
D6.1 Appendix E Summary Sheet

D6.1 Appendix E Details

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D6.1 Appendix E Sierra Elvira school: Short Description

This document describes the demonstration building Sierra Elvira School.

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Appendix D: Sierra Elvira School. Granada (Spain)

Sierra Elvira School is a primary school located in the west of Granada, Spain. The school has a capacity of 650 students, between 3 and 11 years old, with three classrooms per year.



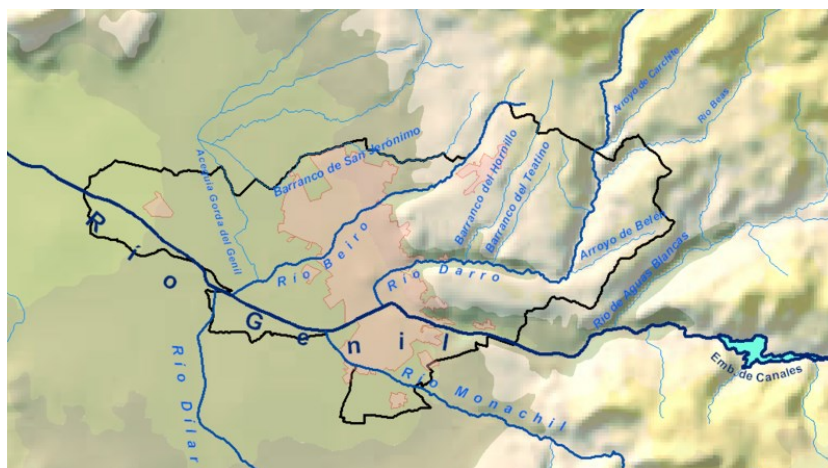
Figure 1: Sierra Elvira School location

Sierra Elvira School complex is formed by three different buildings: *Infant School* (INF), from 3 years to 5 years, *Primary School 1* (PR1), from 6 years to 7 years and *Primary School 2* (PR2), from 8 years to 11 years.



Figure 2: Aerial view of Sierra Elvira School complex

The city of Granada is located between the Genil river basin and the Sierra Nevada foothills, at an altitude of 738 meters, conditioning its weather.



Topographic map of the Sierra Nevada region in Spain. The map shows the Sierra de Huétor, Sierra de Arana, and Sierra Nevada. The Vega del Genil river is visible. A black outline highlights the area of interest, and a red outline highlights a specific sub-area within it.

Considering these external conditions, it is necessary heating in winter and cooling in summer. But due to the school calendar is closed in July and August for holidays, just needs heating.

Table 1: General information of Sierra Elvira building

Name	Sierra Elvira School	Envelopment area	5.907 m ²
Address	27 Virgen Blanca Street	Glazed area	496 m ² (8.4%)
City / Post code	Granada / 18004	From factor (S/V)	0,125
Country	Spain	Heated Area (m ²)	4,253
Contact Person	Javier Martín	Heated Volume (m ³)	12,759
e-mail of contact person	javier.martin@dalkia.es	Cooled Area (m ²)	0
Location (coordinates)	Latitude: 37° 10' 14" N Longitude: 3° 36' 50" W	Cooled Volume (m ³)	0
Orientation	N S W E	Heating degree days (15.5°C)	1,167
Altitude (m)	738	Cooling degree days (15.5°C)	1,660
Year of construction	1.975	Average power consumption (kWh/m ² a)	n.a.
Typology of building	School	Average thermal consumption (kWh/m ² a)	136.84
Floors	Infant School: 3 Primary School (1° -2°): 3 Primary School (3° - 6°): 4	Heating system	Biomass boilers Radiators
Built area	7,670 m ²	Cooling system	n.a.
Net usable area	5,839 m ²	DHW system	n.a.

Table 2: Climate values for Granada

	T (°C)	TM (°C)	Tm (°C)	R (mm)	RH (%)	DR (d)	DN (d)	DT (d)	DF (d)	DH (d)	DD (d)	I (h/mo)
Jan	6.8	12.2	1.3	44	74	6	0	0	3	13	9	161
Feb	8.4	14.1	2.6	36	69	6	0	0	2	6	7	161
Mar	10.7	17.0	4.3	37	62	6	0	1	1	2	7	207
Apr	12.6	18.8	6.4	40	59	7	0	1	1	0	5	215
May	16.5	23.1	9.8	30	55	5	0	2	1	0	5	268
Jun	21.3	28.8	13.9	16	48	2	0	2	0	0	11	314
Jul	25.3	33.5	17.1	3	41	0	0	1	0	0	22	348

Aug	25.1	33.2	17.1	3	42	1	0	1	0	0	18	320
Sep	21.2	28.5	14.0	17	52	2	0	2	0	0	10	243
Oct	15.7	21.9	9.5	40	64	5	0	1	1	0	7	203
Nov	10.6	16.2	5.1	46	73	6	0	1	2	3	8	164
Dec	7.9	13.1	2.8	49	76	7	0	0	3	8	7	147
Total	15.2	21.7	8.7	361	60	54	2	11	13	31	115	2751

T: monthly average temperature; TM: monthly average of highest daily temperatures; Tm: monthly average of lowest daily temperatures; R: monthly average of rainfall; RH: monthly average of relative humidity; DR: monthly average of rainy days (rainfall \geq 1mm); DN: monthly average of snow days; DT: monthly average of storm days; DF: monthly average of foggy days; DH: monthly average of frost days; DD: monthly average of cloudless days; I: monthly average of sunny hours ;**Error! No se encuentra el origen de la referencia.**

2 Building use: distribution and occupancy

2.1 Infant School Building (INF)

INF has a rectangular plan with three floors: ground floor, first floor and second floor. In the ground floor there are bathrooms, boiler room and gym. Most of spaces are free, without rooms or walls.

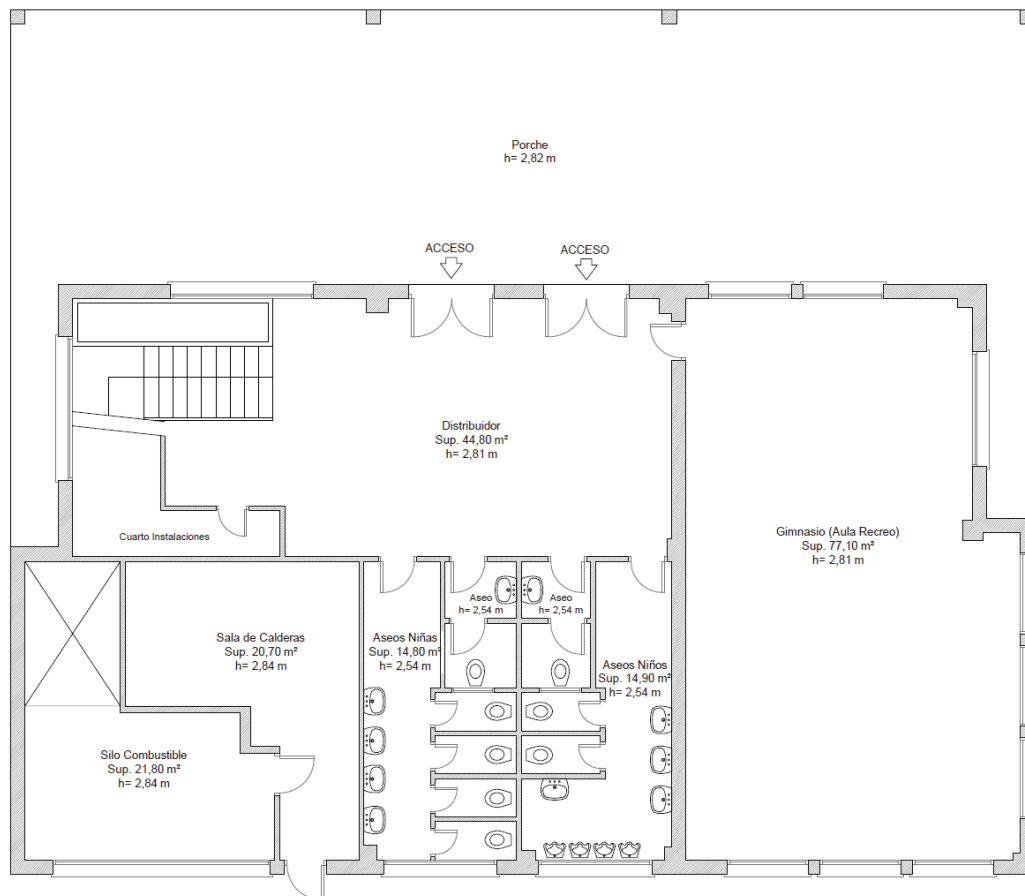


Figure 5: INF ground floor plan of Sierra Elvira School

In the first floor there are classrooms mainly.

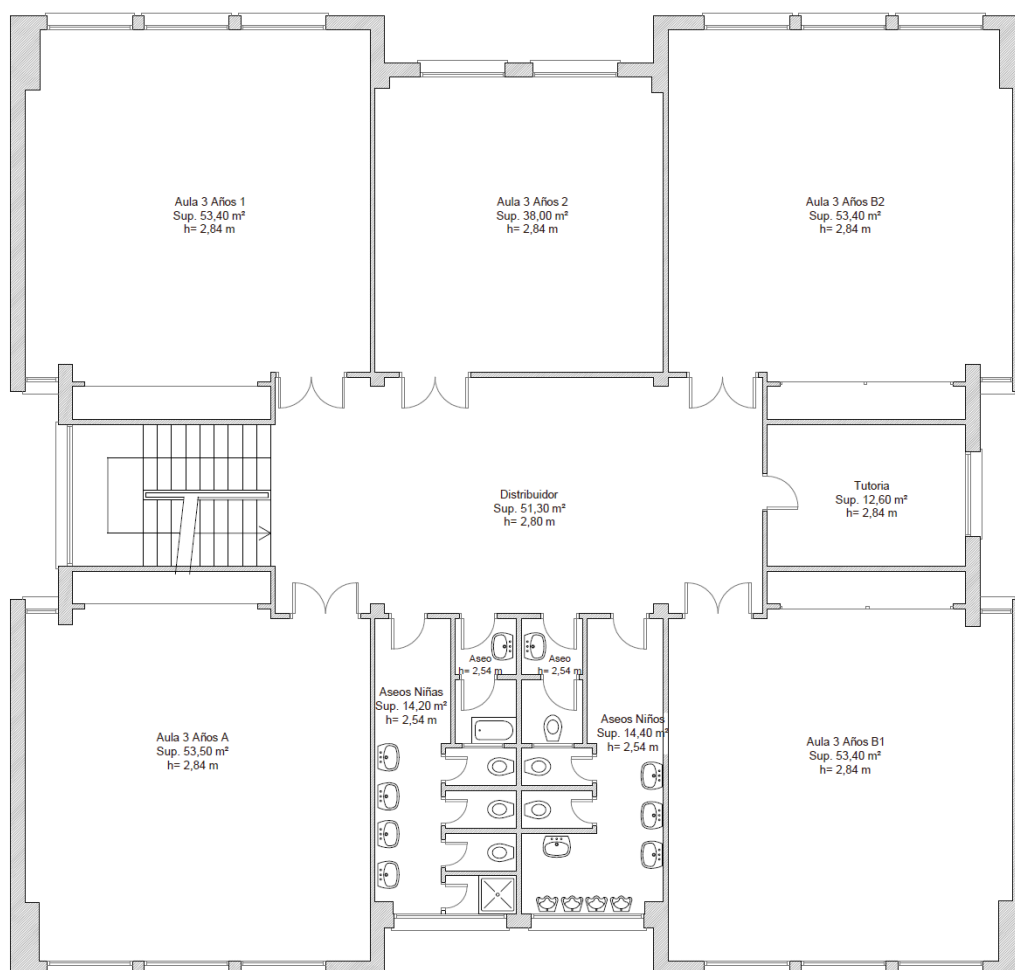


Figure 6: INF first floor plan of Sierra Elvira School

In the second floor there are classrooms mainly.

