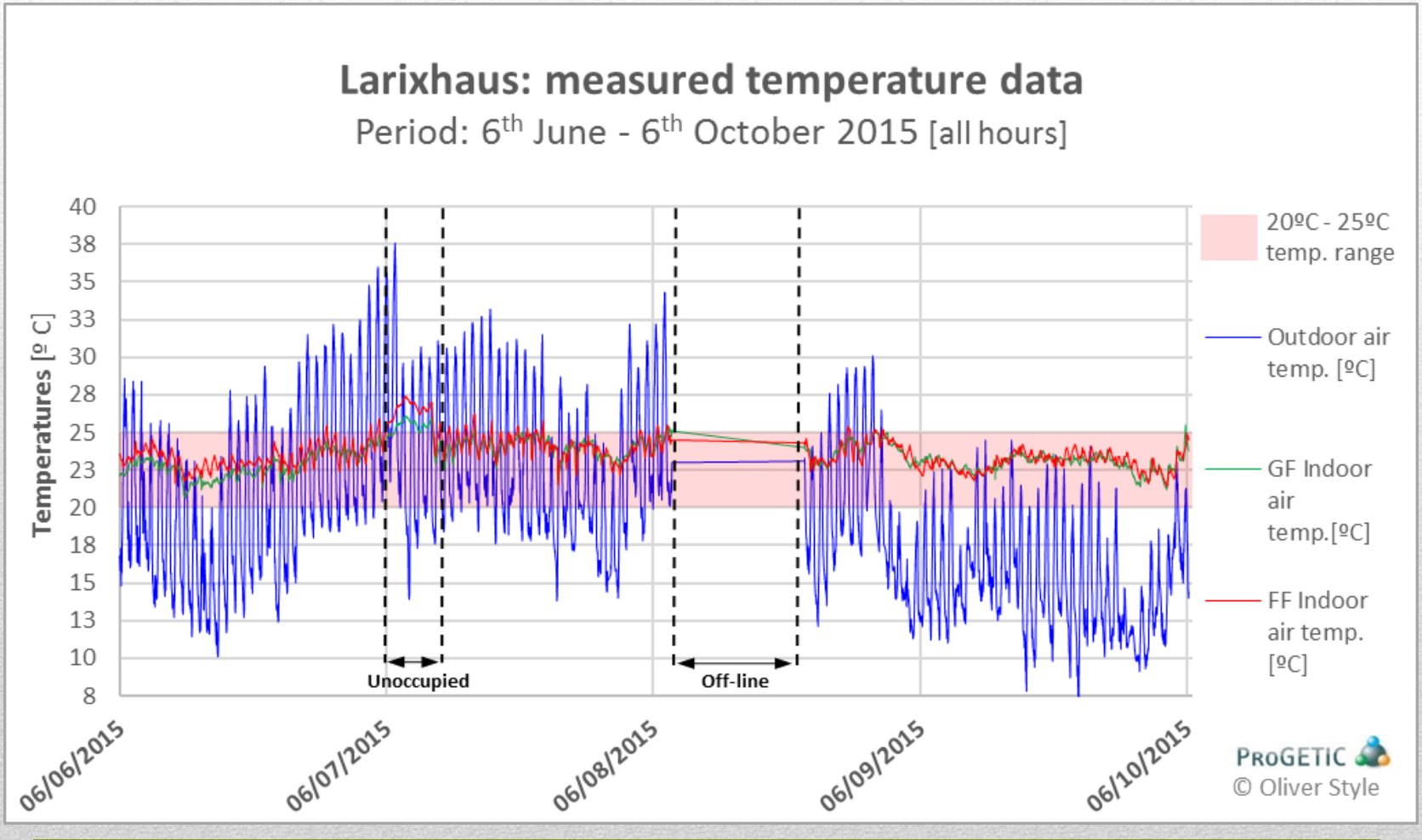
Summer



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

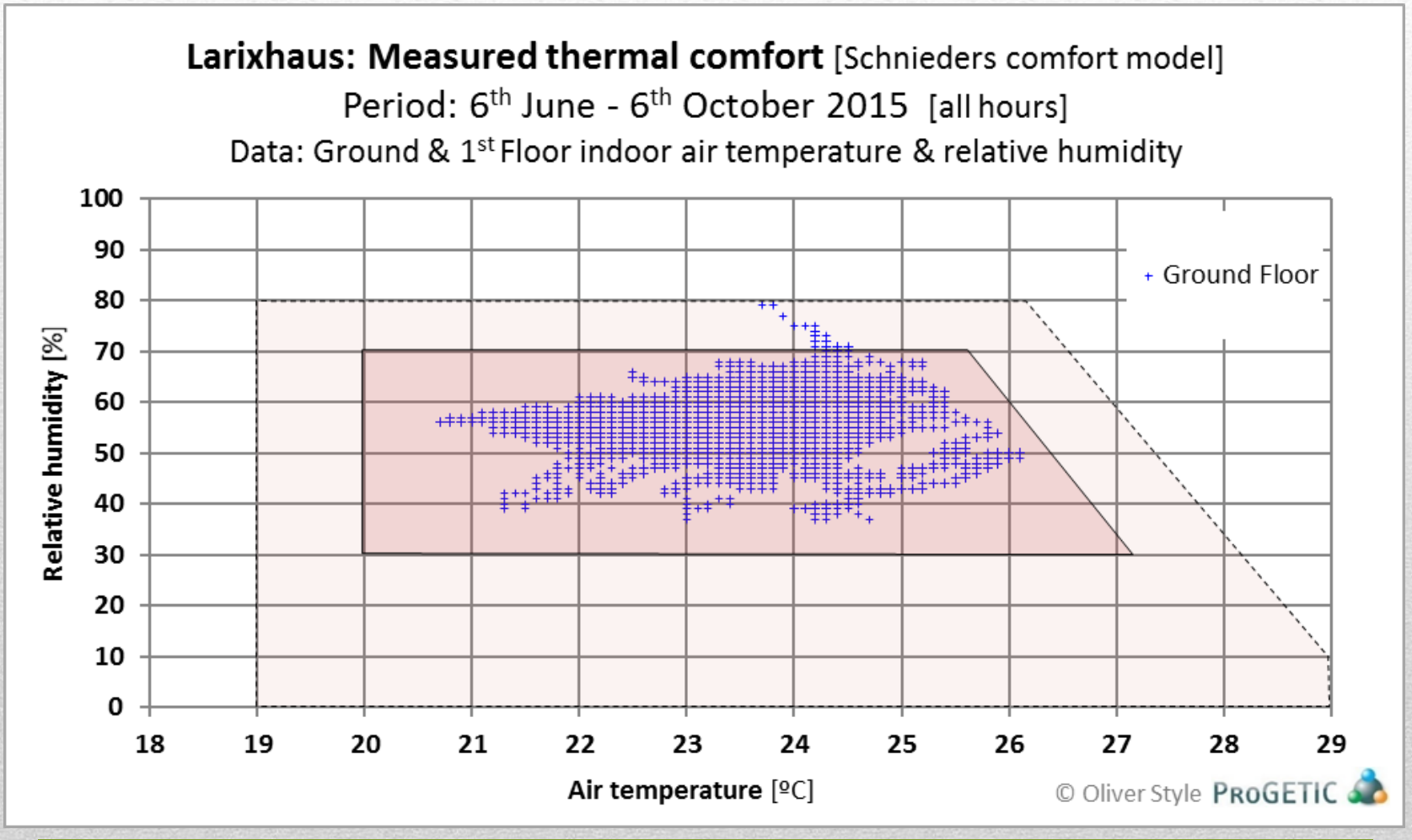
Summer



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

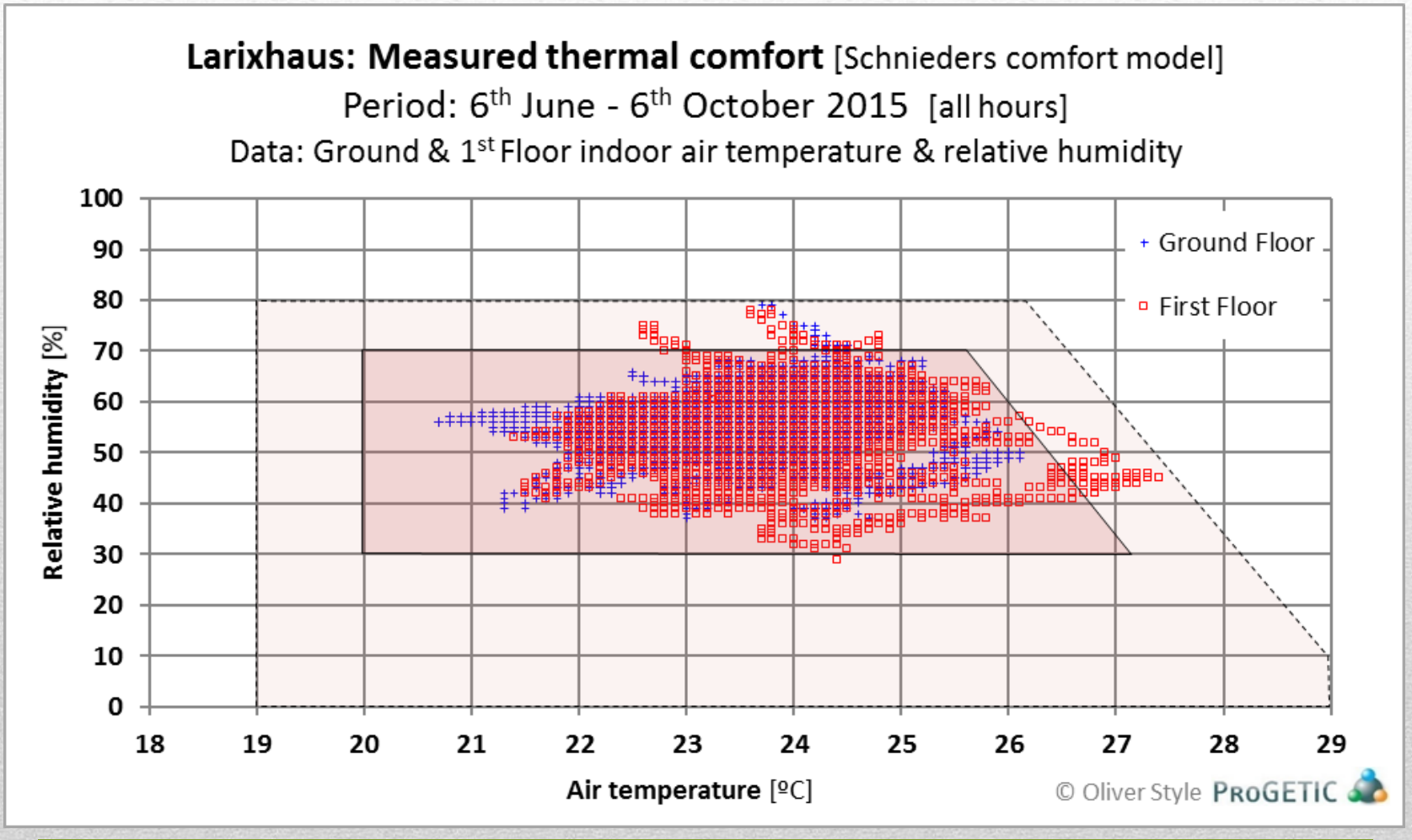
