

INTEGRATED SYSTEM FOR ENERGY OPTIMIZATION AND REDUCTION OF BUILDING CO2 FOOTPRINT: BIM. INDOOR MAPPING, UAV TECHNOLOGIES AND ADVANCED ENERGY SIMULATIONS TOOLS

ENE2013-48015-C3-2R

“DISEÑO INTEGRADO

como base para la optimización energética y reducción de la huella de CO²”

FLAVIO CELIS D'AMICO, DR ARQUITECTO
UNIVERSIDAD DE ALCALA DE HENARES, ESPAÑA



Organisers:



International Co-owners:



Sustainable Buildings and Climate Initiative
Promoting Policies and Practices for Sustainability





Organisers:



International Co-owners:





International Co-owners:





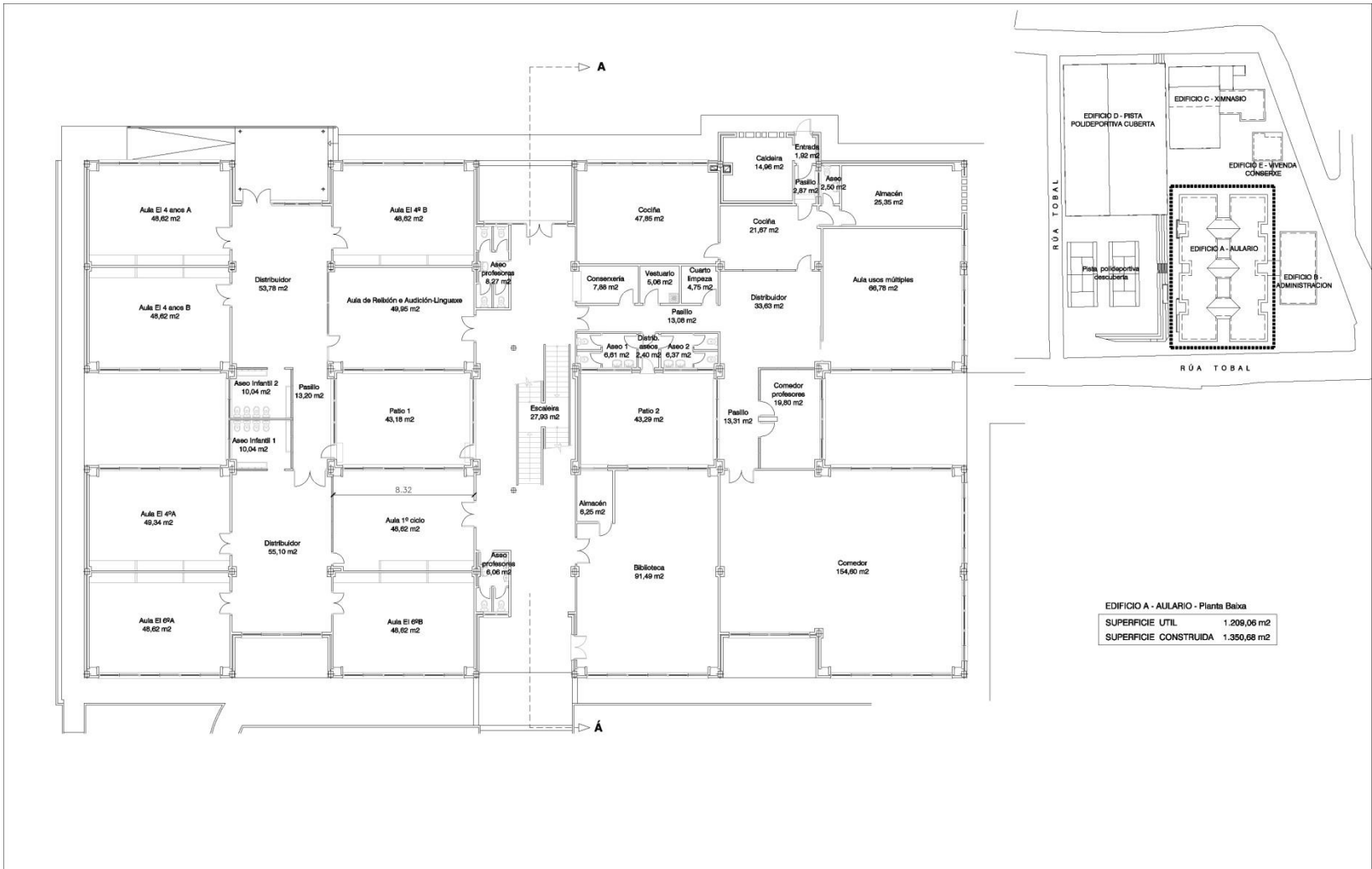
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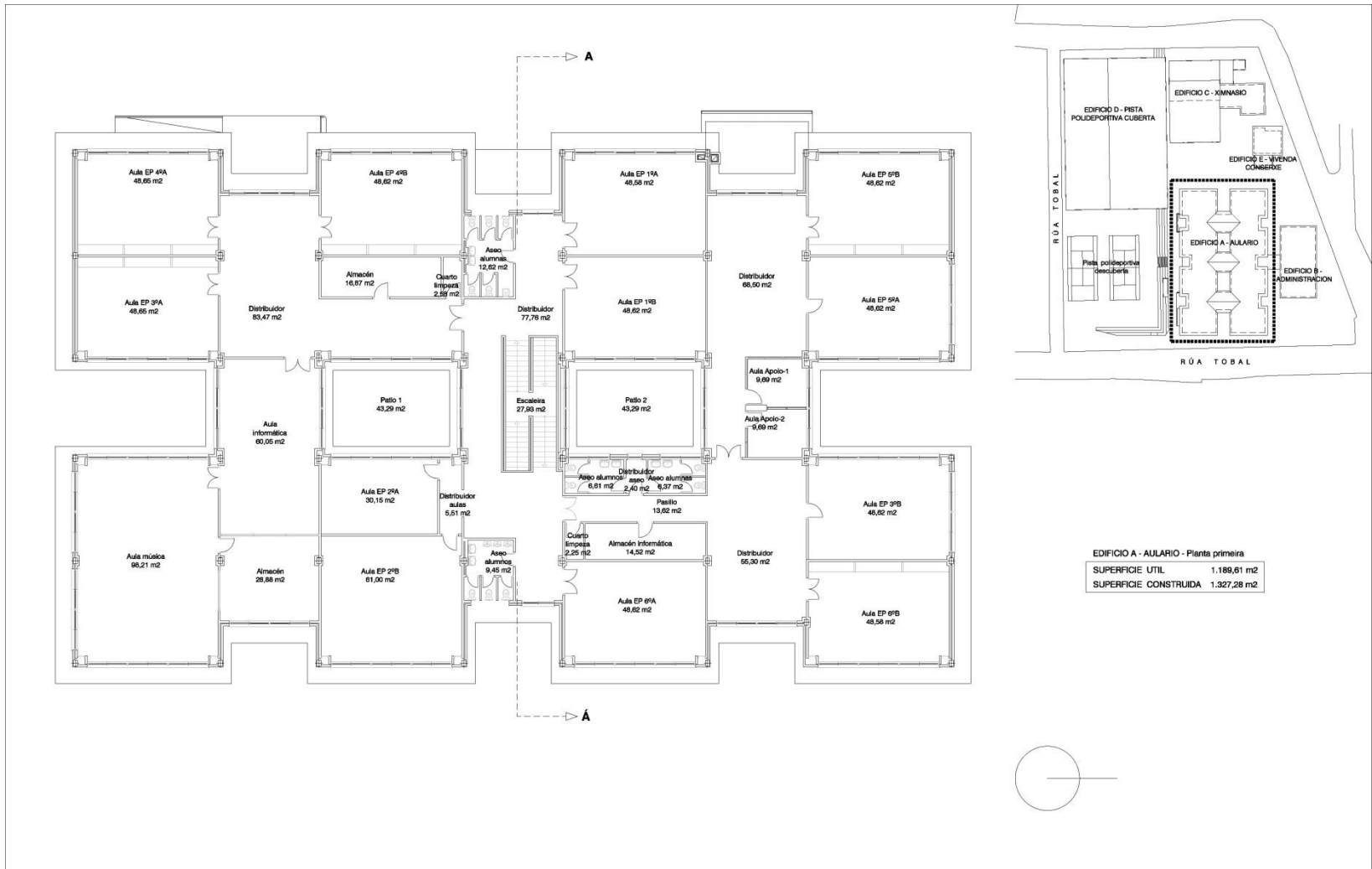