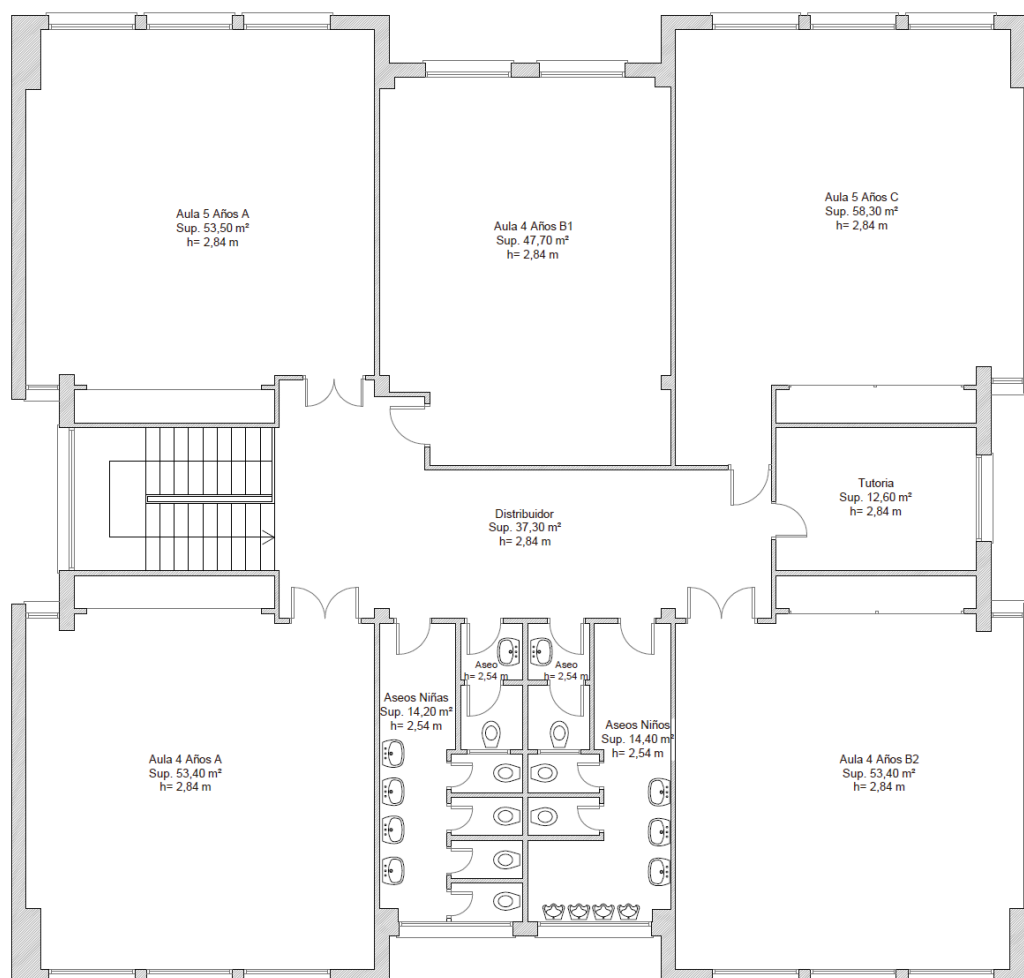


Figure 7: INF second floor plan of Sierra Elvira School

Table 3: Sierra Elvira building distribution / usage of Sierra Elvira School

Zone	Floor	Useful area (m²)	Height (m)	Vol. (m³)	% cond.	Occ. (pax)	Cond. services
INF01. Hall	0	44.80	2.81	125.89	100%	-	2X23 RADIATORS
INF02. Gym	0	77.10	2.81	216.65	100%	-	3X19 RADIATORS
INF03. Boys bathroom	0	14.90	2.54	37.85	0%	-	-
INF04. Girls bathroom	0	14.80	2.54	37.59	100%	-	1X16 RADIATORS

INF05. Boiler room	0	20.70	2.84	58.79	0%	-	-
INF06. Silo room	0	21.80	2.84	61.91	0%	-	-
INF07. Storage room	0				100%	-	1X10 RADIATORS
INF08. Classroom 3 years 01	1	53.40	2.84	151.66	100%	15	2X22 RADIATORS
INF09. Classroom 3 years 02	1	38.00	2.84	107.92	100%	15	3X10 RADIATORS
INF10. Classroom 3 years B2	1	53.40	2.84	151.66	100%	15	2X22 RADIATORS
INF11. Office	1	12.60	2.64	33.26	100%	15	1X14 RADIATORS
INF12. Classroom 3 years B1	1	53.40	2.84	151.66	100%	15	2X21 RADIATORS
INF13. Boys bathroom	1	14.40	2.54	36.58	100%	-	1X5 RADIATORS
INF14. Girls bathroom	1	14.20	2.54	36.07	100%	-	1X5 RADIATORS
INF15. Classroom 3 years A	1	53.50	2.84	151.94	100%	15	2X17 RADIATORS
INF16. Hall	1	51.30	2.84	145.69	0%	-	-
INF17. Classroom 5 years A	2	53.50	2.84	151.94	100%	24	2X21 RADIATORS
INF18. Classroom 4 years B1	2	47.70	2.84	135.49	100%	24	3X14 RADIATORS
INF19. Classroom 5 years C	2	58.30	2.84	165.57	100%	24	2X20 RADIATORS
INF20. Office	2	12.60	2.84	35.78	100%	24	1X13 RADIATORS
INF21. Classroom 4 years B2	2	53.40	2.84	151.66	100%	24	2X20 RADIATORS
INF22. Boys bathroom	1	14.40	2.54	36.58	100%	-	1X5 RADIATORS
INF23. Girls bathroom	1	14.20	2.54	36.07	100%	-	1X5 RADIATORS
INF24. Classroom 4	2	53.40	2.84	151.66	100%	24	2X20

years A							RADIATORS
INF25. Hall	2	37.30	2.84	105.93	0%	-	-

Table 4: Building daily occupation profile of INF building¹ of Sierra Elvira School

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Mon-Fri	0	0	0	0	0	0	1	1	2	2	2	2
Weekend	0	0	0	0	0	0	0	0	0	0	0	0
Hour	13	14	15	16	17	18	19	20	21	22	23	24
Mon-Fri	2	2	1	1	0	0	0	0	0	0	0	0
Weekend	0	0	0	0	0	0	0	0	0	0	0	0

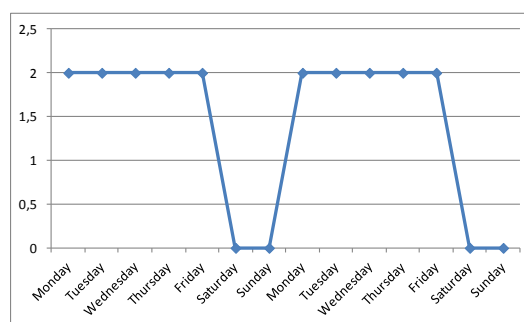
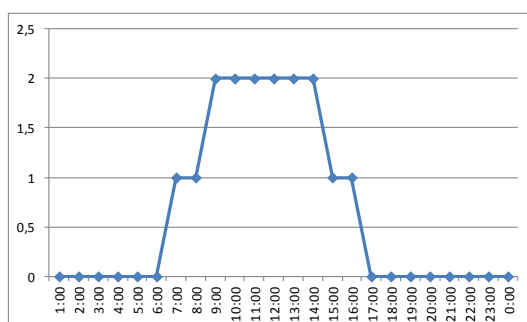


Figure 8: INF building daily occupation of Sierra Elvira School

Table 5: Building yearly occupation profile of INF building of Sierra Elvira School

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Mon-Fri	0	2	2	2	2	2	1	2	2	2	2	2	1
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Mon-Fri	2	2	2	2	1	2	2	2	2	2	2	2	1
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Mon-Fri	1	1	1	0	0	0	0	0	0	1	1	1	2
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Mon-Fri	2	2	2	2	1	2	2	2	2	1	2	2	0

¹ (Not occup.=0; partially occup.=1; occup.=2)

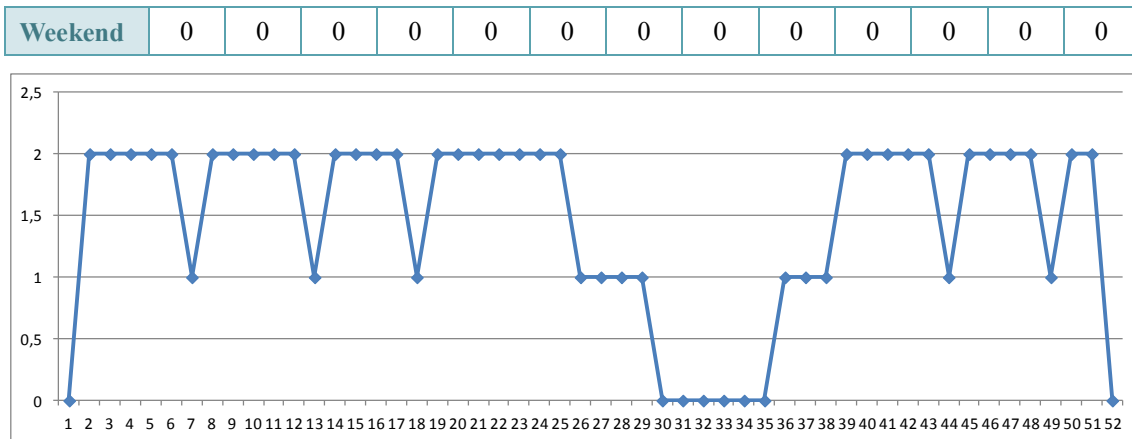


Figure 9: INF building yearly occupation of Sierra Elvira School

2.2 Primary School 1 (PR1)

PR1 has a rectangular plan with three floors: ground floor, first floor and second floor. In the ground floor there are storage room, bathrooms and a gym. Most of space are free, without rooms or walls.

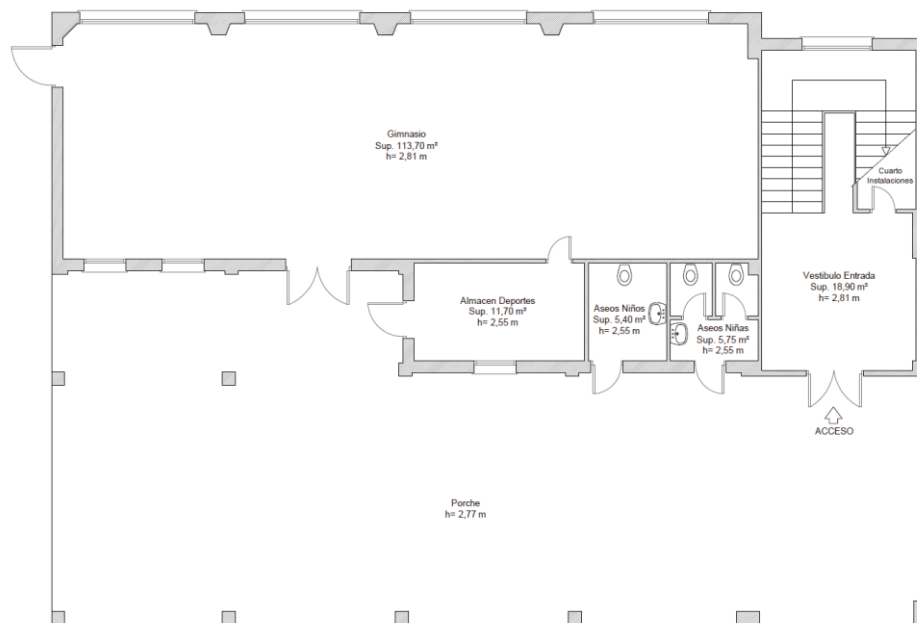


Figure 10: PR1 ground floor plan of Sierra Elvira School

In the first floor there are classrooms mainly.