Summer



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

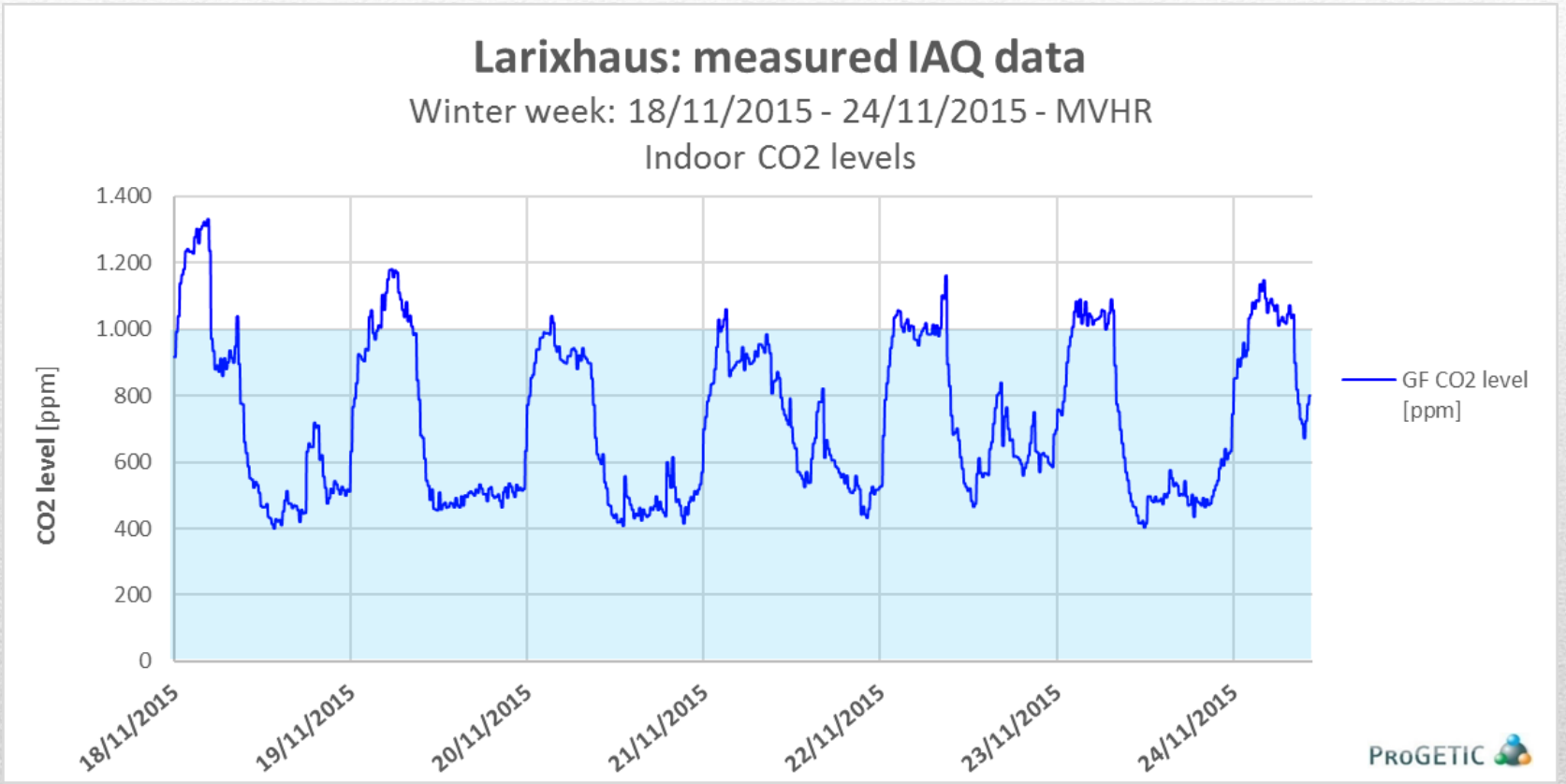
Summer



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

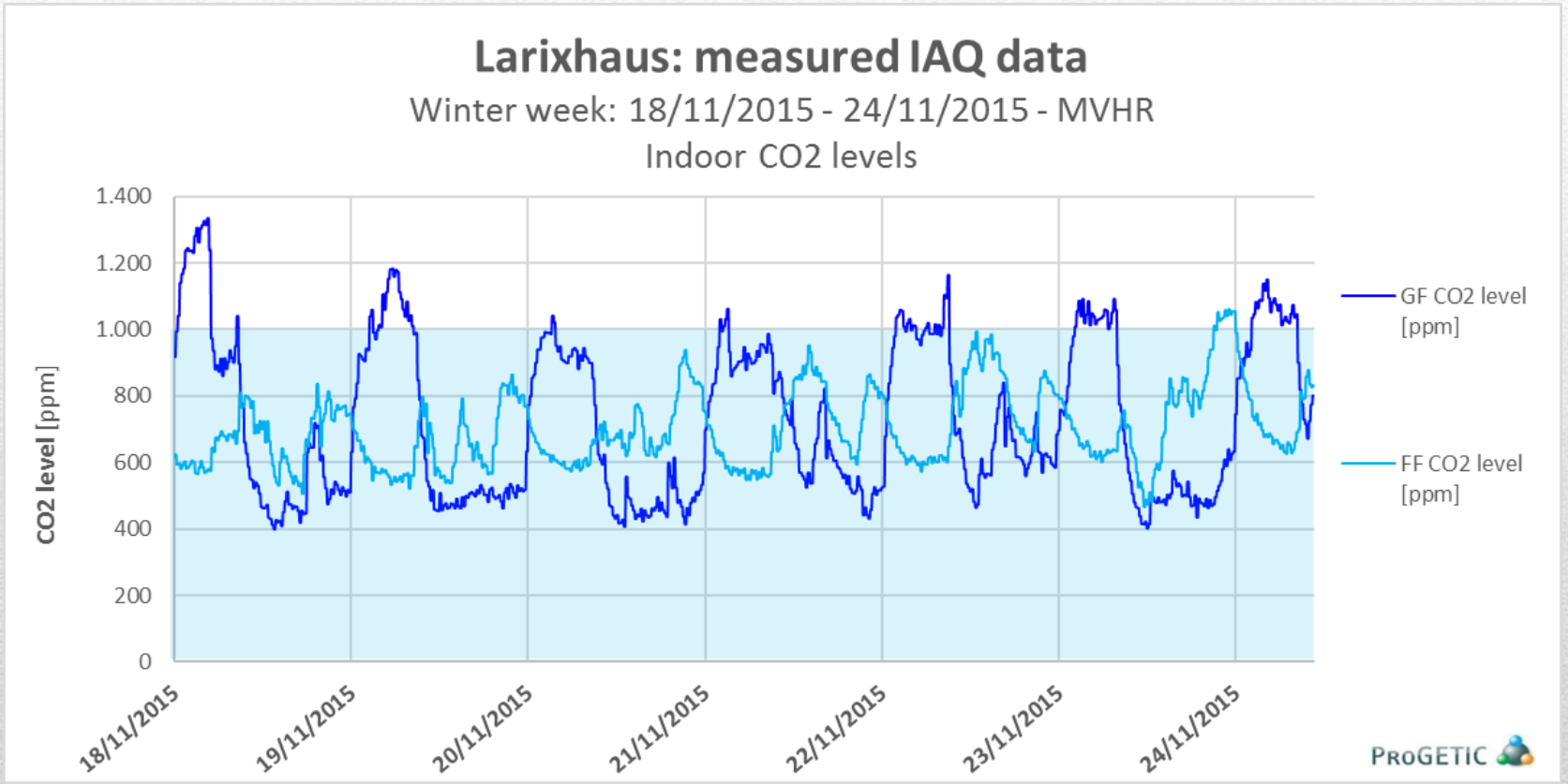
Indoor air quality