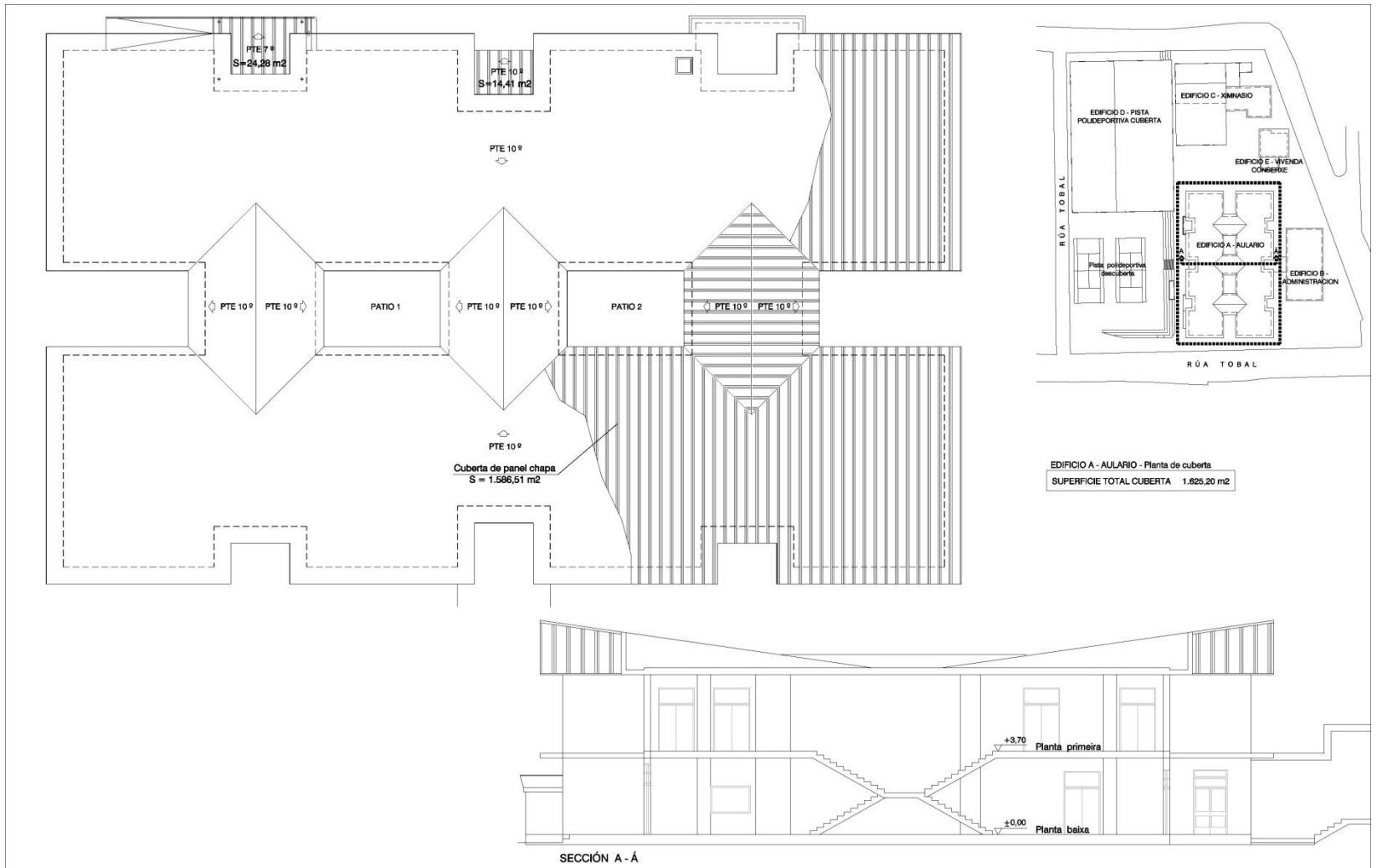
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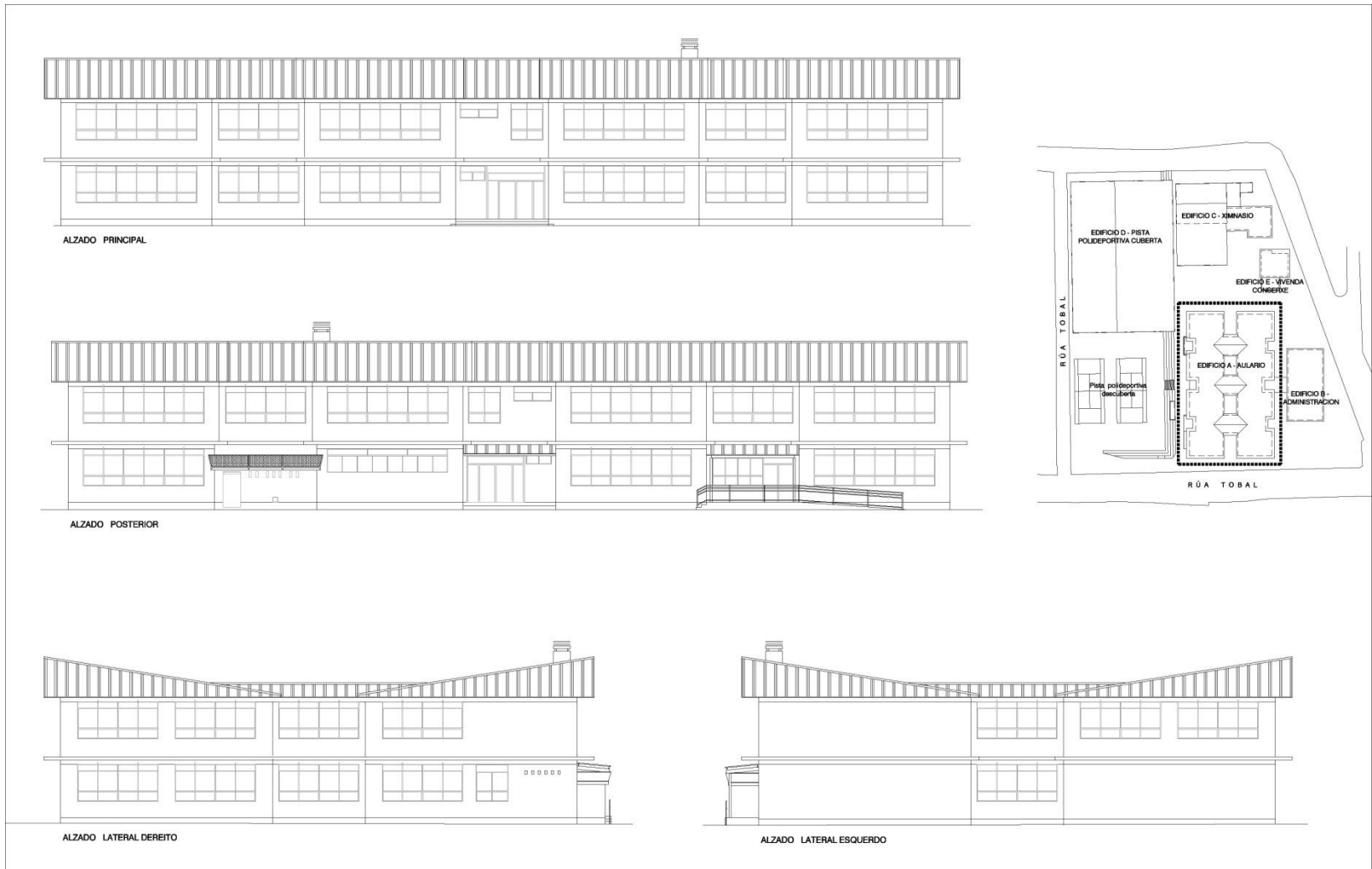












Centros escolares en Galicia
 29 vistas

Todos los cambios se han guardado en Drive.

Añadir capa + Compartir
 Obtener una vista previa

- CEIP de Oímbra
- CEIP Eduardo Ávila Bustillo
- CEIP de Carballedo
- CEIP de Tenorio
- CEIP Mestre Manuel García
- CEIP de Chancelas
- CEIP de Viñas
- CEIP de Cerdeiriñas
- CEIP Nosa Señora da Piedade**
- CEIP de San Marcos
- CPI Antonio Failde
- CEIP de Seixalbo
- CPI Tomás Lemos
- CEIP Rosalía de Castro
- CEIP Carlos Casares
- CEIP San Roque-Darbo
- CEIP de Hío
- CEIP Pérez Viondi
- CEIP Valle Inclán
- CPI de Monteiro

Search bar with magnifying glass icon

Navigation icons: back, forward, hand, location pin, share, print, street view

CEIP Nosa Señora da Piedade



1 de 1

LATITUD 42.79216
 LONGITUD -8.166799

42.79216, -8.16679

Map interaction icons: edit, camera, print, share, delete

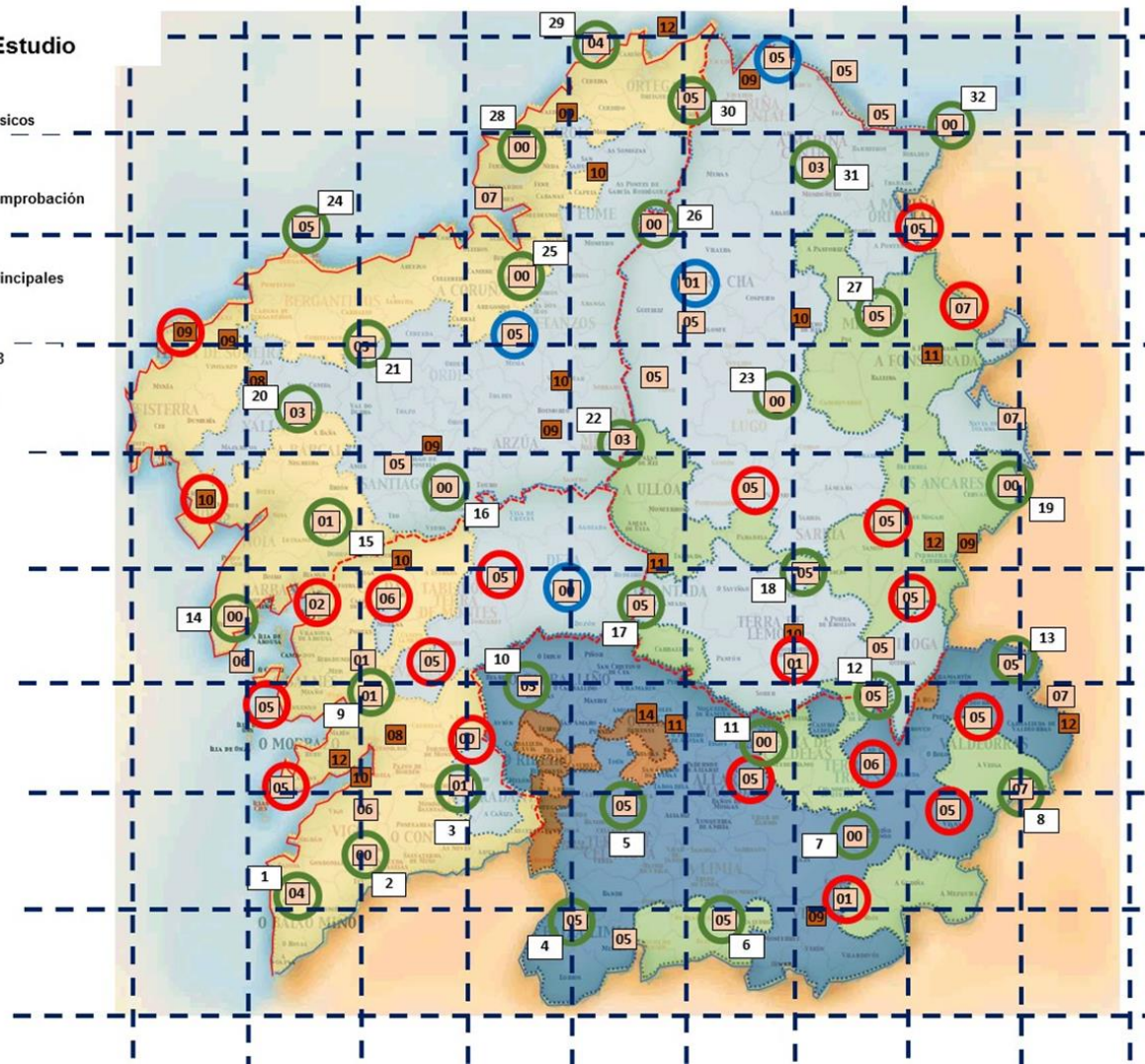


OBSERVATORIOS METEOROLÓGICOS

(www.meteogalicia.es)