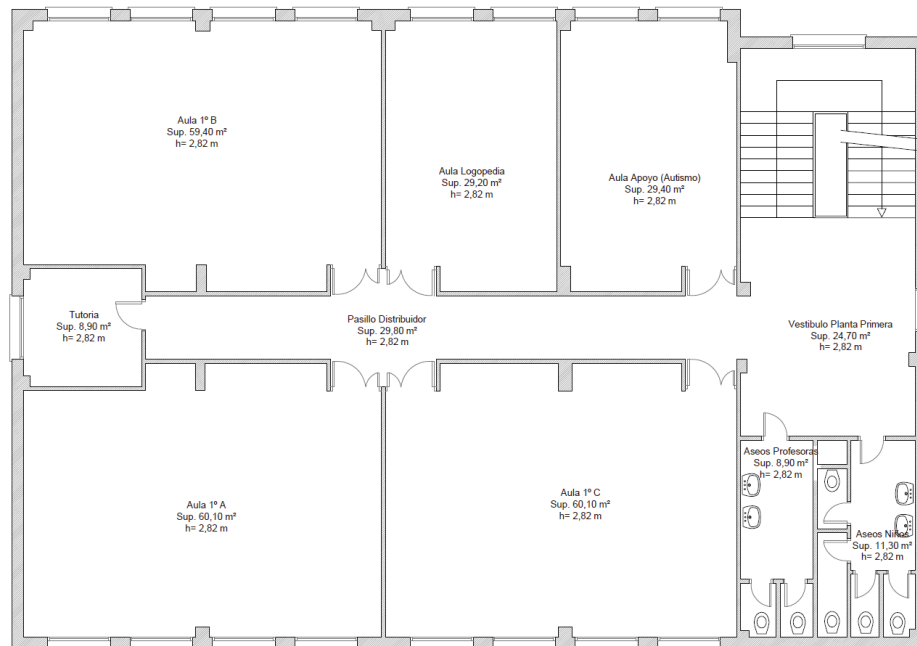


Figure 11: PR1 first floor plan of Sierra Elvira School

In the second floor there are classrooms mainly.

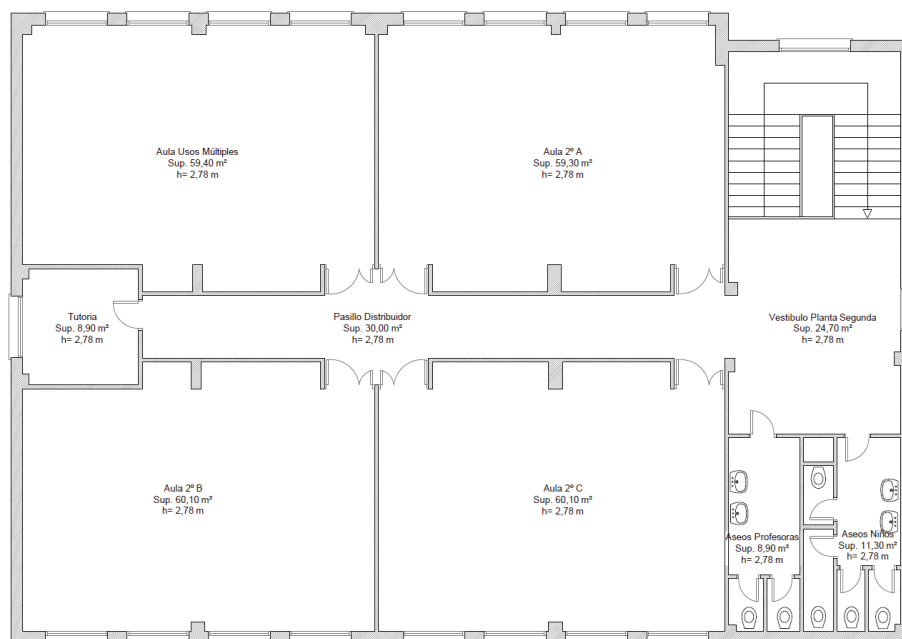


Figure 12: PR1 second floor plan of Sierra Elvira School

Table 6: PR1 building distribution / usage of Sierra Elvira School

Zone	Floor	Useful area (m ²)	Height (m)	Vol. (m ³)	% cond.	Occ. (pax)	Cond. services
PR101. Gym	0	113.70	2.81	319.49	100%	-	2X15 RADIATORS
PR102. Sports storage room	0	11.70	2.55	29.84	0%	-	-
PR103. Boys bathroom	0	5.40	2.55	13.77	0%	-	-
PR104. Girls bathroom	0	5.75	2.55	14.66	0%	-	-
PR105. Hall	0	18.90	2.81	53.11	0%	-	-
PR106. Classroom 1ºA	1	59.40	2.82	167.51	100%	24	2X16 RADIATORS
PR107. Logopedics classroom	1	29.20	2.82	82.34	100%	-	1X15 RADIATORS
PR108. Autism classroom	1	29.40	2.82	82.91	100%	-	1X15 RADIATORS
PR109. Hall	1	24.70	2.82	69.65	0%	-	-
PR110. Boys bathroom	1	11.30	2.82	31.87	100%	-	1X6 RADIATORS
PR111. Girls bathroom	1	8.90	2.82	25.10	100%	-	1X4 RADIATORS
PR112. Classroom 1ºC	1	60.10	2.82	169.48	100%	24	2X15 RADIATORS
PR113. Classroom 1ºA	1	60.10	2.82	169.48	100%	24	2X16 RADIATORS
PR114. Office	1	8.90	2.82	25.10	0%	-	-
PR115. Hallway	1	29.80	2.82	84.04	100%	-	2X13 RADIATORS
PR116. Classroom	2	59.40	2.78	165.13	100%	-	2X16 RADIATORS
PR117. Classroom 2ºA	2	59.30	2.78	164.85	100%	24	2X15 RADIATORS
PR118. Hall	2	24.70	2.78	68.67	0%	-	-
PR119. Boys bathroom	2	11.30	2.78	31.41	100%	-	1X6 RADIATORS
PR120. Girls bathroom	2	8.90	2.78	24.74	100%	-	1X4

							RADIATORS
PR121. Classroom 2°C	2	60.10	2.78	167.08	100%	24	2X15 RADIATORS
PR122. Classroom 2°B	2	60.10	2.78	167.08	100%	24	2X16 RADIATORS
PR123. Office	2	8.90	2.78	24.74	0%	-	-
PR124. Hallway	1	30.00	2.78	83.40	100%	-	2X13 RADIATORS

Table 7: Building daily occupation profile of PR1 building² of Sierra Elvira School

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Mon-Fri	0	0	0	0	0	0	1	1	2	2	2	2
Weekend	0	0	0	0	0	0	0	0	0	0	0	0
Hour	13	14	15	16	17	18	19	20	21	22	23	24
Mon-Fri	2	2	1	1	0	0	0	0	0	0	0	0
Weekend	0	0	0	0	0	0	0	0	0	0	0	0

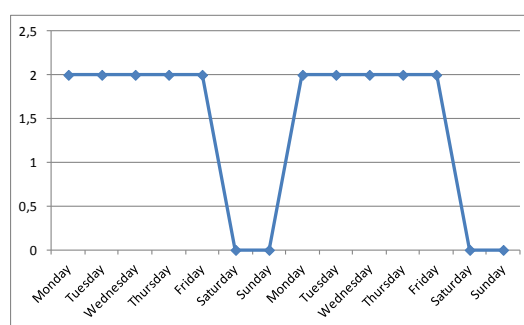
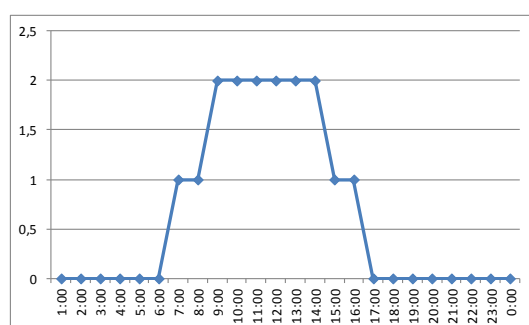
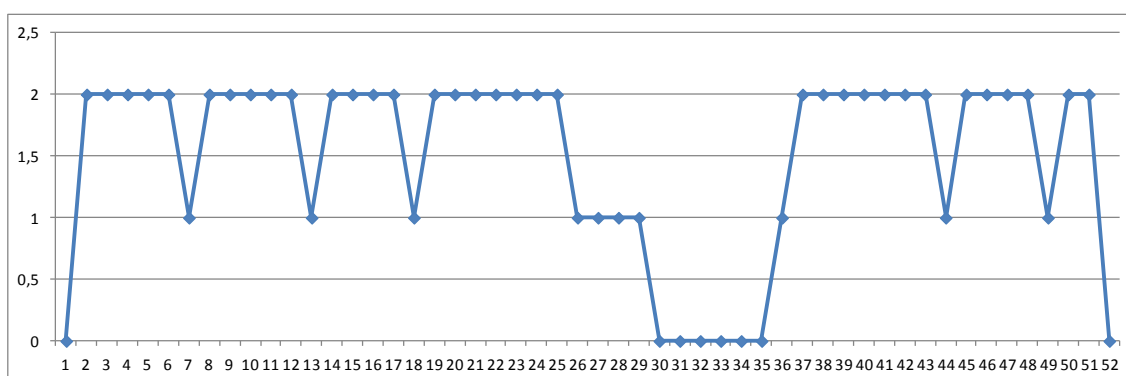


Figure 13: PR1 building daily occupation of Sierra Elvira School

Table 8: Building yearly occupation profile of PR1 building of Sierra Elvira School

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Mon-Fri	0	2	2	2	2	2	1	2	2	2	2	2	1
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Mon-Fri	2	2	2	2	1	2	2	2	2	2	2	2	1

² (Not occup.=0; partially occup.=1; occup.=2)



2.3 Primary School 2 (PR2)

PR2 has a rectangular plan with four floors: ground floor, first floor, second floor and third floor. In the ground floor there are storage rooms, boiler room, bathrooms and a library. Most of spaces are free, without rooms or walls.