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use & performance

Indoor air quality



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

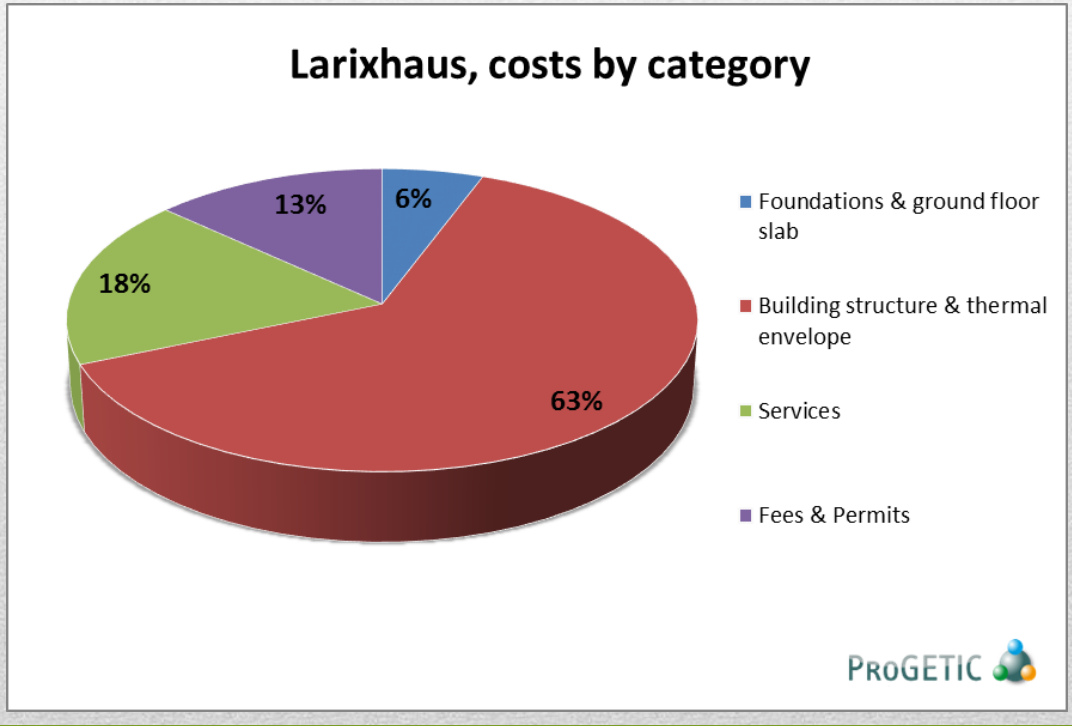
Larixhaus: capital cost

Category	Concept	Price [€ incl. VAT]
Foundations & ground floor slab	Groundworks	3.000,00 €
	Ground slab	7.165,00 €
Building structure & thermal envelope	Structure, windows, flooring, inner & outer finishes	106.365,00 €
	Service void, Fermacell and Pavaflex insulation	4.250,00 €
	Straw insulation	900,00 €
Services	Ventilation unit, ducts, components & installation	6.152,00 €
	Kitchen, bathroom and plumbing services	11.000,00 €
	Electrical services	8.500,00 €
	Heating & DHW services	6.450,00 €
TOTAL Specific Construction Cost		**153.782,00 €**
Treated Floor Area PHPP [TFA m^2]		91,50
Gross Floor Area [GFA m^2]		142,00
TOTAL Specific Construction Cost [€/m^2 TFA]		**1.680,68 €**
TOTAL Specific Construction Cost [€/m^2 GFA]		**1.082,97 €**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: capital cost