Selección observatorios Estudio

- Observatorios seleccionados básicos
- Observatorios seleccionados comprobación
- Observatorios seleccionados principales
- 08 Observatorios posteriores a 2008
- 00 Observatorios anteriores a 2008
- 1 N° clave Observatorio estudio



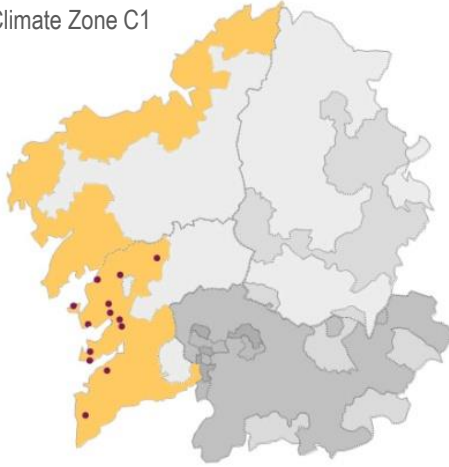
Organisers:



International Co-owners:



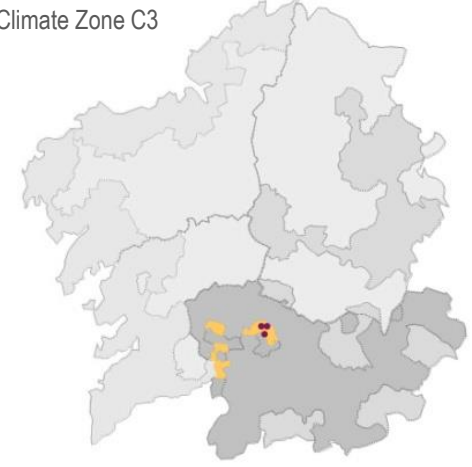
Climate Zone C1



Climate Zone C2



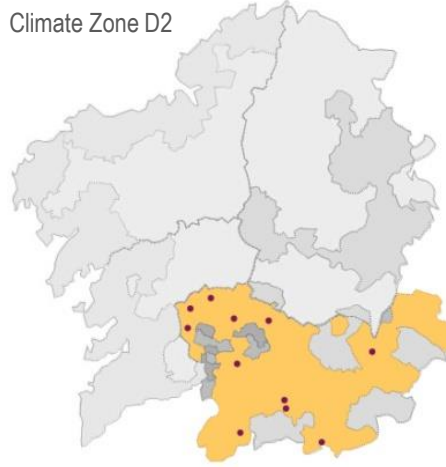
Climate Zone C3



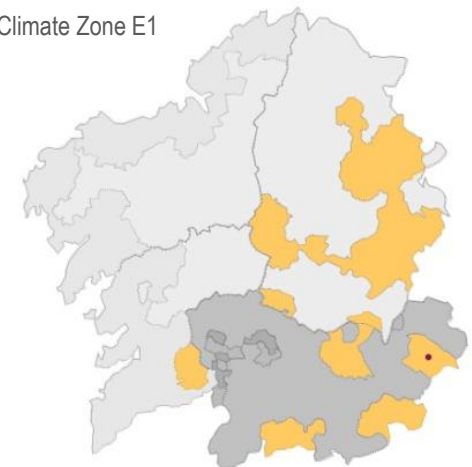
Climate Zone D1

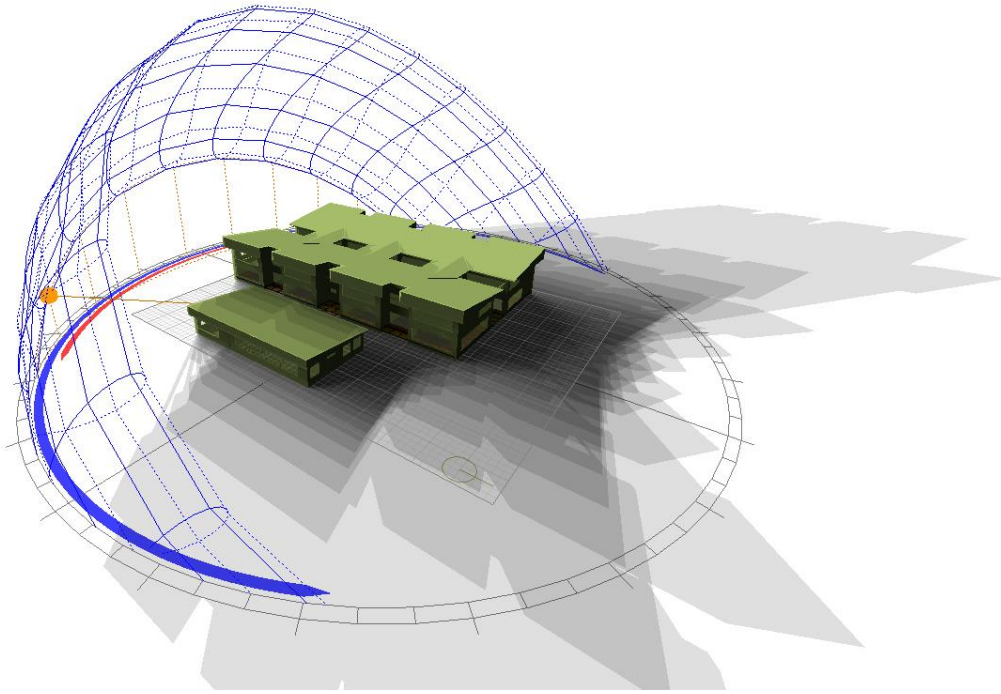


Climate Zone D2

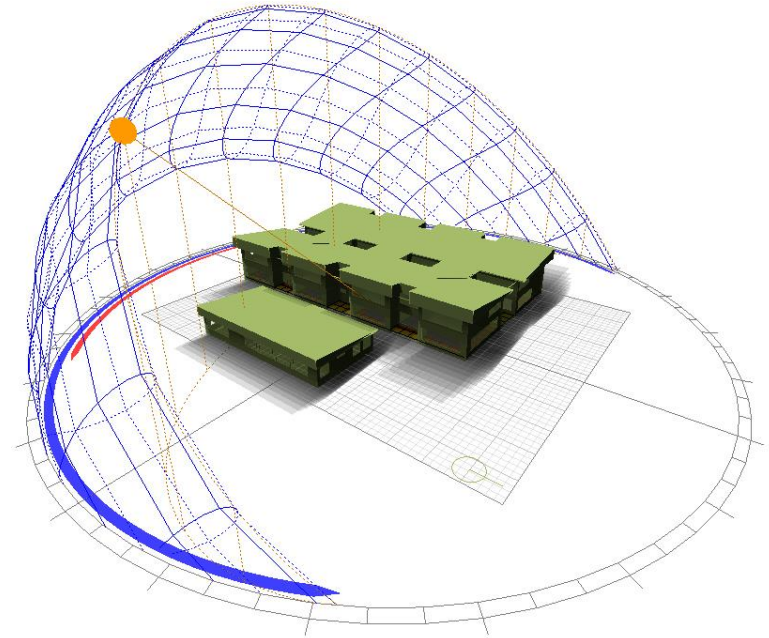


Climate Zone E1





Winter



Summer



Organisers:

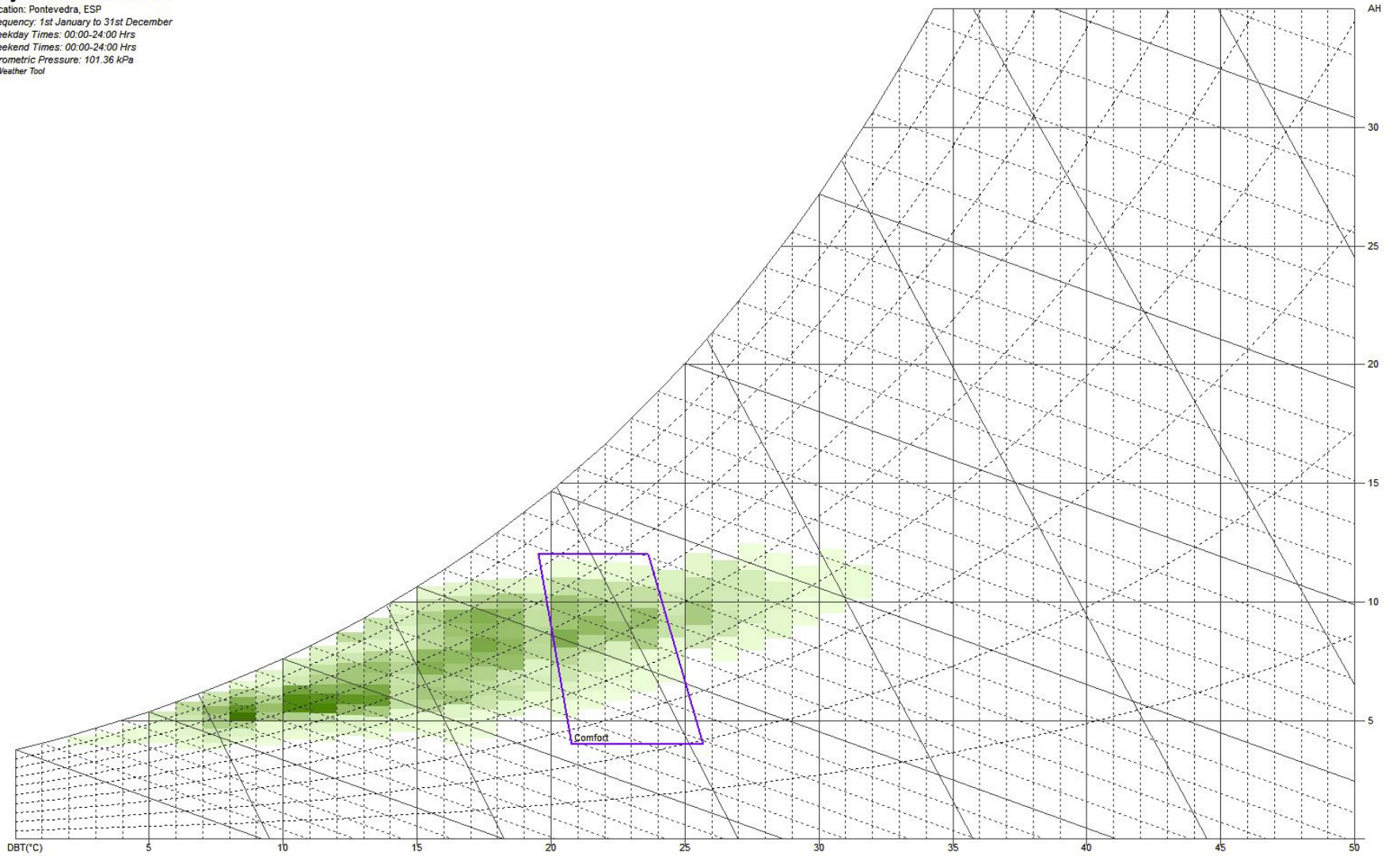


International Co-owners:



Psychrometric Chart

Location: Pontevedra, ESP
Frequency: 1st January to 31st December
Weekday Times: 00:00-24:00 Hrs
Weekend Times: 00:00-24:00 Hrs
Barometric Pressure: 101.36 kPa
© Weather Tool

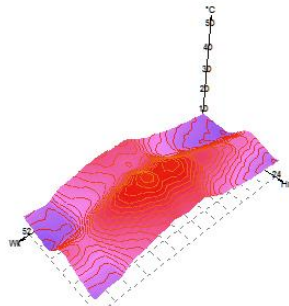


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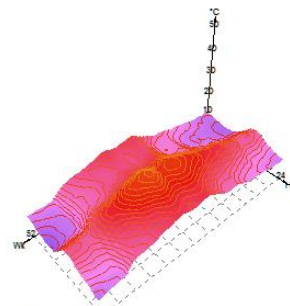


International Co-owners:

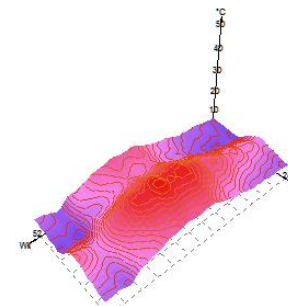




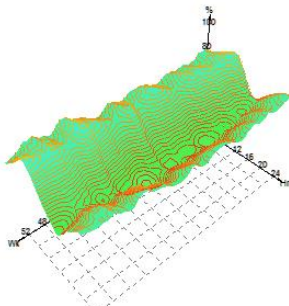
Average Temperature (°C)



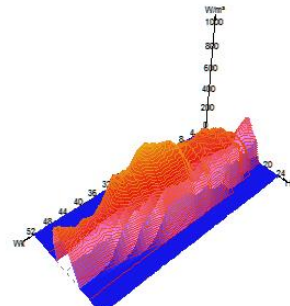
Maximum Temperature (°C)



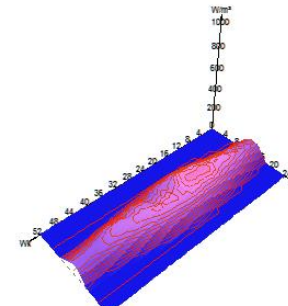
Minimum Temperature (°C)



Relative Humidity (%)



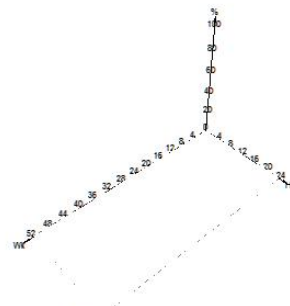
Direct Solar Radiation (W/m²)



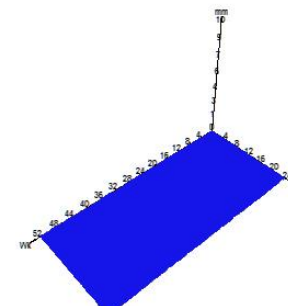
Diffuse Solar Radiation (W/m²)



Average Wind Speed (km/h)



Average Cloud Cover (%)



Average Daily Rainfall (mm)



Organisers:



International Co-owners:



RESULTADOS DATOS

OBSERV N°

1

Castro Vicaludo (Po)

Oia

AÑOS CONSULTADOS

12

	Tª MAX	Tª medMAX	Tª MIN	Tª medMIN	HR MAX	HR MIN
ENERO	14,84	10,50	0,86	6,11	95,75	73,75
FEBRERO	15,22	10,68	0,61	5,54	92,58	66,42
MARZO	19,15	12,71	1,61	7,12	89,67	62,50
ABRIL	22,75	14,74	4,37	8,75	91,45	64,18
MAYO	25,22	16,44	6,17	10,36	92,50	65,25
JUNIO	29,37	19,83	9,28	13,32	91,42	62,00
JULIO	30,25	21,14	11,02	14,60	92,67	63,00
AGOSTO	29,95	21,91	11,48	15,02	91,50	60,33
SEPTIEMBRE	28,94	21,35	10,02	14,68	89,42	59,25
OCTUBRE	24,09	17,73	7,81	12,40	91,50	67,17
NOVIEMBRE	19,17	13,31	3,38	8,48	94,58	71,58
DICIEMBRE	16,36	11,28	1,95	6,70	93,08	69,42

ESTRATEGIAS DE CLIMATIZACIÓN

Blanco	Estrategias de Refrigeración
Azul	Zona de confort
Amarillo	Ganacias Internas
Verde	Calefacción Solar Pasiva
Marrón	Calefacción Solar Activa
Rojo	Calefacción Convencional