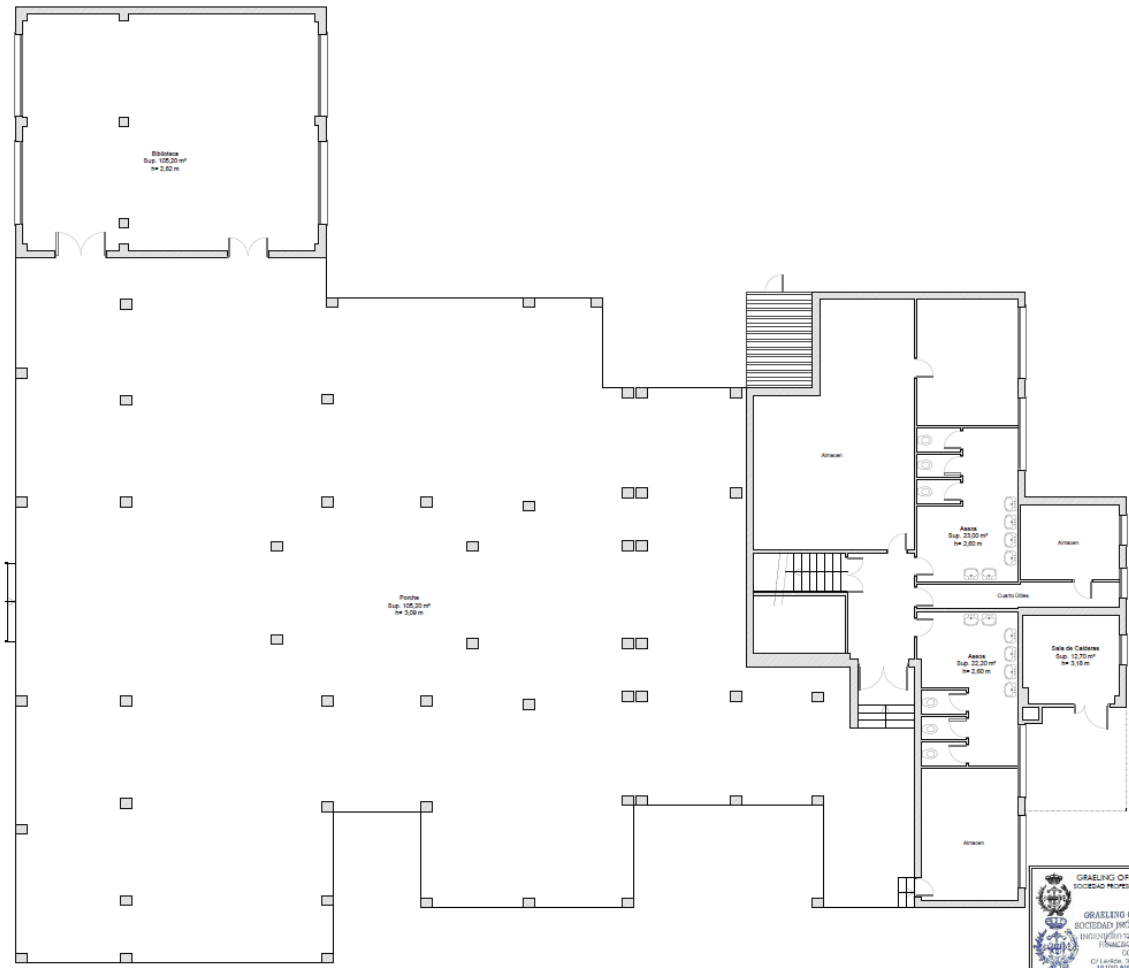


Figure 15: PR2 ground floor plan of Sierra Elvira School

Figure 16: PR2 first floor plan of Sierra Elvira School

Figure 17: PR2 second floor plan of Sierra Elvira School

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Table 9: PR2 building distribution / usage of Sierra Elvira School

Zone	Floor	Useful area (m ²)	Height (m)	Vol. (m ³)	% cond.	Occ. (pax)	Cond. services
PR2.01 Library	0	105.20	2.82	296.66	100%	-	4X25 RADIATORS
PR2.02 Storage room 01	0	51.29	3.10	159.99	0%	-	-
PR2.03 Storage room 02	0	19.33	3.10	59.92	0%	-	-
PR2.04 Storage room 03	0	11.13	3.10	34.50	0%	-	-
PR2.05 Storage room 04	0	7.62	3.10	23.62	0%	-	-
PR2.06 Storage room 05	0	19.17	3.10	59.43	0%	-	-
PR2.07 Bathroom 01	0	23.00	2.6	59.80	100%	-	1X10 RADIATORS
PR2.08 Bathroom 02	0	22.20	2.6	57.72	100%	-	1X10 RADIATORS
PR2.09 Boiler room	0	12.70	3.18	40.39	0%	-	-
PR2.10 Hall	0	10.61	3.10	32.89	0%	-	-
PR2.11 Refectory	1	221.00	2.91	643.11	100%	-	4X26 RADIATORS
PR2.12 Kitchen	1	99.86	2.94	293.58	0%	-	-
PR2.13 Caretaker: Hall	1	5.87	2.97	17.43	0%	-	-
PR2.14 Caretaker: Living room	1	16.32	2.97	15.83	100%	-	1X26 RADIATORS
PR2.15 Caretaker: Kitchen	1	5.43	2.97	16.13	0%	-	-
PR2.16 Caretaker: Bathroom	1	3.83	2.97	11.38	0%	-	-
PR2.17 Caretaker: Room 01	1	10.41	2.97	30.92	100%	-	1X13 RADIATORS
PR2.18 Caretaker: Room 02	1	9.46	2.97	28.10	100%	-	1X13 RADIATORS
PR2.19 Caretaker: Room 03	1	9.74	2.97	28.93	100%	-	1X13 RADIATORS
PR2.20 Refectory 4 years	1	57.70	2.97	171.37	100%	-	2X23 RADIATORS
PR2.21 Refectory 3 years	1	59.20	2.97	175.82	100%	-	2X27 RADIATORS
PR2.22 Boys bathroom	1	13.00	2.93	38.09	100%	-	1X5 RADIATORS

PR2.23 Girls bathroom	1	12.90	2.97	38.31	100%	-	1X5 RADIATORS
PR2.24 Refectory 5 years	1	59.40	2.97	176.42	100%	-	2X25 RADIATORS
PR2.25 Office 01	1	13.60	2.97	40.39	100%	-	1X20 RADIATORS
PR2.26 Storage room 01	1	5.51	3.00	16.53	0%	-	-
PR2.27 Storage room 02	1	2.54	3.00	7.62	0%	-	-
PR2.28 Office 02	1	16.00	3.00	48.00	100%	1	1X23 RADIATORS
PR2.29 Office 03	1	19.60	3.00	58.8	100%	1	1X20 RADIATORS
PR2.30 Office 04	1	13.30	3.00	39.9	0%	-	-
PR2.31 Men bathroom	1	2.61	3.00	7.83	0%	-	-
PR2.32 Women bathroom	1	2.61	3.00	7.83	0%	-	-
PR2.33 Office 05	1	21.40	3.00	64.20	100%	2	1X19 RADIATORS
PR2.34 Hall 01	1	30.00	2.99	89.7	0%	-	-
PR2.35 Hall 02	1	29.40	3.00	88.2	0%	-	-
PR2.36 Hallway	1	135.28	2.97	401.78	100%	-	7X13 RADIATORS
PR2.37 Classroom 3°B	2	58.40	2.94	171.70	100%	24	2X22 RADIATORS
PR2.38 Office 01	2	13.30	2.94	39.10	100%	1	1X13 RADIATORS
PR2.39 Classroom 3°A	2	58.50	2.94	171.99	100%	24	2X20 RADIATORS
PR2.40 Teachers bathroom	2	7.80	2.97	23.17	0%	-	-
PR2.41 Girls bathroom	2	19.60	2.97	58.21	0%	-	-
PR2.42 Classroom 4°A	2	66.40	2.94	195.22	100%	24	2X22 RADIATORS
PR2.43 Classroom 4°C	2	59.30	2.94	174.34	100%	24	2X24 RADIATORS
PR2.44 French Computer classroom	2	57.50	2.94	169.05	100%	-	2X23 RADIATORS
PR2.45 Teachers bathroom	2	7.80	2.97	23.17	0%	-	-
PR2.46 Boys bathroom	2	18.50	2.97	54.95	0%	-	-

PR2.47 Teachers classroom	2	59.20	2.97	175.82	100%	-	2X22 RADIATORS
PR2.48 Office 02	2	13.60	2.94	39.10	100%	1	1X11 RADIATORS
PR2.49 Music classroom	2	57.40	2.94	168.76	100%	-	2X23 RADIATORS
PR2.50 Special Education Classroom	2	30.70	3.00	92.10	100%	-	2X27 RADIATORS
PR2.51 Computers classroom	2	28.50	3.00	85.50	100%	-	1X22 RADIATORS
PR2.52 Hallway	2	114.03	2.97	338.67	100%	-	6X13 RADIATORS
PR2.53 Classroom 6°B	3	59.00	2.94	173.46	100%	24	2X27 RADIATORS
PR2.54 Office 01	3	13.30	2.94	39.10	100%	-	1X13 RADIATORS
PR2.55 Classroom 6°C	3	58.00	2.94	170.52	100%	24	2X25 RADIATORS
PR2.56 Teachers bathroom	2	7.80	2.94	22.93	0%	-	-
PR2.57 Girls bathroom	2	19.60	2.94	57.62	0%	-	-
PR2.58 Classroom 3°C	3	66.40	2.94	195.22	100%	24	2X27 RADIATORS
PR2.59 Classroom 6°A	3	59.20	2.94	174.05	100%	24	2X24 RADIATORS
PR2.60 Classroom 5°B	3	57.50	2.94	169.05	100%	-	2X23 RADIATORS
PR2.61 Teachers bathroom	3	7.80	2.94	22.93	0%	-	-
PR2.62 Boys bathroom	3	18.50	2.94	54.39	0%	-	-
PR2.63 Classroom 5°A	3	59.20	2.97	175.82	100%	-	2X26 RADIATORS
PR2.64 Office 02	3	13.60	2.94	39.10	100%	-	1X11 RADIATORS
PR2.65 Classroom 5°C	3	57.40	2.94	168.76	100%	-	2X28 RADIATORS
PR2.66 Classroom 4°B	3	60.00	2.94	176.40	100%	-	2X27 RADIATORS
PR2.67 Hallway	3	114.03	2.97	338.67	100%	-	6X13

							RADIATORS
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Table 10: Building daily occupation profile of PR2 building of Sierra Elvira School³

Hour	1	2	3	4	5	6	7	8	9	10	11	12
Mon-Fri	0	0	0	0	0	0	1	1	2	2	2	2
Weekend	0	0	0	0	0	0	0	0	0	0	0	0
Hour	13	14	15	16	17	18	19	20	21	22	23	24
Mon-Fri	2	2	1	1	0	0	0	0	0	0	0	0
Weekend	0	0	0	0	0	0	0	0	0	0	0	0

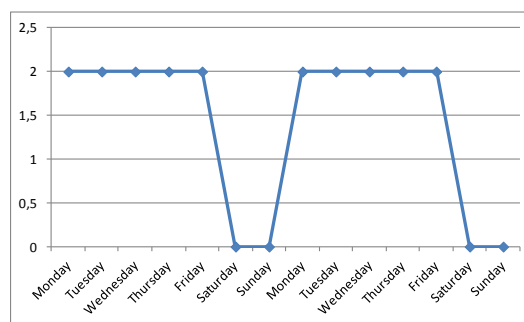
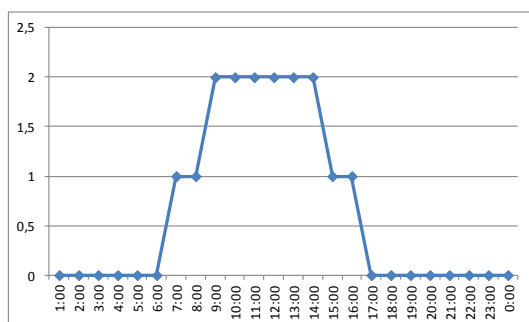


Figure 19: PR2 building daily occupation of Sierra Elvira School

Table 11: Building yearly occupation profile of PR2 building of Sierra Elvira School

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Mon-Fri	0	2	2	2	2	2	1	2	2	2	2	2	1
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Mon-Fri	2	2	2	2	1	2	2	2	2	2	2	2	1
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Mon-Fri	1	1	1	0	0	0	0	0	0	1	2	2	2
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Mon-Fri	2	2	2	2	1	2	2	2	2	1	2	2	0
Weekend	0	0	0	0	0	0	0	0	0	0	0	0	0

³ (Not occup.=0; partially occup.=1; occup.=2)

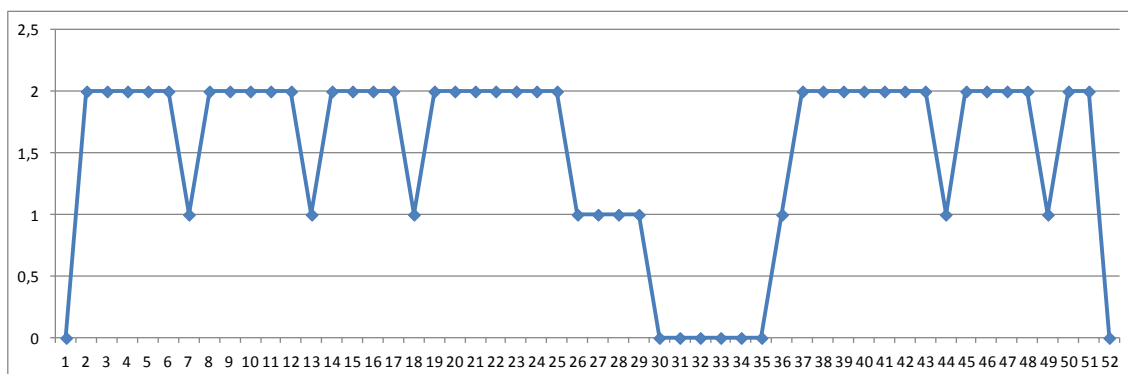


Figure 20: PR2 building yearly occupation of Sierra Elvira School

3 Building characteristics

3.1 Envelope elements and thermal characteristics

Table 12: Construction elements of Sierra Elvira building






Envelope Element	Description (material and thickness)	Total thick. (m)	U-Value (W/m ² K)	Abs int. – abs ext	Details section's sketch from inner face to outer face
External wall	1 Brick 0,125 2 Air cavity 0.050 3 Perforated brick 0.070 4 Plaster 0.005	0.250	1.08		
Internal wall	1 Plaster 0.005 2 Perforated brick 0.090 3 Plaster 0.005	0.100	2.13		
Roof	1 Ceramic roof tile 0.015 2 Cement 0.005 3 Waterproofing layer 0.002 4 Concrete 0.200	0.222	3.70		
Floor	1 Concrete 0.350 2 Concrete 0.010 3 Cement 0.005 4 Ceramic tile 0.010	0.465	2.50		

Table 13: Windows description of Sierra Elvira building

Envelope Element	Description	U-Value (W/m ² K)	g	Details section's sketch from inner face to outer face
Window	1 Aluminium woodwork 2 Glass 6+4+4	3.2	0.9	

4 Energy flow

Sierra Elvira School complex has two different biomass boiler rooms, one for *Infant School* building and *Primary School 1* building and the other one for *Primary School 2* building. The boilers generate hot water that is distributed by two circuits, each one regulated with a three-way valve in the return.

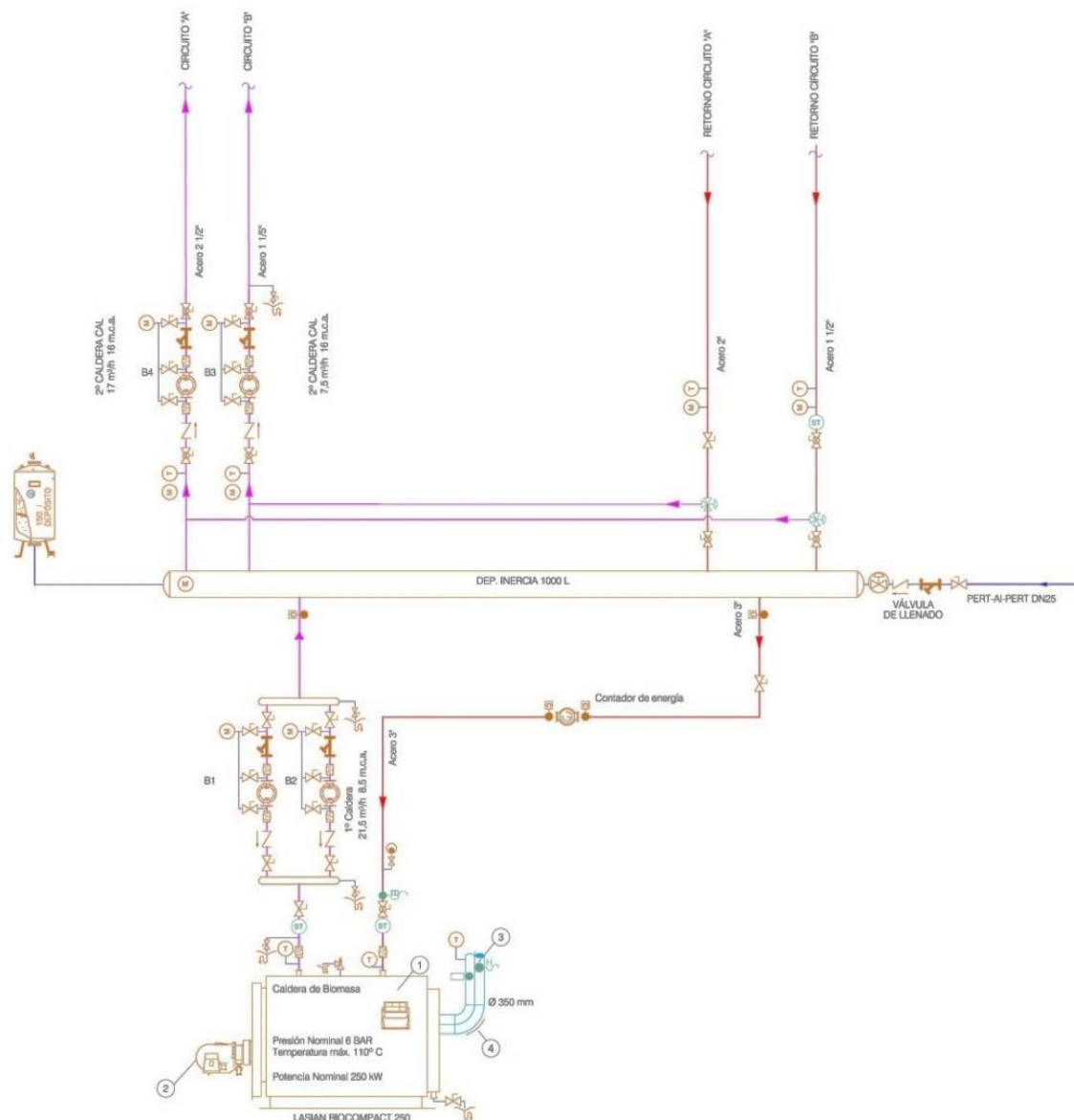


Figure 21: Scheme of the thermal system of Sierra Elvira building

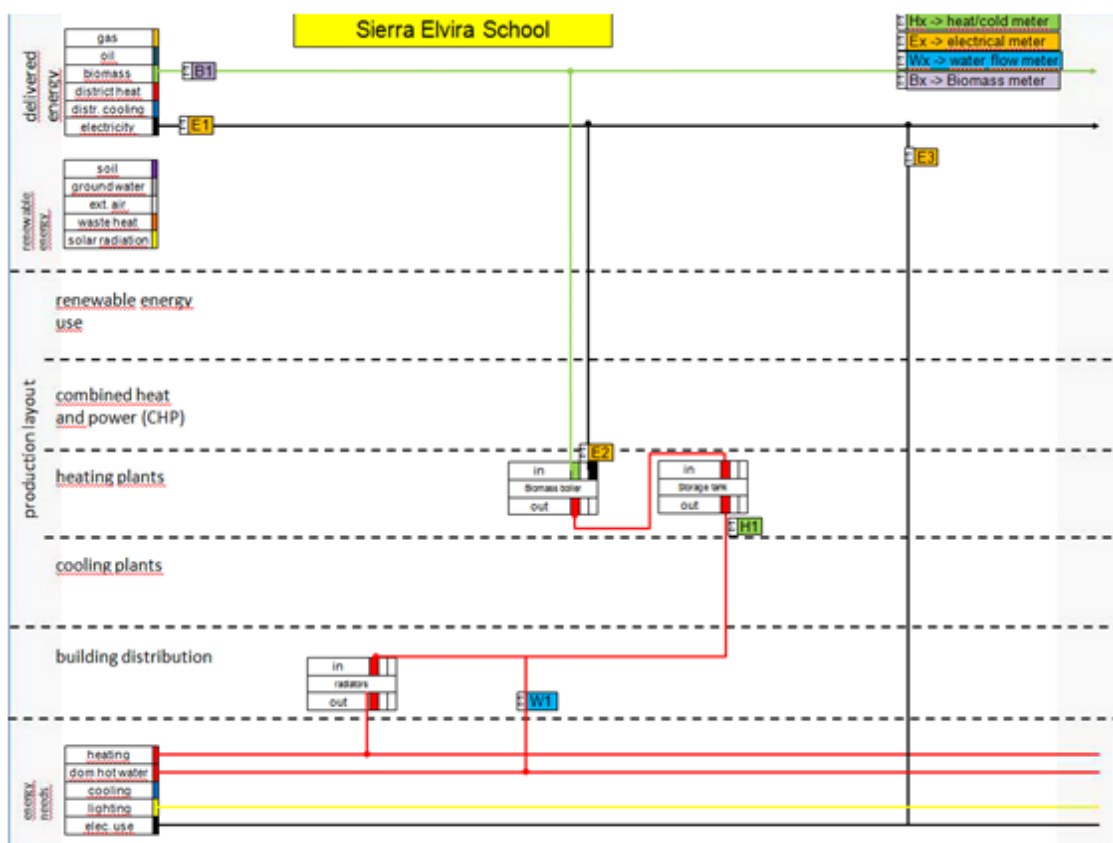






Figure 22: Energy flow

Table 14: Energy flow elements of Sierra Elvira building

HVAC PLANT	Installed system	N° units	Picture
Heating	Biomass Boiler (INF + PR1) LASIAN BIOCOPACT 205 Heating Power: 200kW Max. temperature: 110°C Working pressure: 6bar	1	

	<p>Biomass Boiler (PR2) LASIAN BIOCOMPACT 205 Heating Power: 250kW Max. temperature: 110°C Working pressure: 6bar</p>	1	
Storage	<p>Heat storage (INF + PR1) SICC Max. temperature: 99°C Working pressure: 6bar Volume: 1.000 l</p>	1	
	<p>Heat storage (PR2) SICC Max. temperature: 99°C Working pressure: 6bar Volume: 1.000 l</p>	1	

Terminal units	Radiators	128	
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4.1 Biomass system

There are two different boiler rooms located at ground floor of INF building and PR2 building. Both of them have the same system to produced heat water.

The biomass boilers produced hot water and stored it in a 1.000 liters heat storage tank, after that, hot water is distributed in two different circuits, with a fix flow pump, regulated by a three-way valve and controlled by return temperature.

Biomass system has a pellet silo that feeds the boiler.



Figure 23: Pellet silo PR1 of Sierra Elvira School



Figure 24: Pellet silo INF of Sierra Elvira School

4.2 Terminal Units

There is only one type of terminal elements: iron radiators without thermostatic valve. Depending on the room, the radiators are of 4-28 items.



Figure 25: Iron Radiator of Sierra Elvira school

5 Energy supply and use

5.1 Electricity supply and consumption

Table 15: Information about electricity supply of Sierra Elvira building

Energy supplier (Name of organization)						
Tariff	3.0A					
N° tariff periods	3					
Periods	1	2	3			
Contracted power (kW)	29.6	29.6	29.6			
€/kW	n.a.	n.a.	n.a.			
€/kWh	n.a.	n.a.	n.a.			