Category	Price [€ incl. VAT]
Foundations & ground floor slab	10.165,00 €
Building structure & thermal envelope	111.515,00 €
Services	32.102,00 €
Fees & Permits	23.454,00 €
TOTAL	**177.236,00 €**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: operational energy use

Measured vs. calculated PHPP & Spanish CTE Building regulations

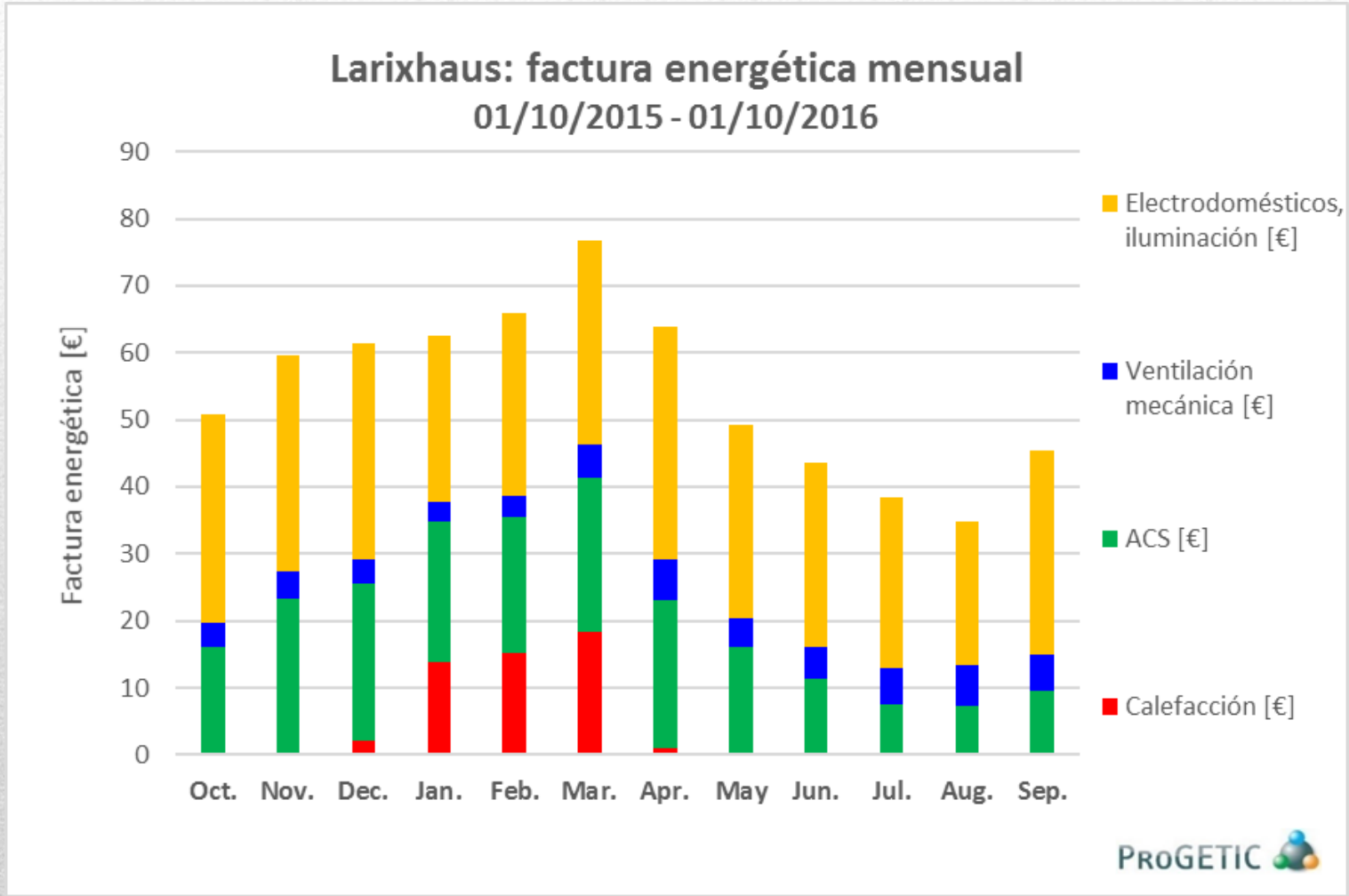
* Period: 01/09/2015 – 01/09/2016

	PHPP [kWh/m2·a]	Spanish CTE 2009 [kWh/m2·a]	Measured * [kWh/m2·a]
Equip., lighting, aux. elec.	13.4	39.2	18.2
DHW production	17.8	17.8	10.6
MVHR Unit	3.3	2.3	2.8
Space heating	12.0	152.0	3.2
Total energy consumption	**40.5**	**211.3**	**34.3**

Total anual heating bill: 73,75 €

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: running cost



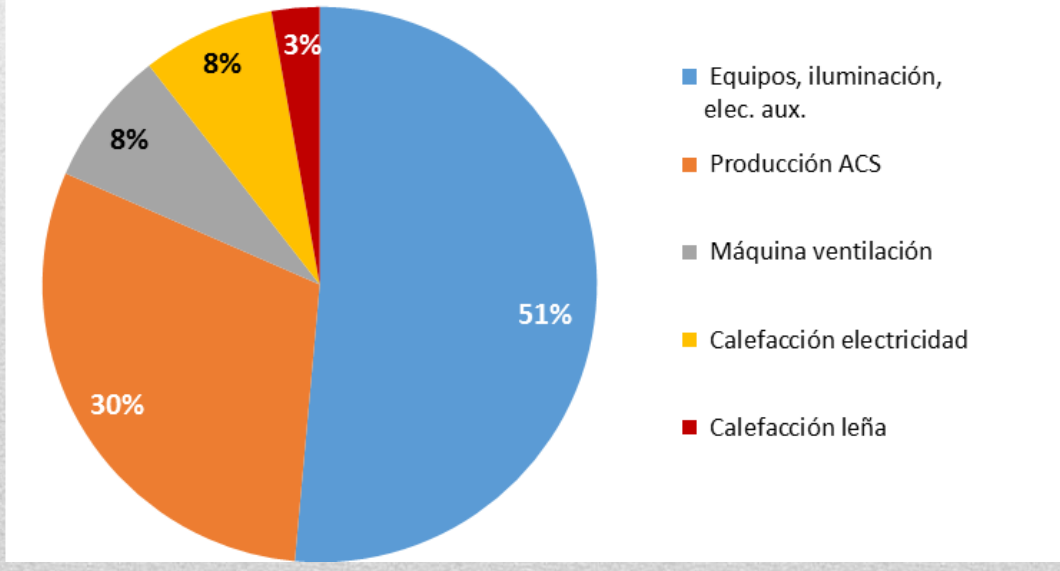
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Larixhaus: running cost

Concepto	kWh	Coste
Equipos, iluminación, elec. aux.	1.662	342 €
Producción ACS	974	200 €
Máquina ventilación	255	52 €
Calefacción electricidad	251	51 €
Calefacción leña	40	19 €
TOTAL	3.182	**666 €**

Total anual heating bill:

73,75 €



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

ISOBIO objectives

- **50 % lower embodied energy & carbon**
- **20 % increase in thermal insulation**
- **15 % reduction in cost**

…vs. oil-based & traditional alternatives

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

Conclusions

- Bio-based materials work
- They are safe and cost effective
- They can be procured for nearly-zero energy buildings, in compliance with EPBD Directive 2010/31/EU
- The ISOBIO consortium is working to improve their performance and reduce their cost, removing barriers for large-scale uptake

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.

THANK YOU

Oliver Style

Progetic

ostyle@progetic.com

C/Ramon Turró 100-104. 3-3

08005 Barcelona. Spain

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N°636835.