Lonxitude: 511201 UTMX-29T ED-50

Latitude: 4649389 UTMX-29T ED-50

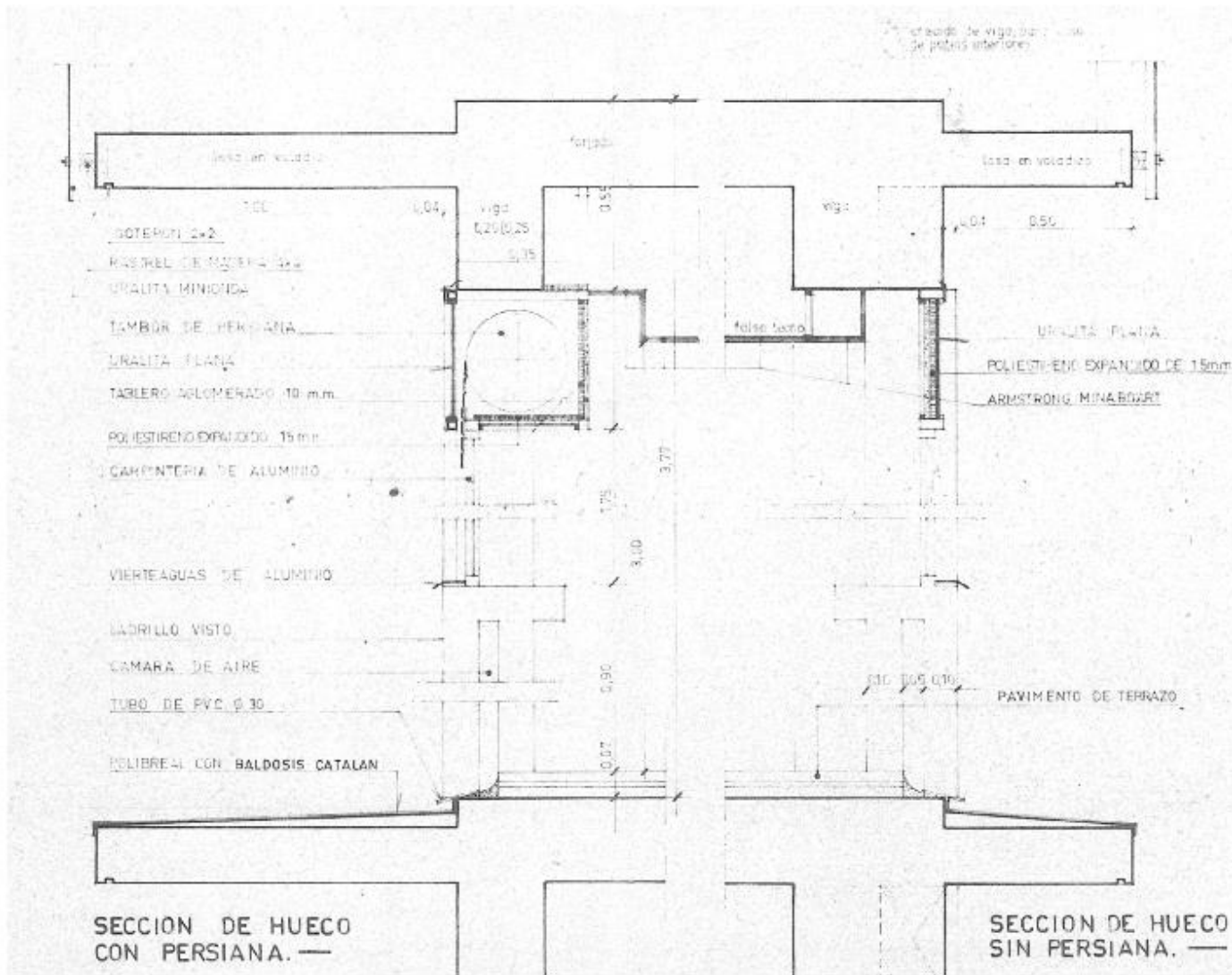


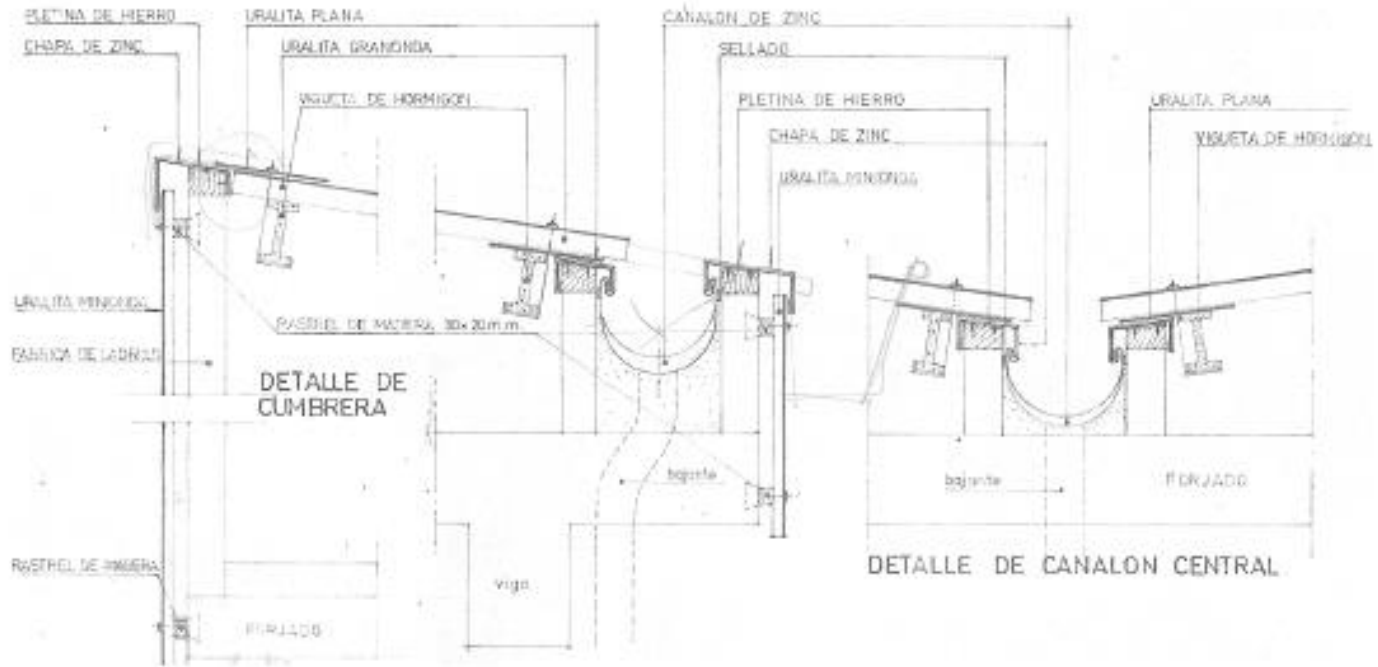
Organisers:



International Co-owners:





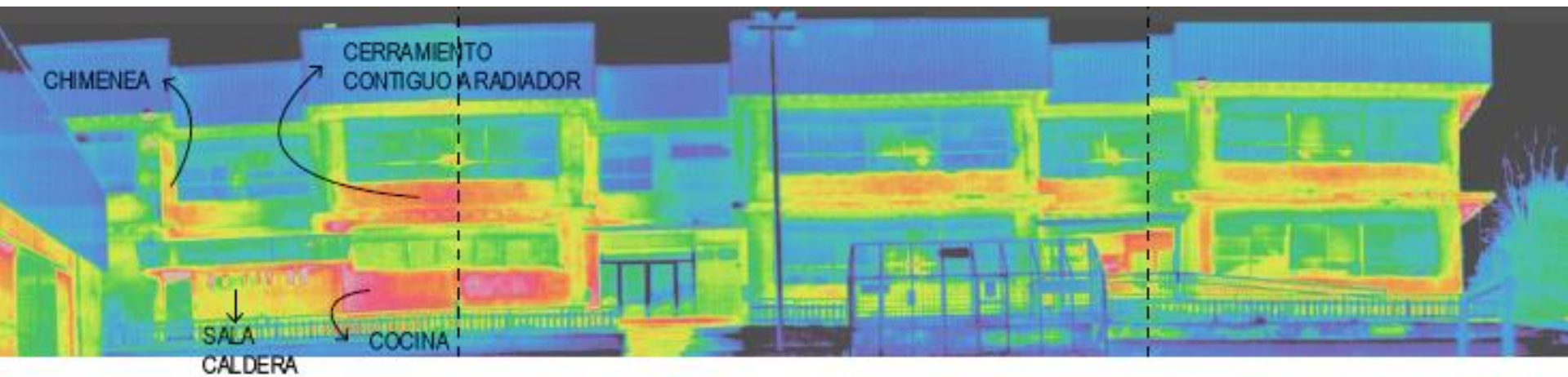


Organisers:



International Co-owners:



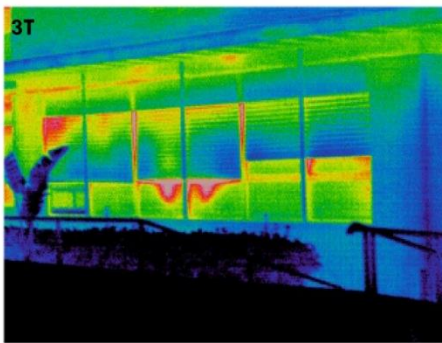
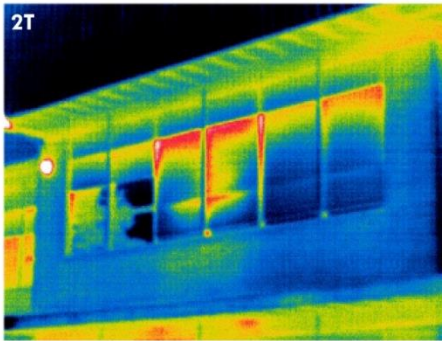
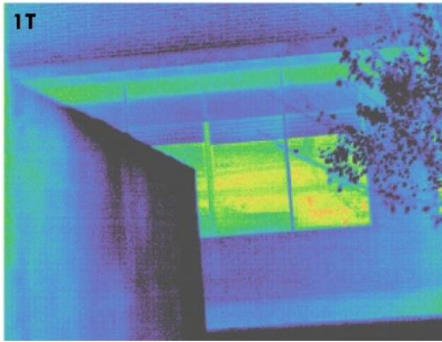


Organisers:



International Co-owners:





International Co-owners:

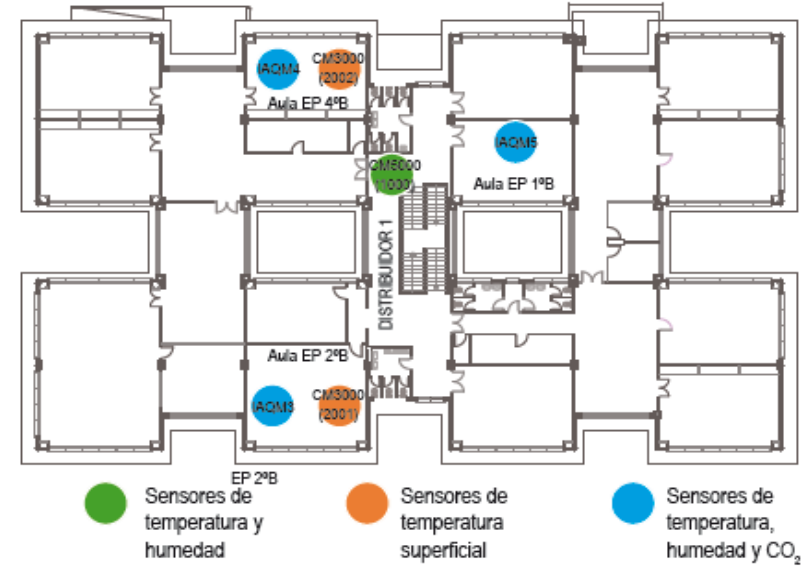


Colocación sensores inalámbricos aulaario

Planta baja



Planta primera



Coeficiente de transmitancia global del centro.