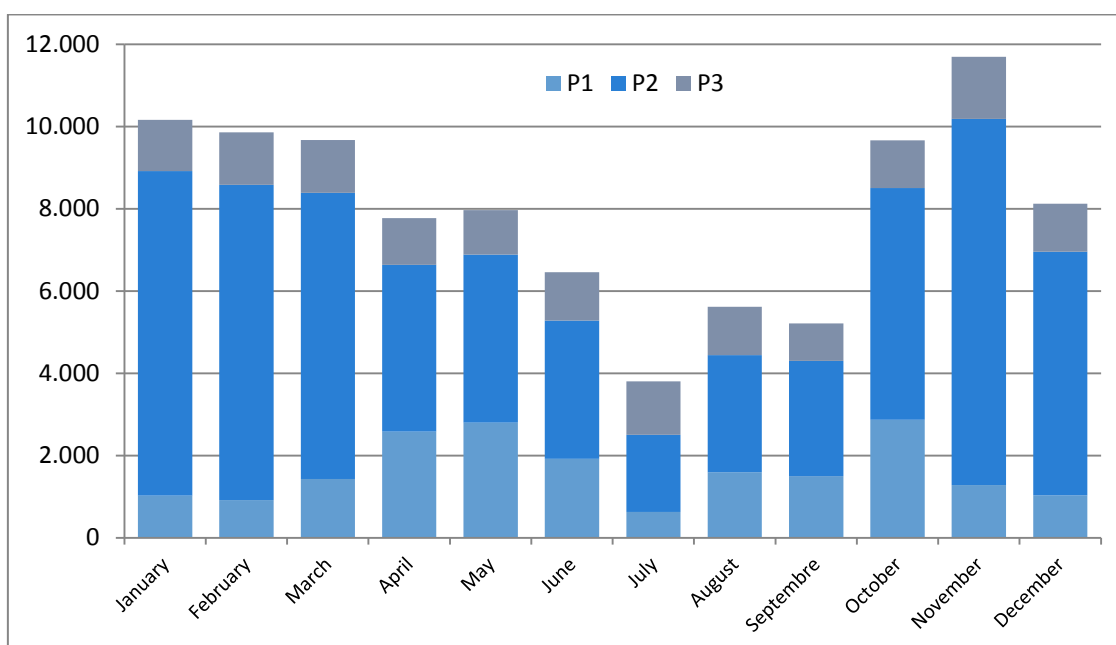


Figure 26: Monthly electrical consumption of Sierra Elvira School complex

Table 16: Electricity consumption of Sierra Elvira School complex

	Jan	Feb	Mar	Apr	May	Jun
kWh	1.025	912	1.426	2.581	2.798	1.918
	Jul	Aug	Sep	Oct	Nov	Dec
kWh	630	624	2.464	2.870	1.277	1.032

Total (kWh): 19.555

5.2 Fuel supply and consumption

Table 17: Information about fuel supply of Sierra Elvira building

Energy supplier (Name of organization)	Several suppliers
Contratred energy/flow	> 550.000 kWh/year
Tariff	n.a.
N° tariff periods	n.a.
€/kWh	Variable
€/kWh Special Tax Hydrocarbon	n.a.

Table 18: Gas consumption of Sierra Elvira building

	Jan	Feb	Mar	Apr	May	Jun
kWh	96.826	102.373	85.666	42.973	0	0
	Jul	Aug	Sep	Oct	Nov	Dec
kWh	0	0	-	44.862	96.253	86.533

Total (kWh): 555.486

6 Building Management System

Sierra Elvira School Complex is provided with a monitoring and control system in their boilers rooms. The system only has control over energy production and is located in boilers room. The variable to control energy production is the return temperature.

6.1 Energy generation monitoring and control

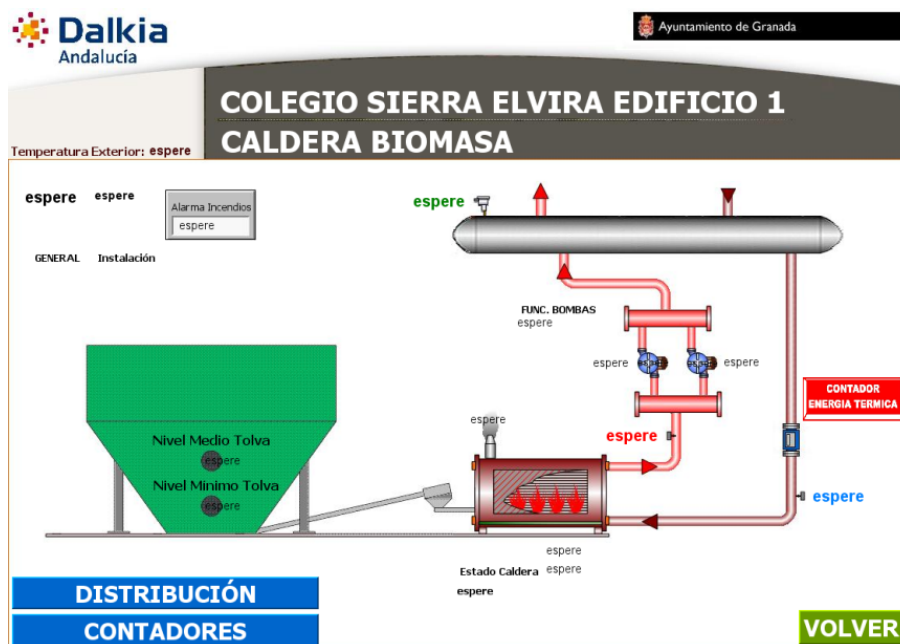


Figure 27: Heat production management of Sierra Elvira School boiler room 1

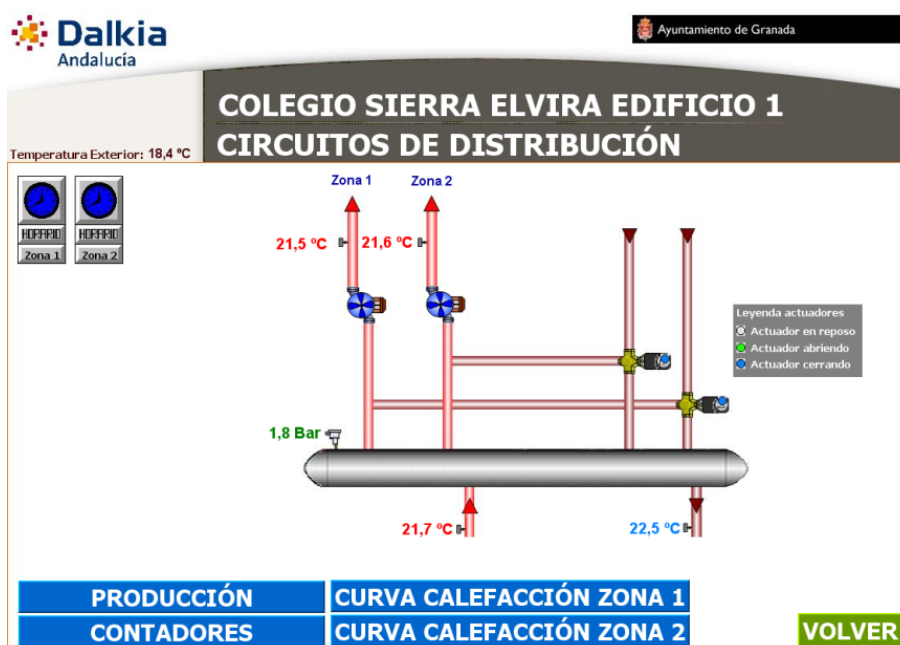


Figure 28: Heating system management of Sierra Elvira School boiler room 1

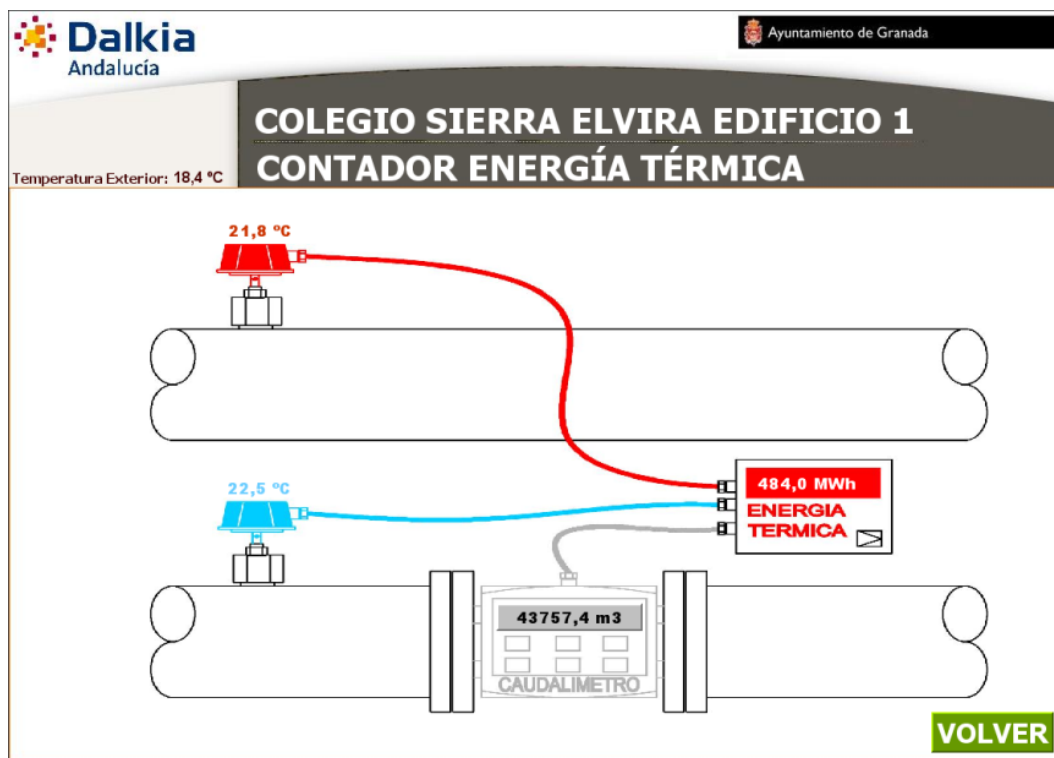


Figure 29: Energy metering of Sierra Elvira School boiler room 1



Figure 30: Management of heating values of Sierra Elvira School boiler room 1

Table 19: BMS installed devices and power balance of Sierra Elvira building

Device	Model	Manufacturer	Power (W)	Voltage (V)
Web Enabled Controller	IQ 3XCITE/96	TREND CONTROLS		46VA
Standard I/O Module	XCITE/IO/16DI	TREND CONTROLS		36 mA
Standard I/O Module	XCITE/IO/8DO	TREND CONTROLS		100 mA
Temperature sensor	TB/TI	TREND CONTROLS		
External Temperature sensor	TB/TI	TREND CONTROLS		
Energy meter	MULTICAL 601	KAMSTRUP		

6.2 Control strategies

6.2.1 Heating system

Control strategy for heating systems is based on external temperature and regulated bay return temperature in each circuit.

Table 20: Systems level control strategies of Sierra Elvira building

SYSTEM	Programming	WINTER: 1 st DEC – 1 st MAR		
	Days	MON	TUE - FRI	WEEKEND
	Set points	Depend external temperature		OFF
	Scheduling	06:00 – 17:00	06:00 – 13:30	24H
	Programming	NORMAL: 1 st NOV – 1 st DEC AND 1 st MAR – 1 st MAY		
	Days	WORKING DAYS		WEEKEND
	Set points	Depend external temperature		OFF
	Scheduling	07:00 – 11:00		24H

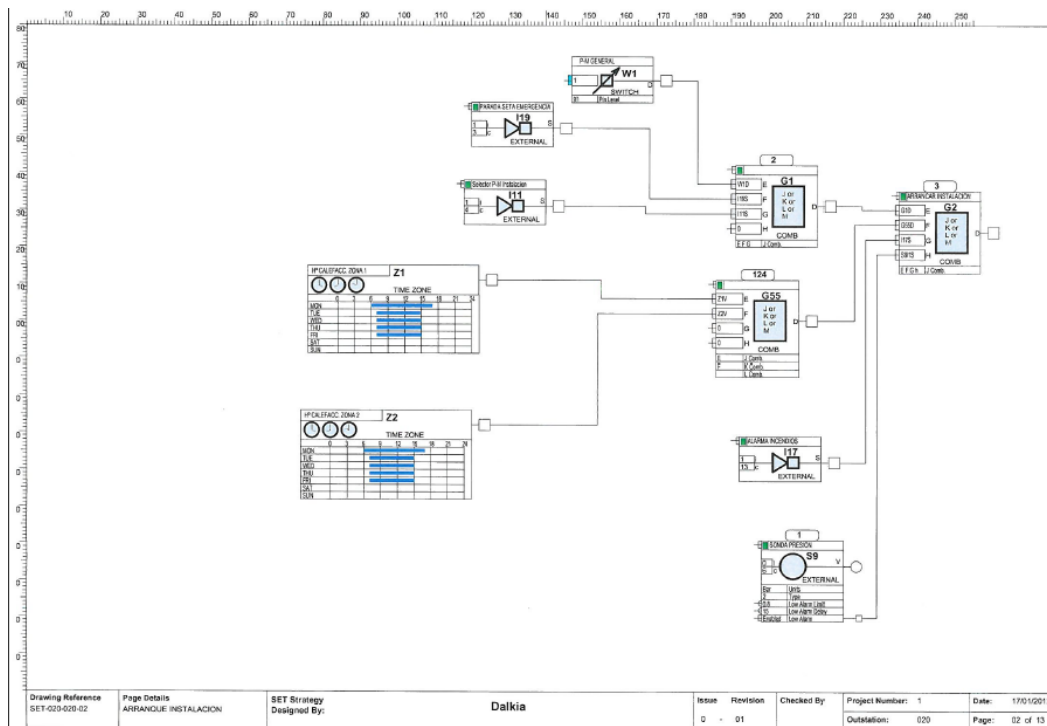


Figure 31: Strategy for installation start

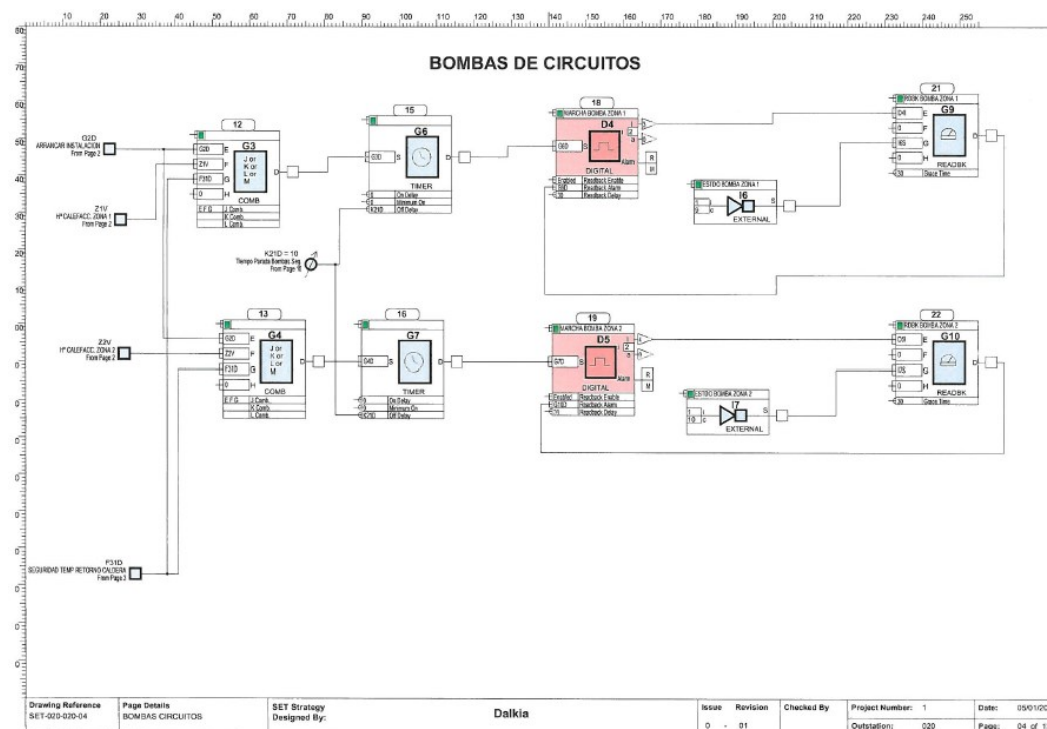


Figure 32: Strategy for circuit pumps

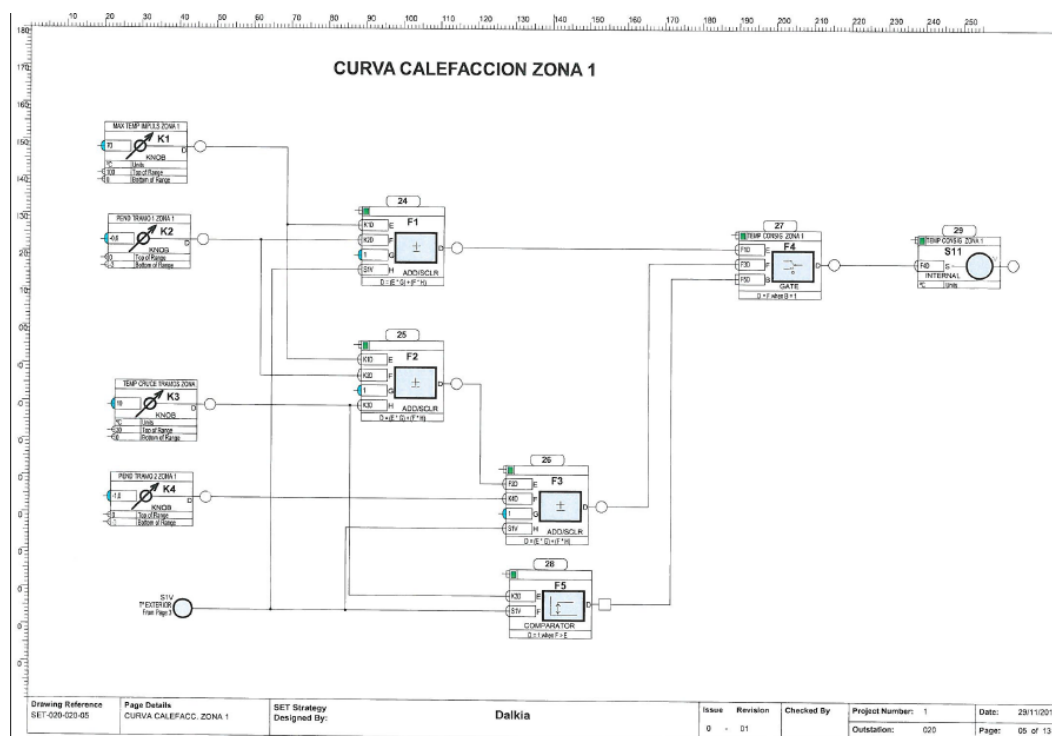


Figure 33: Strategy for heating curve: circuit 1

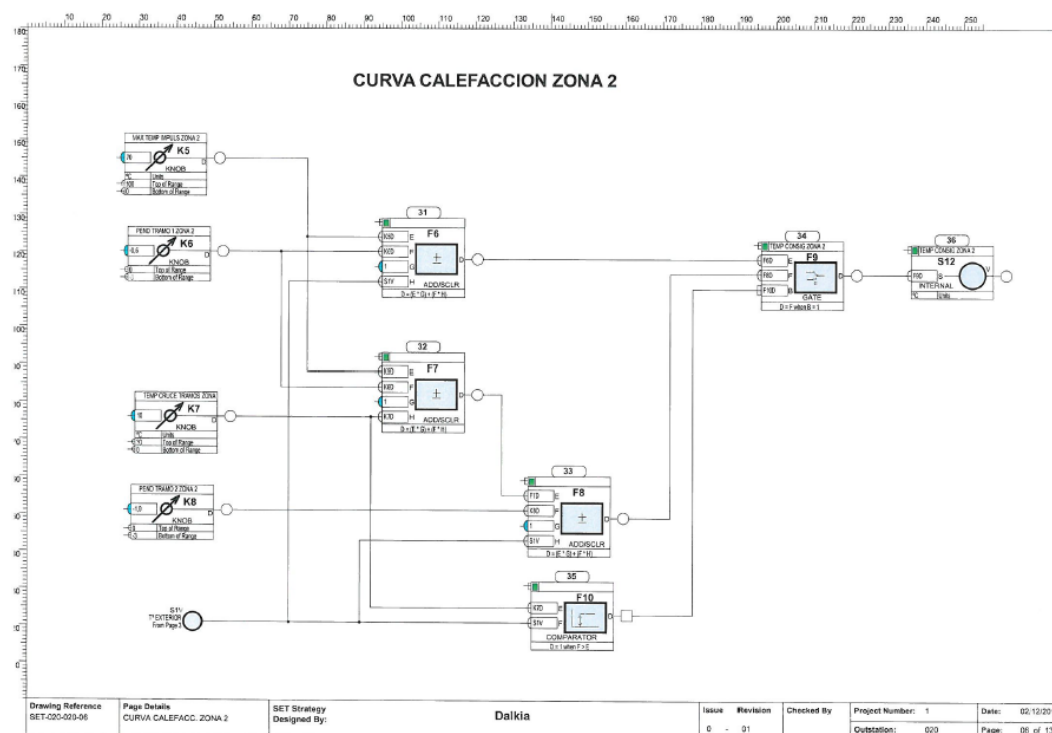


Figure 34: Strategy for heating curve: circuit 2

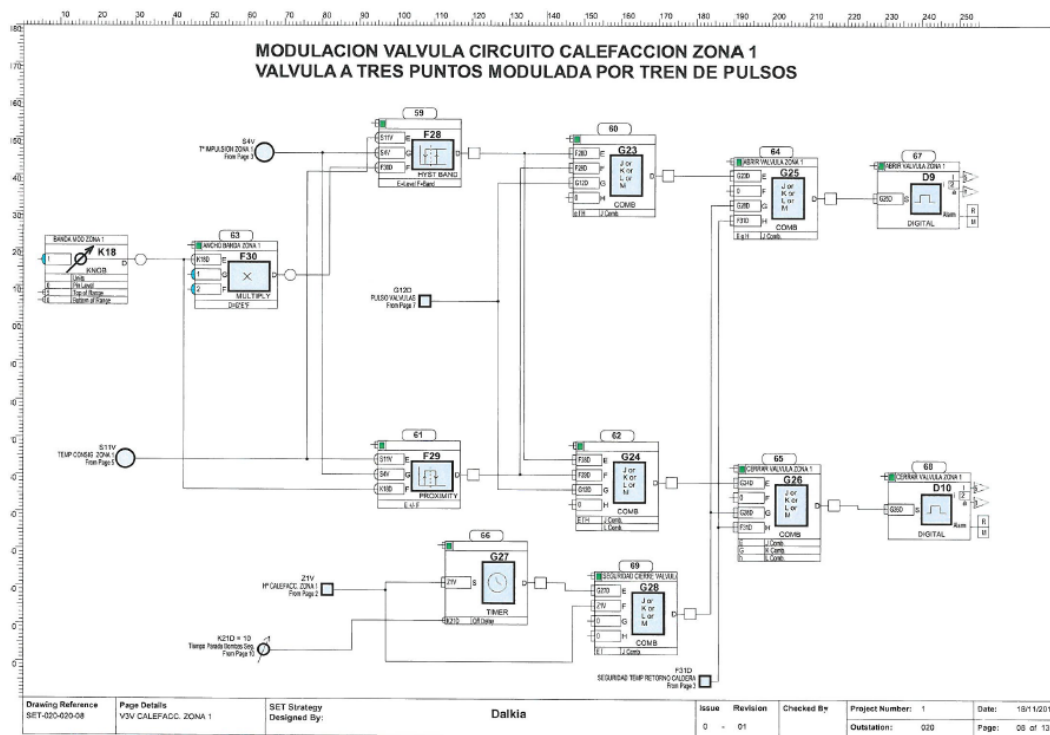


Figure 35: Strategy for heating three-way valve: circuit 1

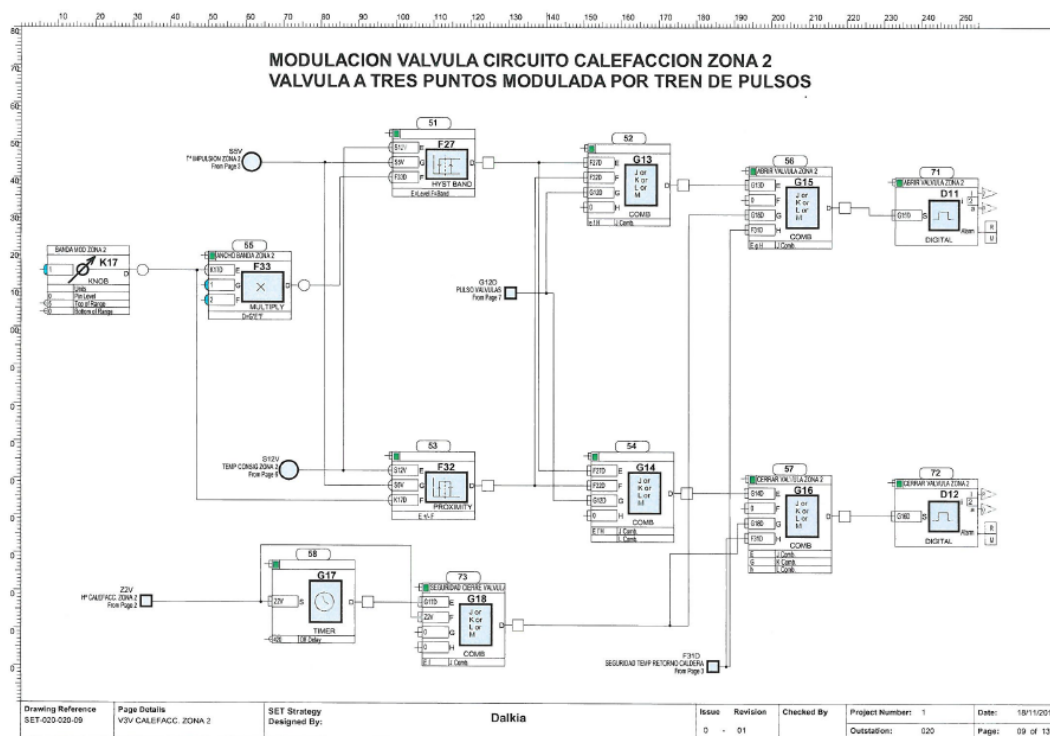


Figure 36: Strategy for heating three-way valve: circuit 2

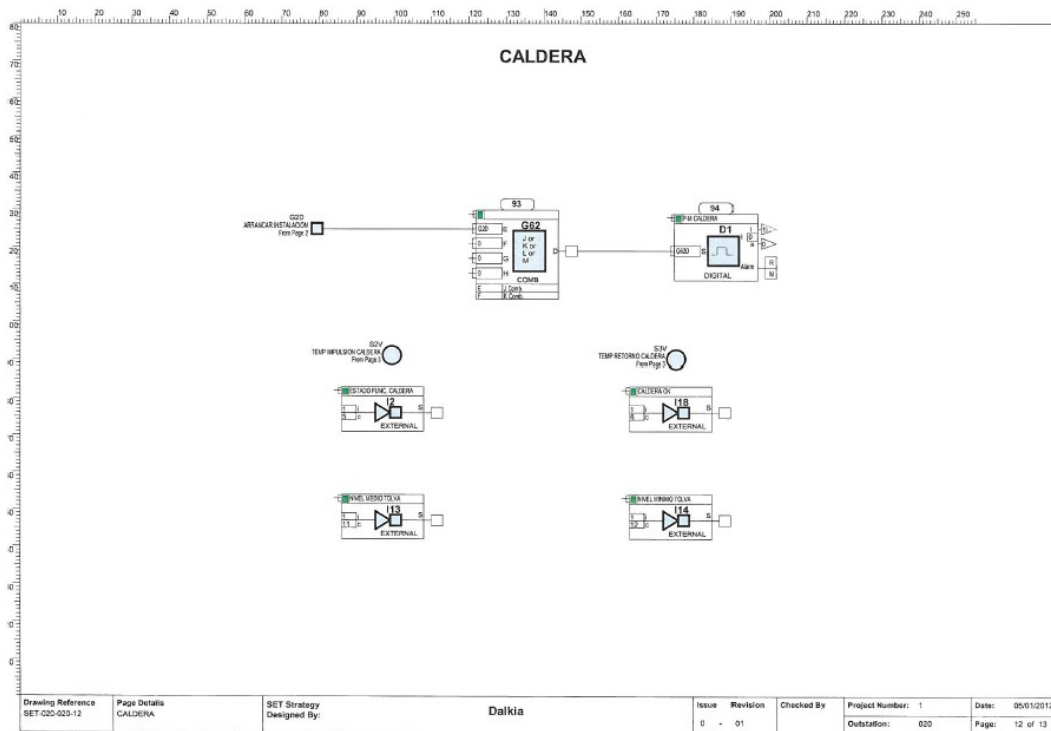


Figure 37: Strategy for biomass boiler

6.2.2 Existing controls

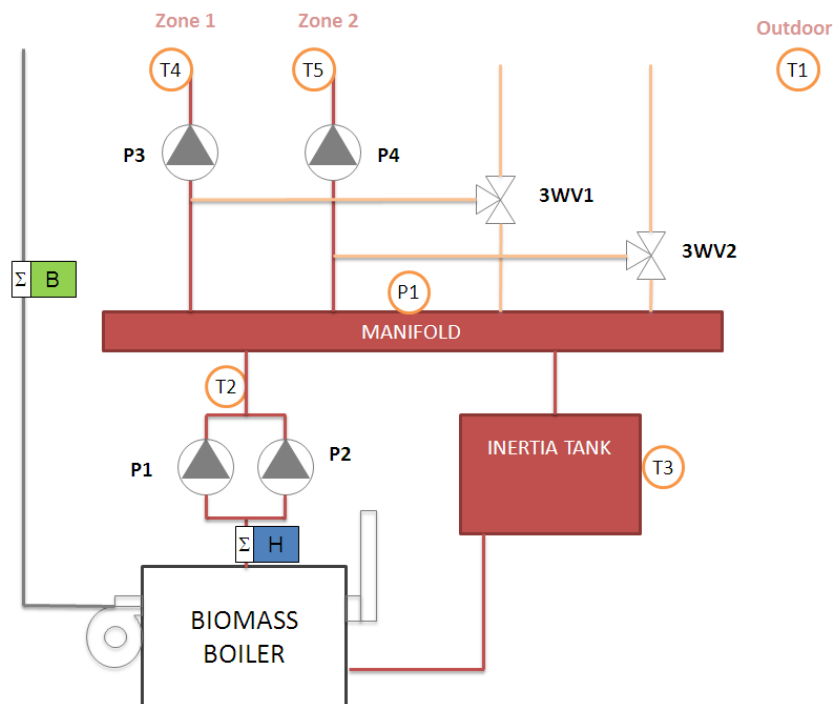


Figure 38: Heating generation scheme

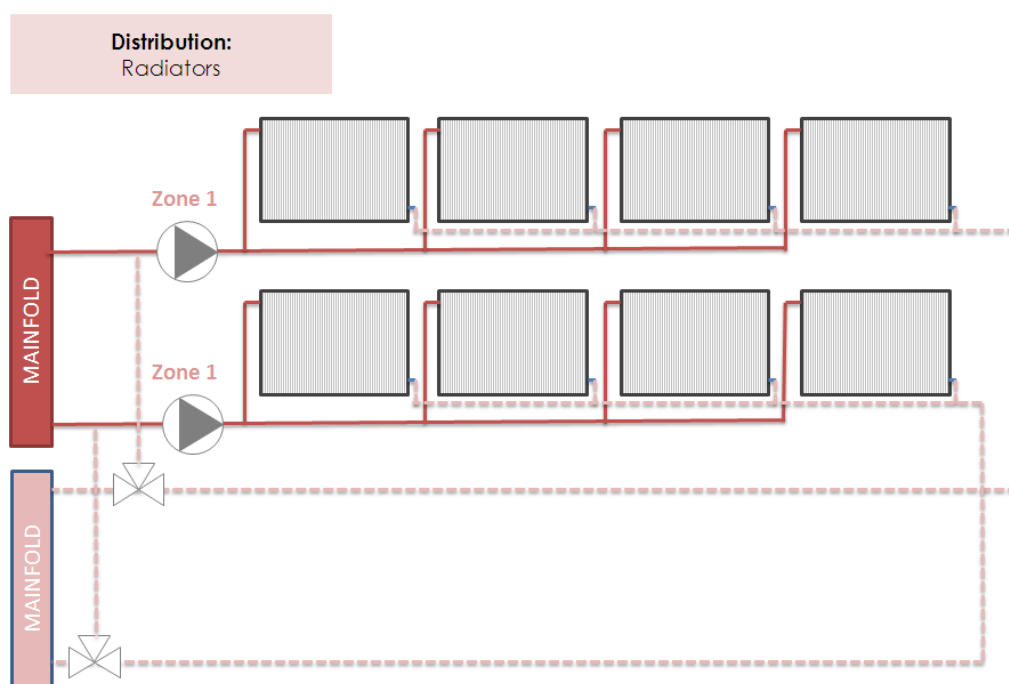


Figure 39: Heating distribution scheme

Table 21: Boiler related sensors

System	ID	Description	Unit
Boiler	T1	Outdoor temperature	°C
	T2	Supply temperature from boiler	°C
	T3	Return temperature to boiler	°C
	T4	Supply temperature from Zone 1	°C
	T5	Supply temperature from Zone 2	°C
	P1	Pressure sensor	°C
	P1	Pump 1	On - Off
	P2	Pump 2	On - Off
	P3	Pump 3	On - Off
	P4	Pump 4	On - Off
	3WV1	Three way valve zone 1	Open - Close
	3WV2	Three way valve zone 2	Open - Close

Table 22: Boiler related control

System	ID	Description	Control
Boiler	Boiler On - Off		Schedule Zone 1 Schedule Zone 2
	P1	Pump Boiler Recirculation	Managed by the boiler
	P2	Pump Boiler Recirculation	Managed by the boiler
	P3	Pump 3	Schedule Zone 1
	P4	Pump 4	Schedule Zone 2
	3WV1	It mixes the return water with the supply water of radiators zone 1.	The set point temperature varies depending on the outside temperature according to a programmed curve.
	3WV2	It mixes the return water with the supply water of radiators zone 2.	The set point temperature varies depending on the outside temperature according to a programmed curve.

7 Historical data: existing data base

7.1 Existing data base

There is no database in Sierra Elvira School.

7.2 Existing historical variables

There is storage with 1,000 values in the controller, which are downloaded weekly in .csv format.

Table 23: Consumed energy parameters of Sierra Elvira building

Consumed Energy				
Concept	Application		Measurement ⁴	Monitoring point and location
Fossil fuel (biomass, natural gas, etc.)	Heating	Y	F + HC	Boilers room
	Cooling	-	-	-
	DHW	-	-	-
Electricity	Heating	--	-	-
	Cooling	-	-	-
	DHW	-	-	-
	Ventilation	-	-	-
	Lighting	Y	E	-
	Appliances	Y	E	-
District energy	District heating	-	-	-
	District cooling	-	-	-

Table 24: Delivered energy parameters of Sierra Elvira building

Delivered energy				
Concept	No.		Explanation	Unit
Biomass system	1	t ₁	Boiler flow temperature	°C
	2	t ₂	Boiler return temperature	°C
	3	t ₃	Circuit 1 flow temperature	°C
	4	t ₃	Circuit 2 flow temperature	°C
	5	p ₁	Boiler pressure	bar

⁴ Electricity meter (E), Fuel meter (F), Water meter (W), Hot/cold water meter (HC), None (N)

	6	f_1	Boiler flow rate	m^3/h
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Table 25: Indoor ambient parameters of Sierra Elvira building

Indoor ambient parameters				
Concept	Measurement		Quantity	Monitoring point and location
Indoor conditions	Temperature	N	-	-
	Relative humidity	N	-	-
	Illumination level	N	-	-
	CO ₂ concentration	N	-	-
	Occupancy	N	-	-
	Window status	N	-	-

8 External data sources: weather data

There is an external temperature sensor in each boiler room.

Table 26: Outdoor ambient parameters of Sierra Elvira building

Outdoor ambient parameters				
Concept	No.		Explanation	Unit
Outdoor ambient param.	1	t _{ext}	Ambient temperature	°C