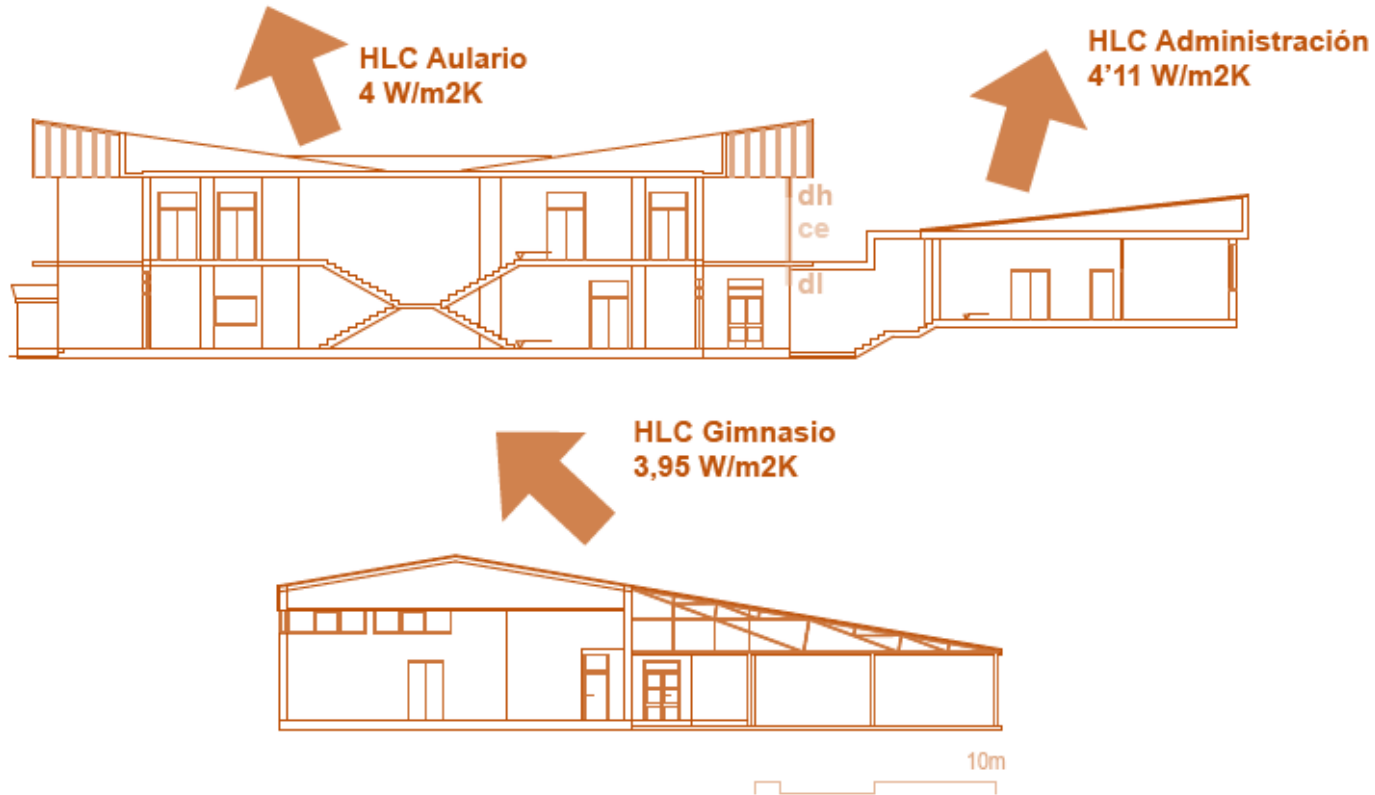
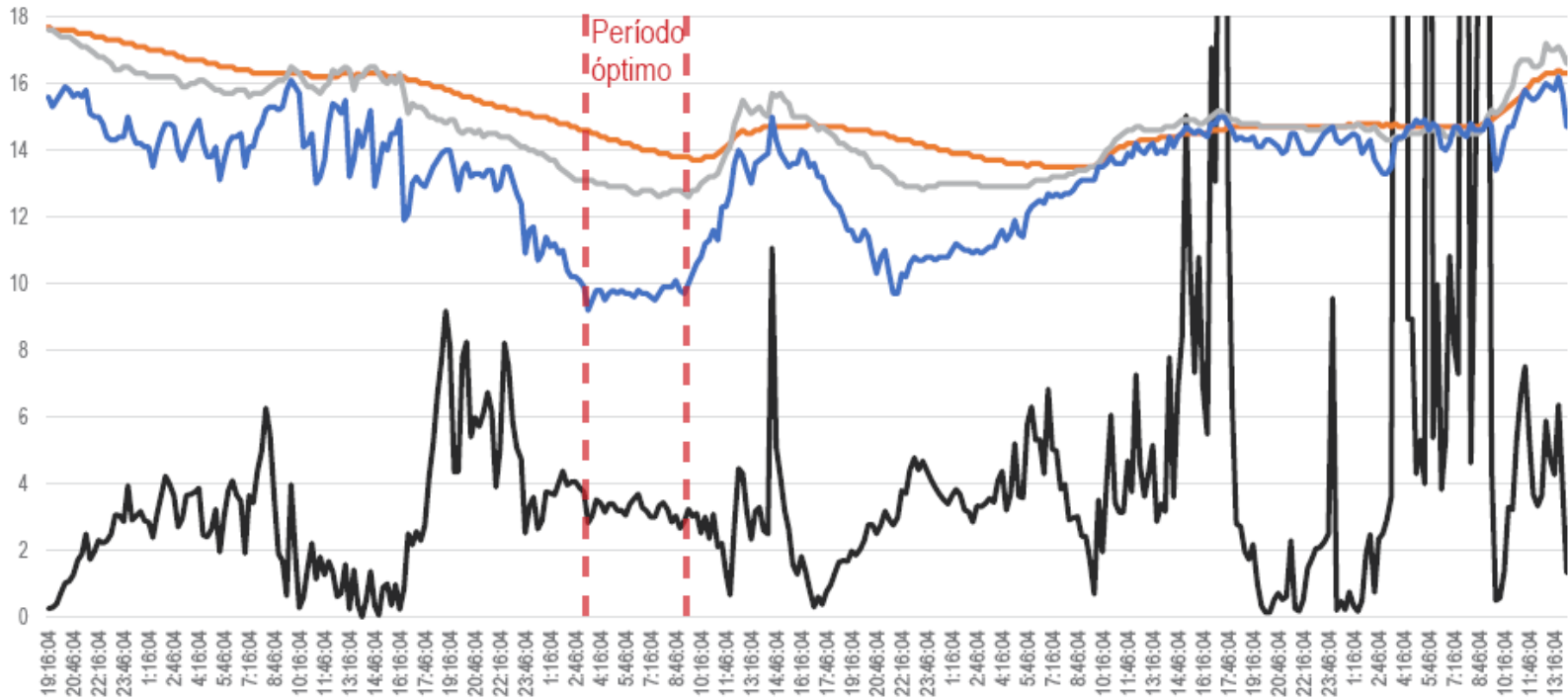


Figura 3.2

Valor de transmitancia térmica de la fachada del aula



- Transmitancia térmica en W/m²K
- Temperatura interior en °C
- Temperatura exterior en °C
- Temperatura superficial interior en °C



Organisers:



International Co-owners:



Tabla 3.1 Transmisiones de la envolvente térmica (W/m2K)

Cubierta	Cerramientos	Huecos	Forjado	
Ucu= 6.73	Uce= 2.86	Uvo= 5,96	Us= 1,37	dh= dintel de hormigón dl= dintel de ladrillo* vo= ventana original vn= ventana nueva cp= caja de persiana
	Udh= 3,70	Uvn= 1,38		
	Udl= 3,03	Ucp= 4,45		

Tabla 2.3 Transmisión térmica máxima y permeabilidad al aire de los elementos de la envolvente térmica

Parámetro	Zona climática de invierno					
	a	A	B	C	D	E
Transmisión térmica de muros y elementos en contacto con el terreno ⁽¹⁾ [W/m ² -K]	1,35	1,25	1,00	0,75	0,60	0,55
Transmisión térmica de cubiertas y suelos en contacto con el aire [W/m ² -K]	1,20	0,80	0,65	0,50	0,40	0,35
Transmisión térmica de huecos ⁽²⁾ [W/m ² -K]	5,70	5,70	4,20	3,10	2,70	2,50
Permeabilidad al aire de huecos ⁽³⁾ [m ³ /h·m ²]	≤ 50	≤ 50	≤ 50	≤ 27	≤ 27	≤ 27

⁽¹⁾ Para elementos en contacto con el terreno, el valor indicado se exige únicamente al primer metro de muro enterrado, o el primer metro del perímetro de suelo apoyado sobre el terreno hasta una profundidad de 0,50m.

⁽²⁾ Se considera el comportamiento conjunto de vidrio y marco. Incluye lucernarios y claraboyas.

⁽³⁾ La permeabilidad de las carpinterías indicada es la medida con una sobrepresión de 100Pa.

Figura 3.1 Limitación de la demanda energética según el Documento Básico de Ahorro de Energía DB- HE del CTE

	Verificación Límite de la demanda				Verificación Límite de consumo					Certificación Energética de Edificios.		
	Demanda del edificio objeto	Demanda límite	Demanda del edificio de referencia	Demanda	Consumo EP no renovable edificio Objeto	Consumo EP no renovable edificio Referencia	Porcentaje respecto al edificio de referencia	Calificación EP	Consumo EP no renovable	Indicador kgCO2/m2 año	Letra	Etiqueta energética
	kWh/m2.año	kWh/m2.año	kWh/m2.año	kwh/m2 año	kWh/m2.año	kWh/m2.año	% maximo 65		kwh/m2 año			
Original	62,62	32,97	43,96		77,59	36,05	215,21	G		17,00	G	
Cambio 001	52,37	32,97	43,96		68,83	36,05	190,90	F		14,70	G	
Cambio 002	60,44	32,97	43,96		76,40	36,05	211,89	G		16,70	G	
Cambio 003	42,54	33,04	44,05		60,41	36,05	167,54	F		12,60	G	
Cambio 004	30,34	33,04	44,05		45,88	36,05	127,25	D		8,90	F	

RESUMEN H.U.L.C



Organisers:



International Co-owners:



4. ANALYSIS OF CURRENT STATUS AND PROPOSED IMPROVEMENTS

As already mentioned in this article has focused attention on the comparison of results between different simulation tools. To analyze the current status and proposed improvements of the building will be used several computer simulations tools:

- HULC: (Herramienta Unificada LIDER CALENER -Unified Tool LIDER-CALENER). It is the official tool provided by the CTE in Spain for energy assessment of buildings. Last version 26/07/2016. (view of results on fig, 5);
- ECOTECT: One of the best simulation tools. It is currently unavailable because it is no longer provided by AUTODESK. (fig. 3, 4);
- REVIT: It's the BIM of AUTODESK suite, and allows to obtain direct 3D image from the robotic entries and is associated with ENERGY PLUS engine analysis;
- CASANOVA: It is a free software. Very accessible and intuitive, It has operative limitations and data input;
- SEFAIRA: It is a plugging for SKETCHUP. It has now been bought by the owner of SKETCHUP, ISCAR. Easy to shape but very simple.

Not all the computer simulations tools allows to use the same starting parameters. In some cases (REVIT, CASANOVA and SEFAIRA), there are not taken into consideration the hours of daily or monthly activity. In other cases, is not possible to use the real thermal data of the enclosures (it is only possible with ECOTECT) because they are much lower than the software admitted.

There are established three starting points:

- Case 0: No timetables or schedules of use are applied. External walls data correspond to the CTE. It can be applied to all analysis tools used in this research;
- Case A: Applying schedules and calendars. Using actual data of transmittance obtained "in situ" with measurement devices. It is only applicable with ECOTECT;
- Case B: Same as Case A, but introducing building materials data from the CTE database. It is applicable with HULC and ECOTECT.

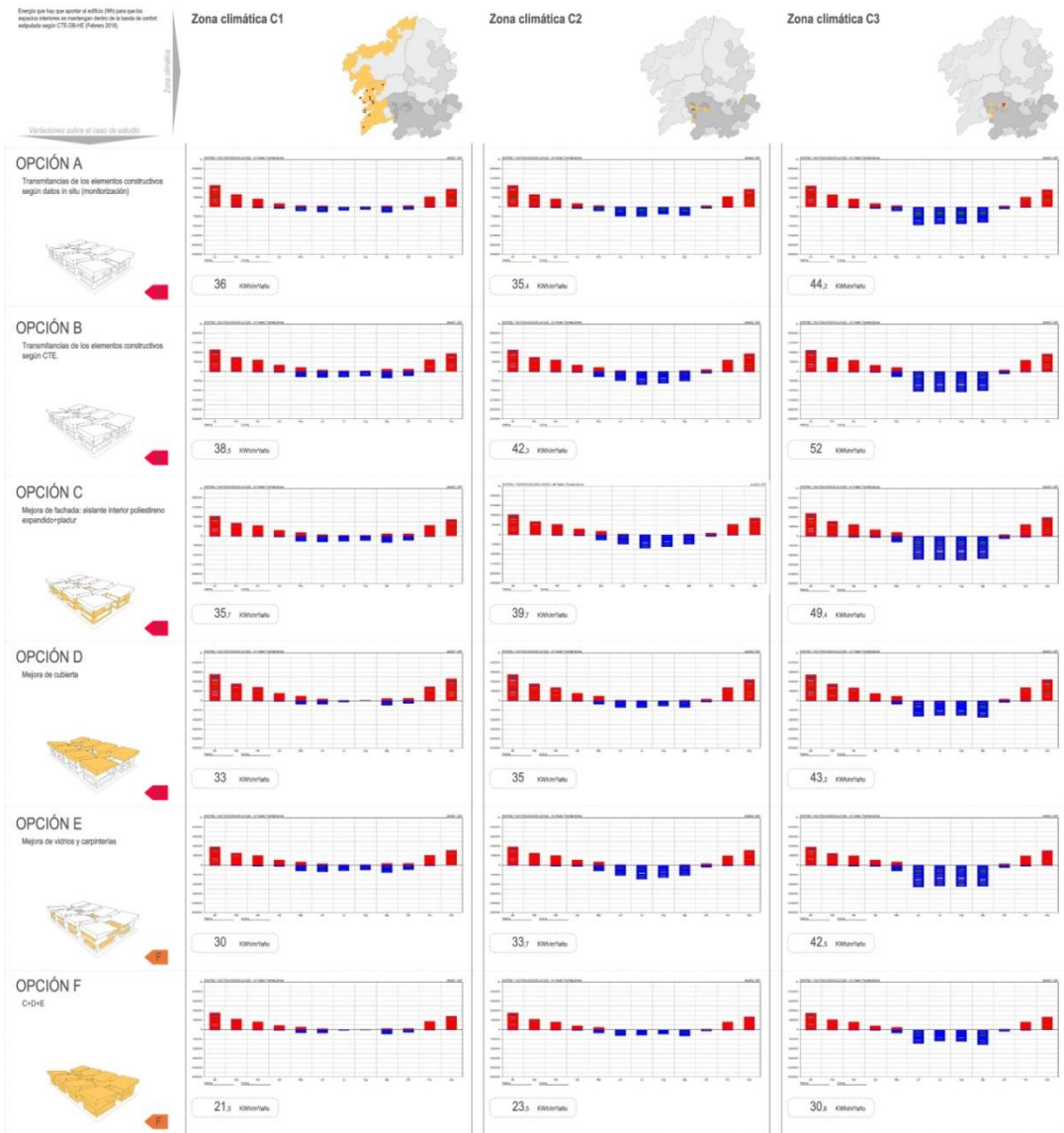
Table 1. Comparison simulations

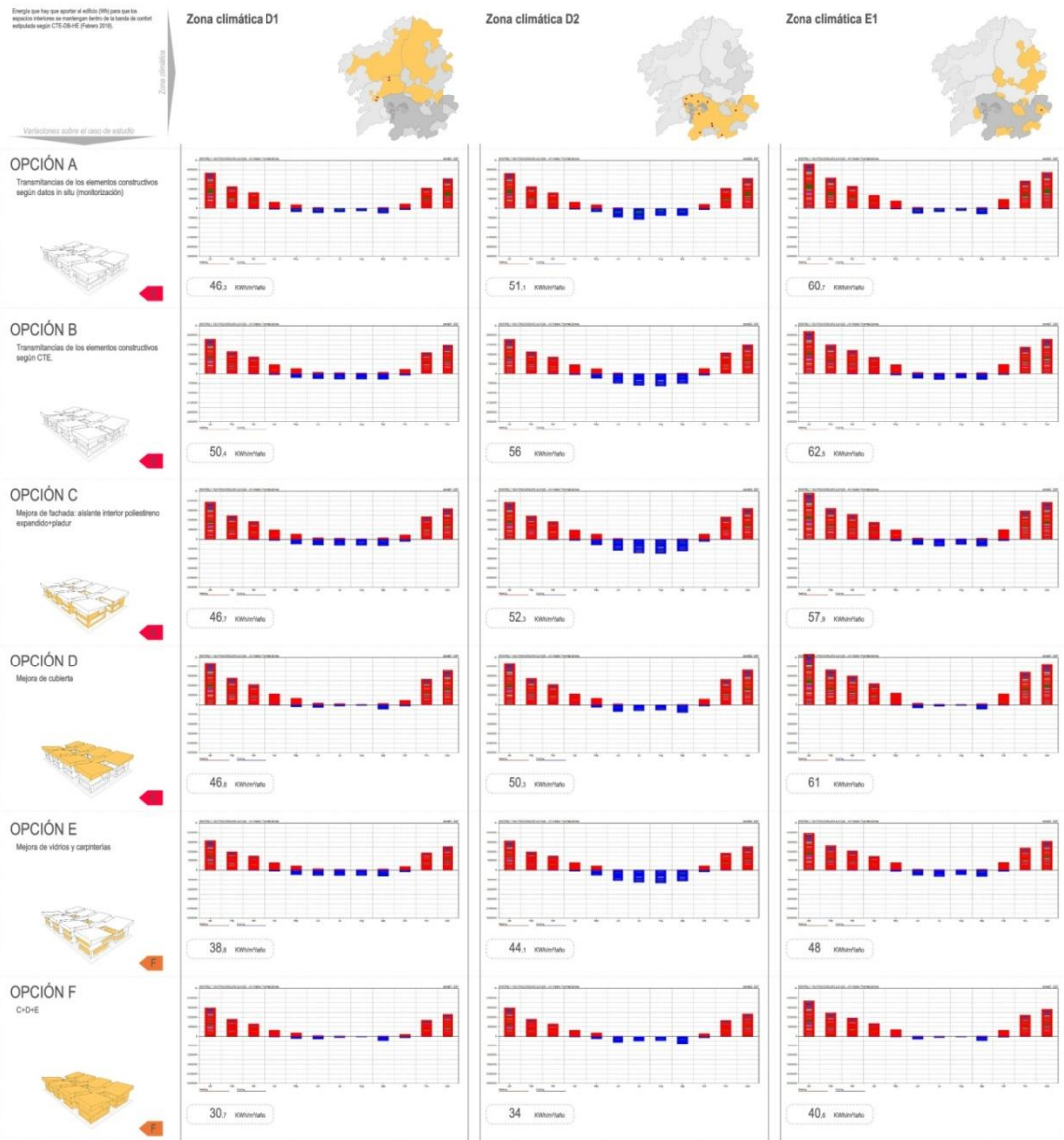
	<u>HULC</u>		<u>ECOTECT</u>		<u>REVIT</u>		<u>SEFAIRA</u>		<u>Casanova</u>	
	*	**	*	**	*	**	*	**	*	**
Caso 0	77,59		143		120	0%	165	0%	162	0%
<u>Op. A</u>			36							
<u>Op. B</u>	77,59	0%	38	0%						
<u>Op. C</u>	68,83	11%	36	5%	118	2%	156	5%	142	12%
<u>Op. D</u>	76,4	2%	33	13%	98	18%	122	26%	123	24%
<u>Op. E</u>	60,41	22%	30	21%	91	24%	122	26%	122,8	24%
<u>Op. F</u>	45,88	41%	22	42%	75	38%	109	34%	66,7	59%

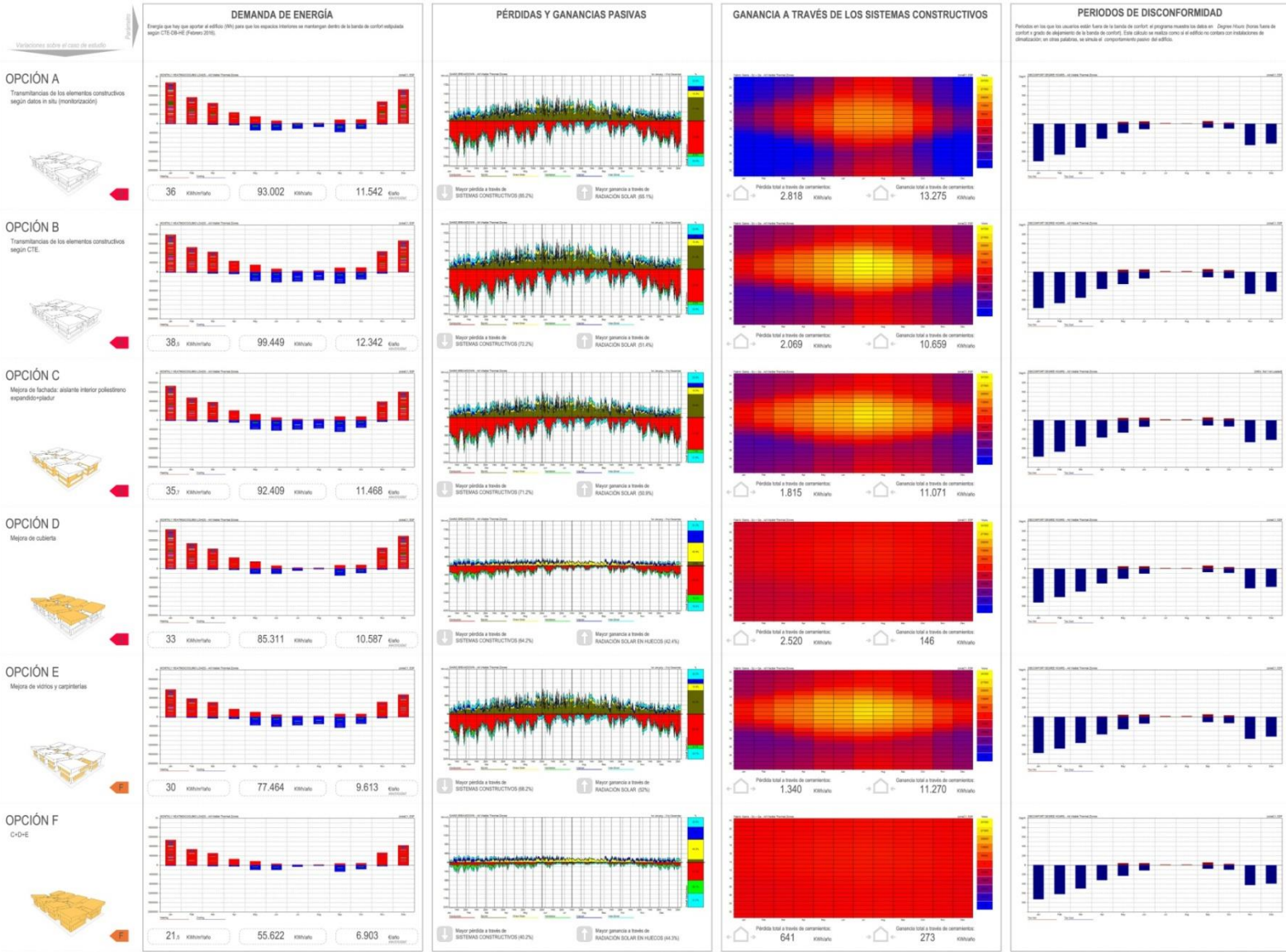
* kW·h/m²·year

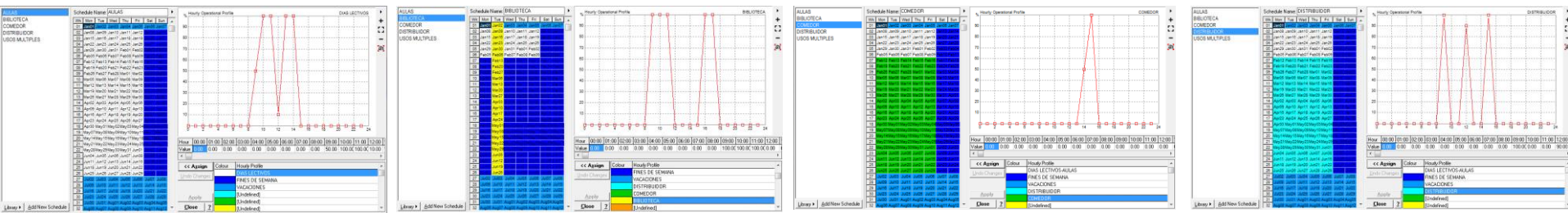
** % Reduction











AULAS

BIBLIOTECA

COMEDOR

DISTRIBUIDOR

USOS MÚLTIPLES

Schedule Name: **USOS MÚLTIPLES**

Wk	Mon	Tue	Wed	Thu	Fri	Sat	Sun
01	Jan01	Jan02	Jan03	Jan04	Jan05	Jan06	Jan07
02	Jan08	Jan09	Jan10	Jan11	Jan12	Jan13	Jan14
03	Jan15	Jan16	Jan17	Jan18	Jan19	Jan20	Jan21
04	Jan22	Jan23	Jan24	Jan25	Jan26	Jan27	Jan28
05	Jan29	Jan30	Jan31	Feb01	Feb02	Feb03	Feb04
06	Feb05	Feb06	Feb07	Feb08	Feb09	Feb10	Feb11
07	Feb12	Feb13	Feb14	Feb15	Feb16	Feb17	Feb18
08	Feb19	Feb20	Feb21	Feb22	Feb23	Feb24	Feb25
09	Feb26	Feb27	Feb28	Mar01	Mar02	Mar03	Mar04
10	Mar05	Mar06	Mar07	Mar08	Mar09	Mar10	Mar11
11	Mar12	Mar13	Mar14	Mar15	Mar16	Mar17	Mar18
12	Mar19	Mar20	Mar21	Mar22	Mar23	Mar24	Mar25
13	Mar26	Mar27	Mar28	Mar29	Mar30	Mar31	Apr01
14	Apr02	Apr03	Apr04	Apr05	Apr06	Apr07	Apr08
15	Apr09	Apr10	Apr11	Apr12	Apr13	Apr14	Apr15
16	Apr16	Apr17	Apr18	Apr19	Apr20	Apr21	Apr22
17	Apr23	Apr24	Apr25	Apr26	Apr27	Apr28	Apr29
18	Apr30	May01	May02	May03	May04	May05	May06
19	May07	May08	May09	May10	May11	May12	May13
20	May14	May15	May16	May17	May18	May19	May20
21	May21	May22	May23	May24	May25	May26	May27
22	May28	May29	May30	May31	Jun01	Jun02	Jun03
23	Jun04	Jun05	Jun06	Jun07	Jun08	Jun09	Jun10
24	Jun11	Jun12	Jun13	Jun14	Jun15	Jun16	Jun17
25	Jun18	Jun19	Jun20	Jun21	Jun22	Jun23	Jun24
26	Jun25	Jun26	Jun27	Jun28	Jun29	Jun30	Jul01
27	Jul02	Jul03	Jul04	Jul05	Jul06	Jul07	Jul08
28	Jul09	Jul10	Jul11	Jul12	Jul13	Jul14	Jul15
29	Jul16	Jul17	Jul18	Jul19	Jul20	Jul21	Jul22
30	Jul23	Jul24	Jul25	Jul26	Jul27	Jul28	Jul29
31	Jul30	Jul31	Aug01	Aug02	Aug03	Aug04	Aug05
32	Aug06	Aug07	Aug08	Aug09	Aug10	Aug11	Aug12

Hourly Operational Profile

USOS MÚLTIPLES

Hour	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00
Value	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	100.00	100.00	0.00	0.00	0.00

<< Assign	Colour	Hourly Profile
Undo Changes		DIAS LECTIVOS-AULAS
		FINES DE SEMANA
		VACACIONES
Apply		DISTRIBUIDOR
		USOS MÚLTIPLES
Close ?		[Undefined]



5. IMPROVEMENT PROPOSALS

The simulations made with the different tools can be seen as requirements are isolation and uptake of radiation. They are used the same premises to discuss the results with all the tools, based on constructive solutions verified by the CTE. Three changes have been proposed but it would be possible to extend the application to many other combinations, using the speed of the simulation analysis:

- Option C: application of a new 15 cm insulation inside the facades is proposed;
- Option D: application of a new 15 cm insulation on the roof/deck is proposed;
- Option E: replacing existing windows by others with thermal break and double low emissivity glazed is proposed;
- Option F: It is the sum of all previous proposals (op. C+ op. D+ op. E).

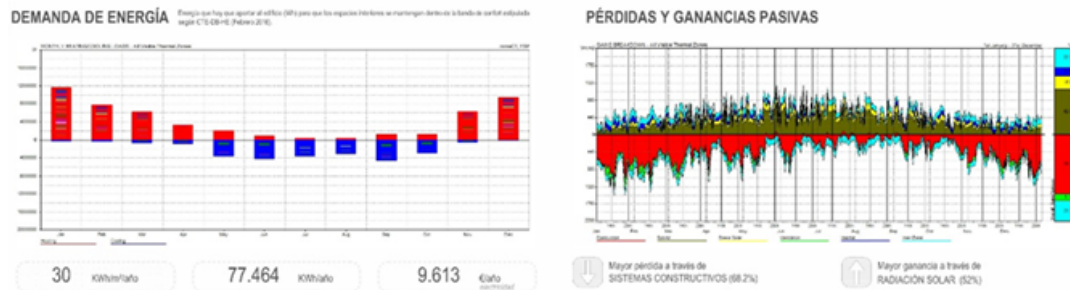
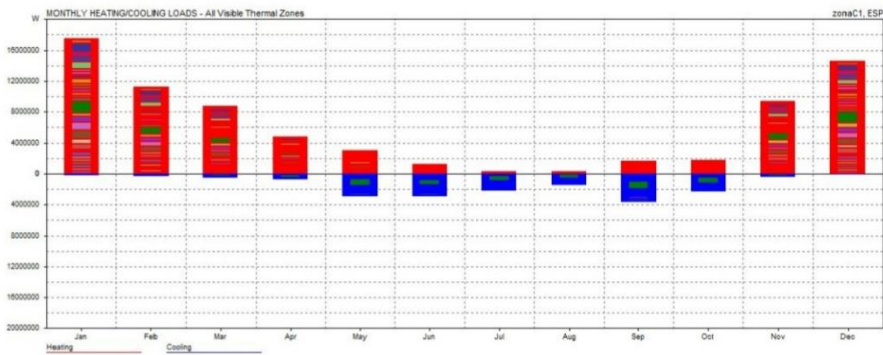


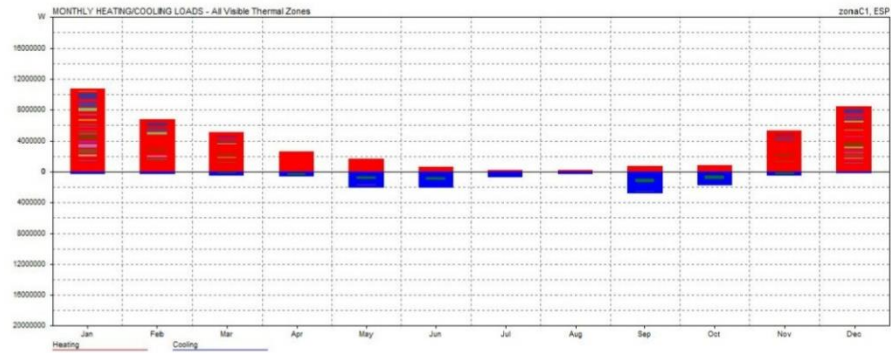
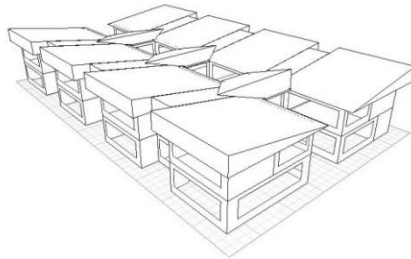
Figure 4. OPTION F- Monthly demand for energy. Passive lost and gains (ECOTECT)



36 KWh/m²/año

93.002 KWh/año

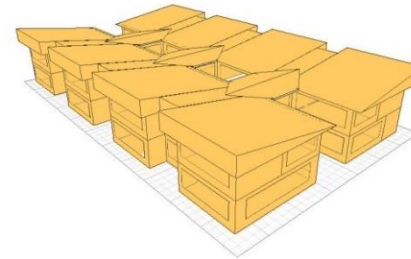
11.542 €/año
 electricidad



21,5 KWh/m²/año

55.622 KWh/año

6.903 €/año
 electricidad



Integrated system for energy optimization and reduction of building CO₂ footprint | Team

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Organisers:



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INTEGRATED SYSTEM FOR ENERGY OPTIMIZATION AND REDUCTION OF BUILDING CO2 FOOTPRINT: BIM. INDOOR MAPPING, UAV TECHNOLOGIES AND ADVANCED ENERGY SIMULATIONS TOOLS

Thank you

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Organisers:



International Co-owners:

