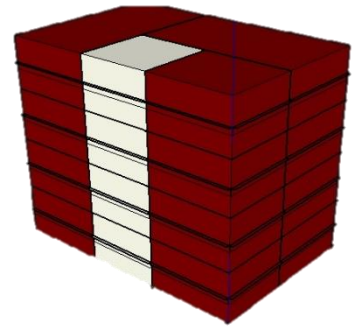
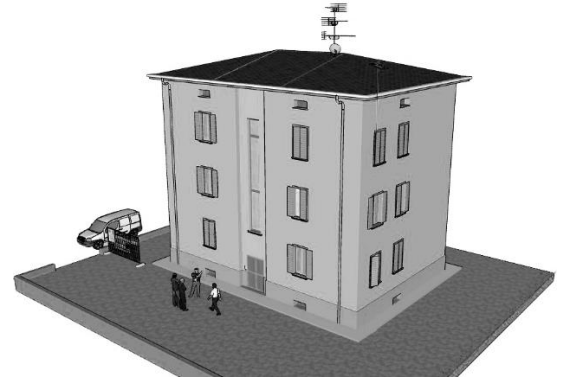


## TECHNICAL ENVIRONMENTAL SYSTEMS FINAL REPORT

The building takes in consideration is a block of flats, located in three different location around Europe: Italy (Piacenza), Spain (Barcelona) and Norway (Oslo).

The technical report is studied upon an ideal model of the building, which comprehends 600 m<sup>2</sup> of gross surface, divided in 4 floors over ground. The ideal model is studied in three different solution: existing condition, first solution (adding insulation to external walls), second solution (adding insultation to external walls and roof).

The building is principally divided in two thermal zones per floor: apartments and stairwell.



### FIRST LOCATION\_PIACENZA [Italy]

#### WEATHER SUMMARY

Location	Piacenza [Italy]
Latitude	44.92
Longitude	9.73
Elevation	134.112m
Time Zone	UTC +1

#### BUILDING SUMMARY

Net Site Energy	133 852.9 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	2072.9 kWh/m <sup>2</sup>

#### SPACE TYPE SUMMARY

DEFINITION	VALUE	UNIT	INST. MULTIPLIER
People Definition	0.030	People/m <sup>2</sup>	1,0
Electric Equipment Definition	3.875	W/m <sup>2</sup>	1,0
Lights Definition	10.656	W/m <sup>2</sup>	1,0
Infiltration	0.0446	cfm/ext suf	

## EXISTING SITUATION

### EXISTING EXTERNAL WALL CONSTRUCTION

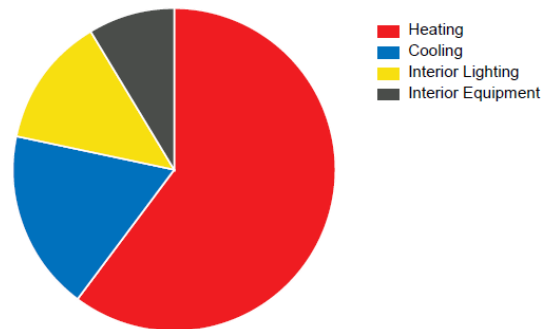
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.6918	1858	837
Concrete	203.3	1.7296	2243	837
Gypsum	12.70	0.1600	784	837

### EXISTING ROOF CONSTRUCTION

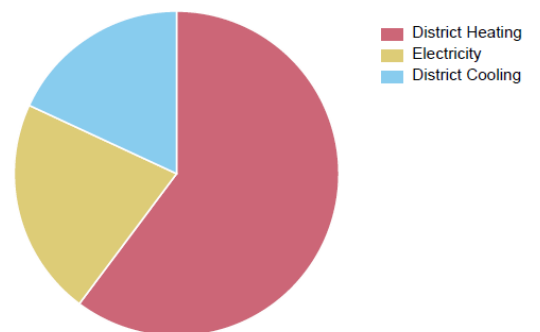
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Metal decking	1.5	45.0060	7680	418,4000

### ANNUAL OVERVIEW

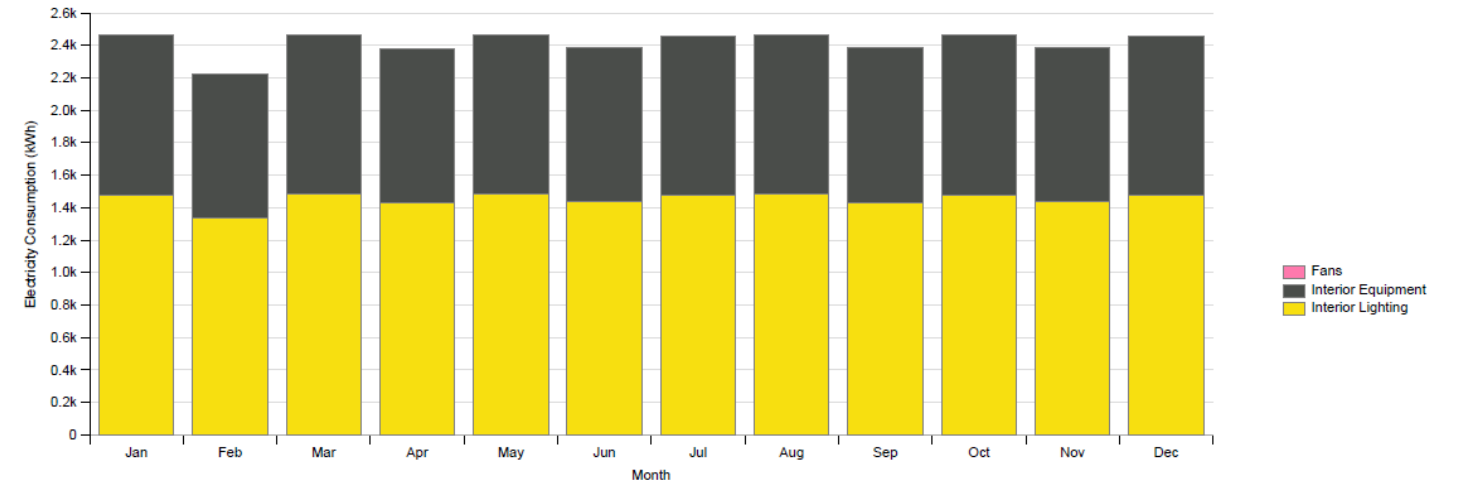
End Use	Consumption [kWh]
Heating	80 611.25
Cooling	24 224.96
Interior Lighting	17 425.13
Interior Equipment	17 452.97



Energy use	Consumption [kWh]
Electricity	31 511.45
District Cooling	14 932.20
District Heating	72 929.34



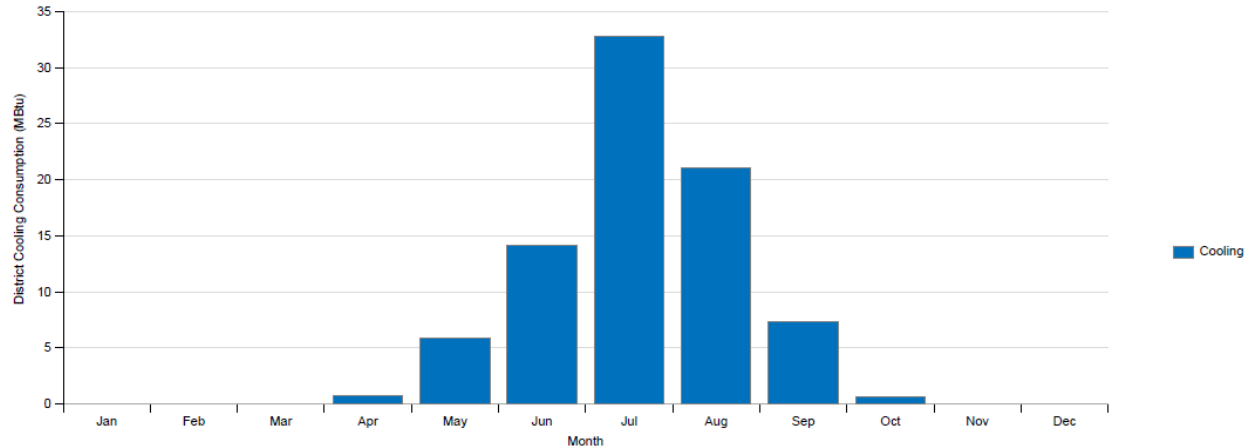
MONTHLY OVERVIEW



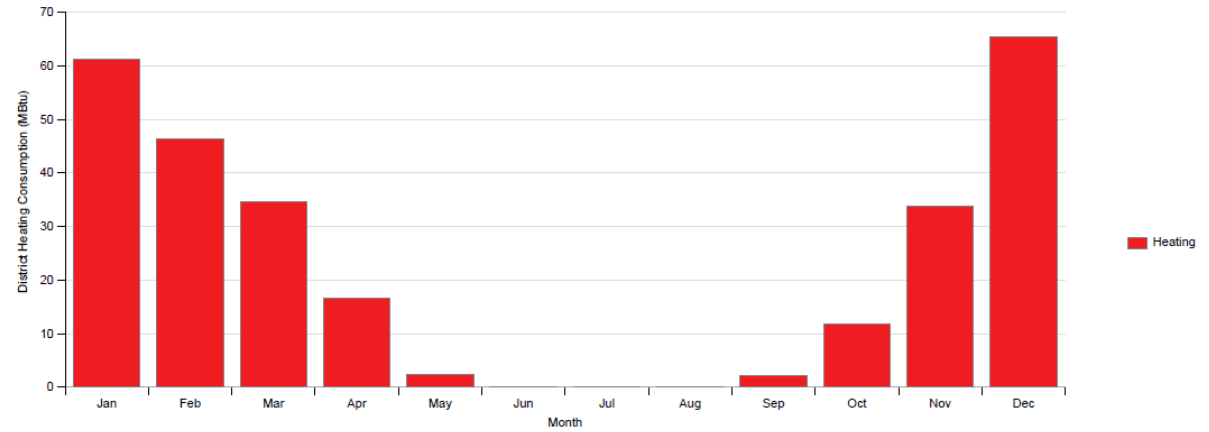
ELECTRICITY CONSUMPTION [kWh]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1478.98	1337.03	1483.74	1426.79	1483.74	1434.84	1475.69	1483.74	1431.54	1478.98	1434.84	1475.69	17425.59
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2463.41	2226.19	2468.17	2379.46	2468.17	2387.51	2460.12	2468.17	2384.21	2463.41	2387.51	2460.12	29016.44

DISTRICT COOLING CONSUMPTION



DISTRICT HEATING CONSUMPTION



## FIRST SOLUTION

### BUILDING SUMMARY

Net Site Energy	128 266.07 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	1828.72 kWh/m <sup>2</sup>

### EXTERNAL WALL CONSTRUCTION

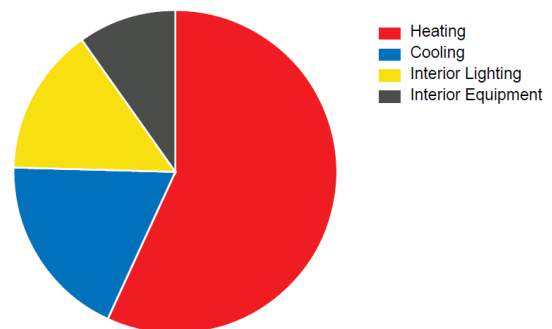
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.69	1858	837
Concrete HW	203.3	1.7296	2243	837
Wall insulation	33.70	0.0432	91	837
Gypsum	12.70	0.1600	784	830

### ROOF CONSTRUCTION

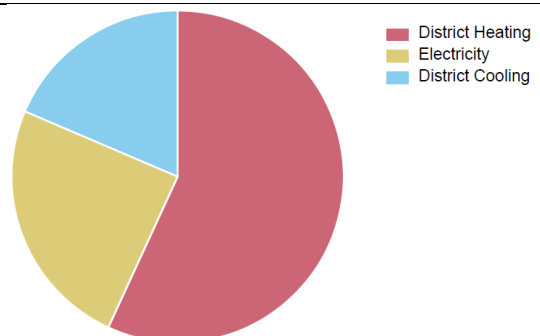
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Metal decking	1.5	45.0060	7680	418.4000

### ANNUAL OVERVIEW

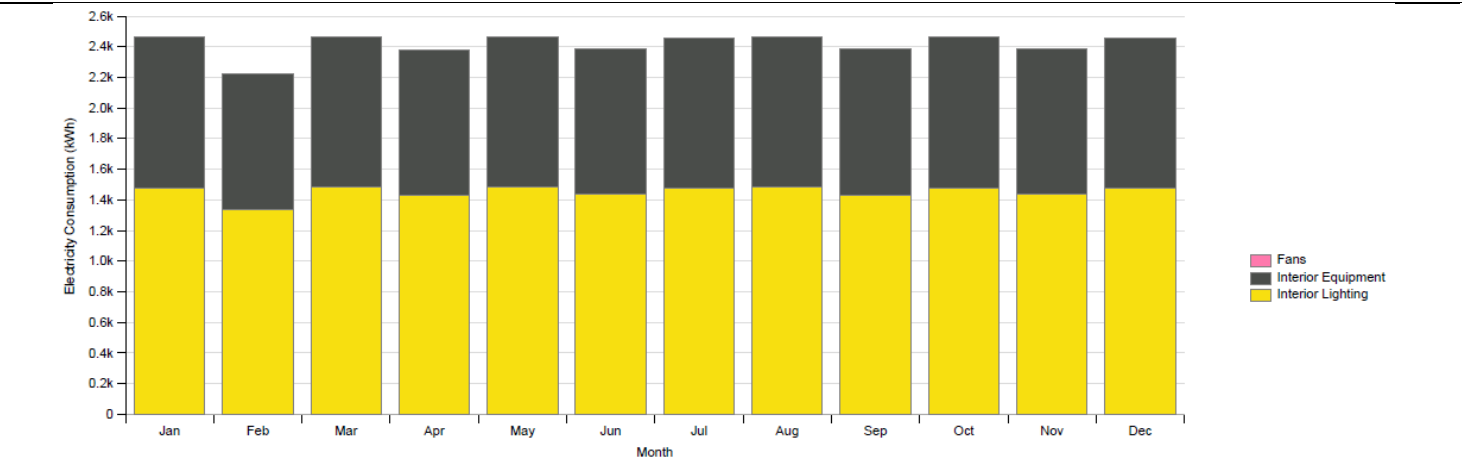
End Use	Consumption [kWh]
Heating	67 155.48
Cooling	21 939.01
Interior Lighting	17 425.13
Interior Equipment	11 591.55



Energy use	Consumption [kWh]
Electricity	31 511.45
District Cooling	14 932.20
District Heating	72 929.34



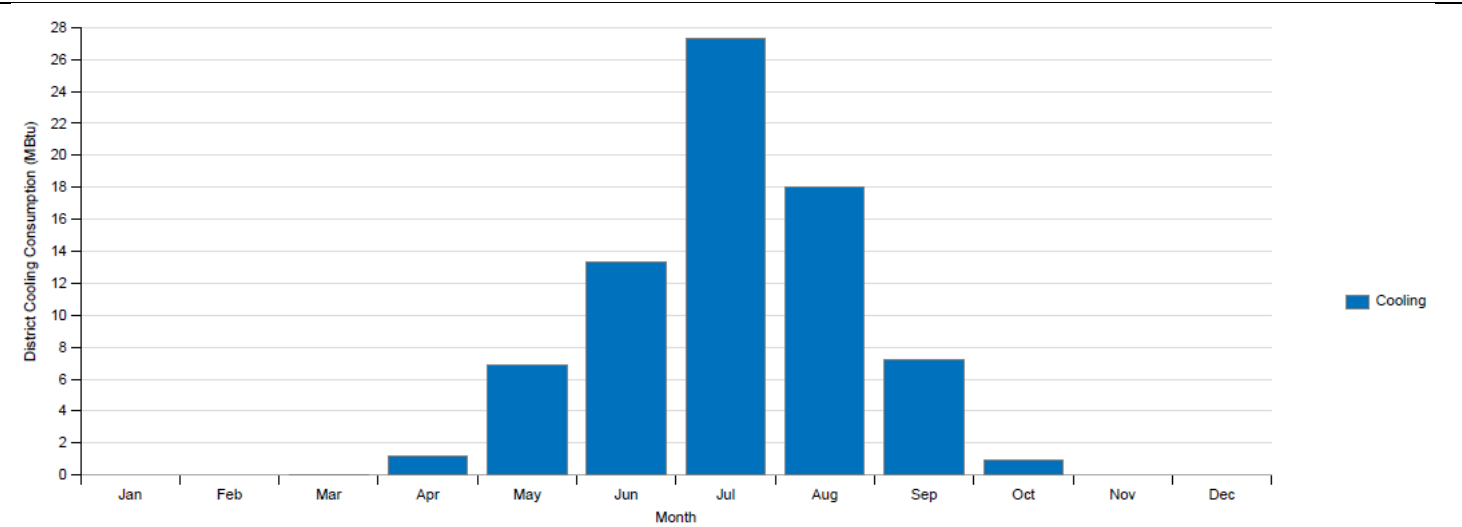
MONTHLY OVERVIEW



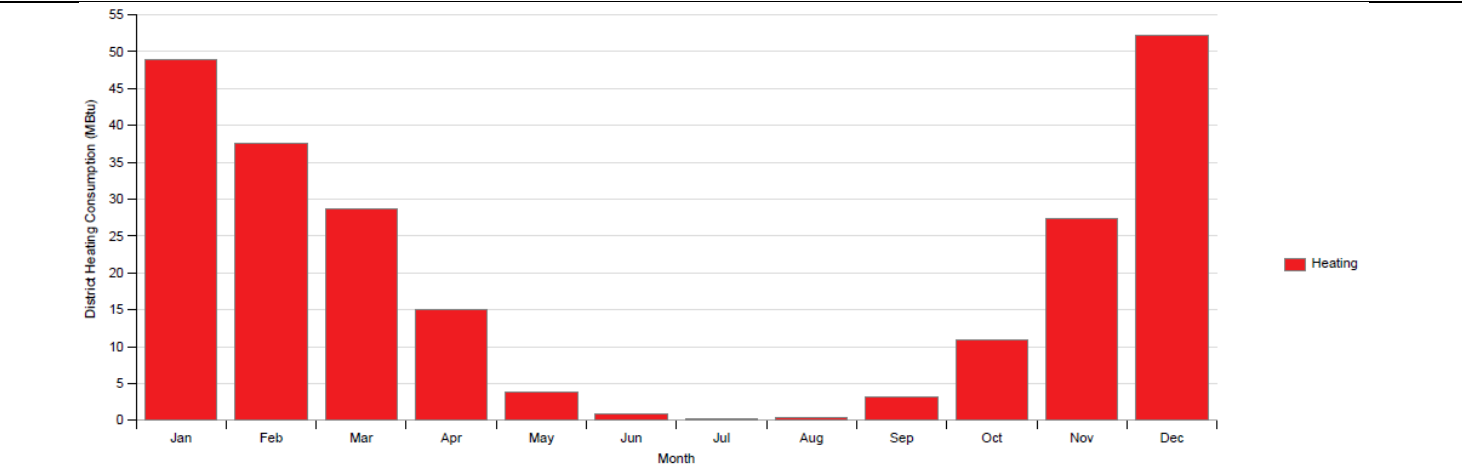
ELECTRICITY CONSUMPTION [KWH]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1478.98	1337.03	1483.74	1426.79	1483.74	1434.84	1475.69	1483.74	1431.54	1478.98	1434.84	1475.69	17425.59
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2463.41	2226.19	2468.17	2379.46	2468.17	2387.51	2460.12	2468.17	2384.21	2463.41	2387.51	2460.12	29016.44

DISTRICT COOLING CONSUMPTION



DISTRICT HEATING CONSUMPTION



SECOND SOLUTION

BUILDING SUMMARY

Net Site Energy	86 232.65 kWh
Total Building Area	600 m²
EUI [based on Net Site Energy and Total Building Area]	1229.3 kWh/ m²

ESTERNAL WALL CONSTRUCTION

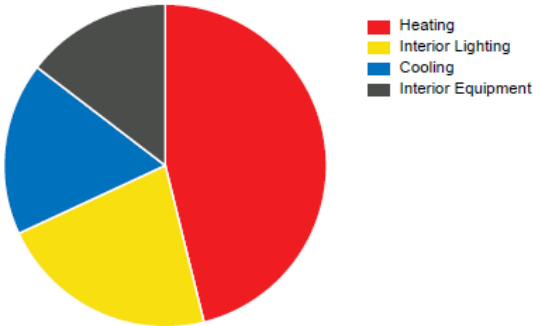
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m³]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.69	1858	837
Concrete HW	203.3	1.7296	2243	837
Wall insulation	33.70	0.0432	91	837
Gypsum	12.70	0.1600	784	830

ROOF CONSTRUCTION

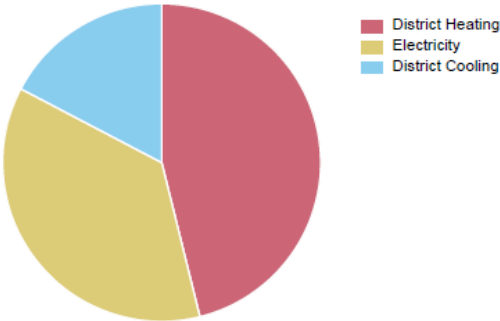
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m³]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Roof insulation	169.3	0.049	265	836.8
Metal decking	1.5	45.006	7680	418.4

ANNUAL OVERVIEW

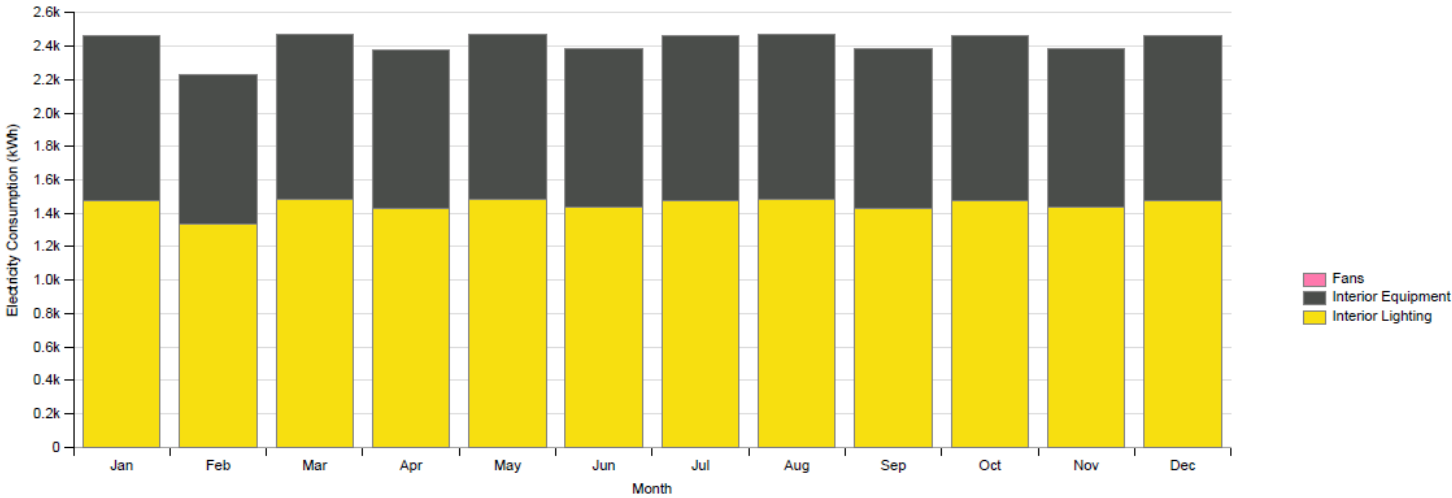
End Use	Consumption [kWh]
Heating	39 788.98
Cooling	14 932.20
Interior Lighting	18 923.29
Interior Equipment	12588.16



Energy use	Consumption [kWh]
Electricity	31 511.45
District Cooling	14 932.20
District Heating	72 929.34



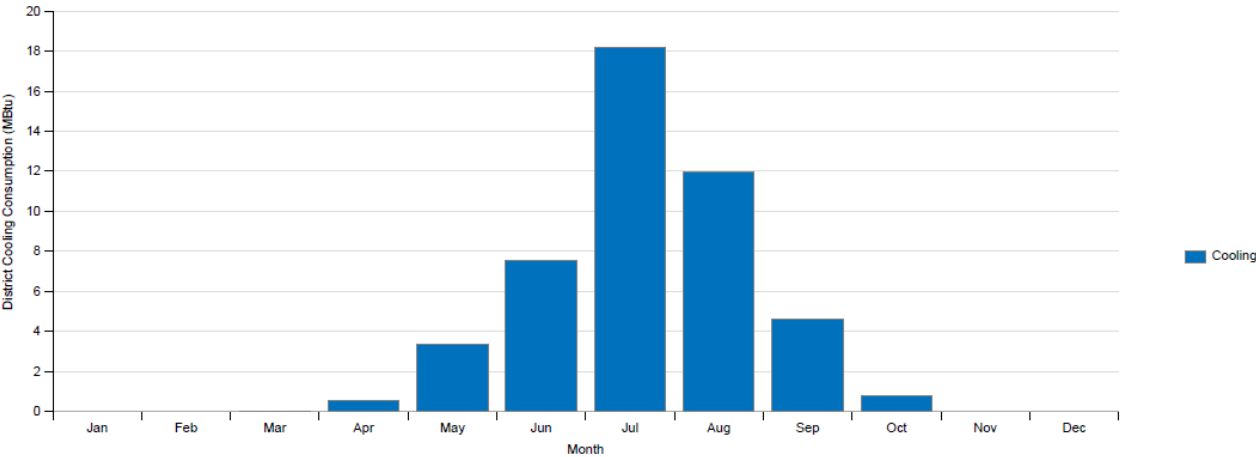
MONTHLY OVERVIEW



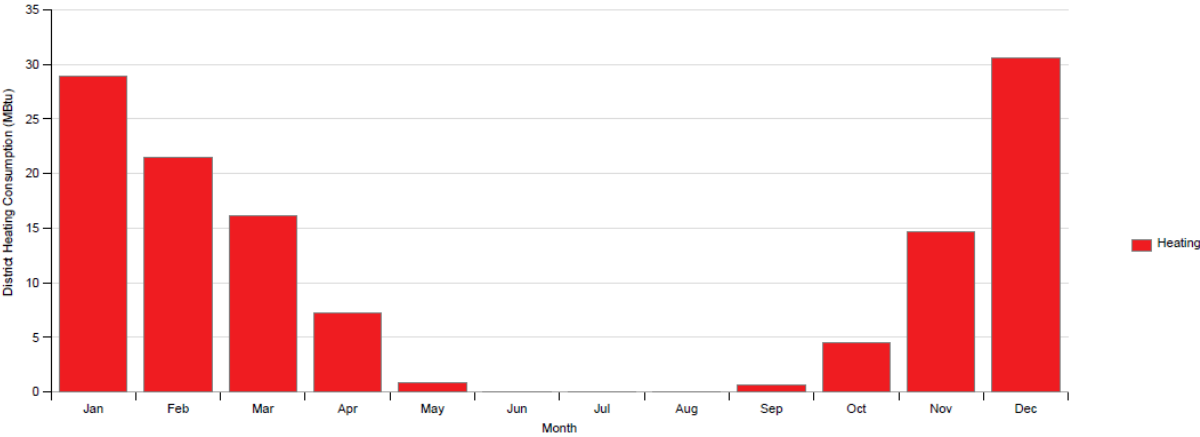
ELECTRICITY CONSUMPTION [kWh]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1478.98	1337.03	1483.74	1426.79	1483.74	1434.84	1475.69	1483.74	1431.54	1478.98	1434.84	1475.69	17425.59
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2463.41	2226.19	2468.17	2379.46	2468.17	2387.51	2460.12	2468.17	2384.21	2463.41	2387.51	2460.12	29016.44

DISTRICT COOLING CONSUMPTION



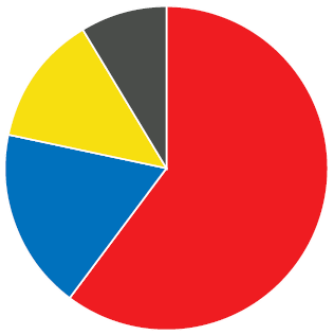
DISTRICT HEATING CONSUMPTION



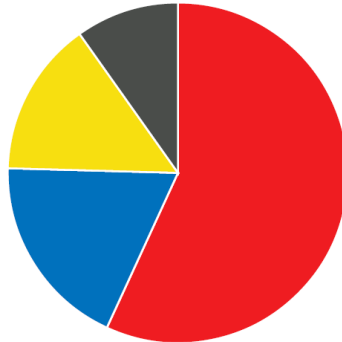
## FIRST LOCATION [PIACENZA]\_SOLUTIONS' COMPARISON

### END USE

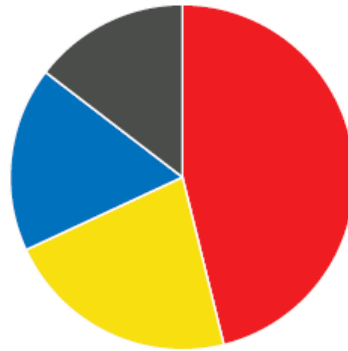
#### EXISTING



#### FIRST SOLUTION



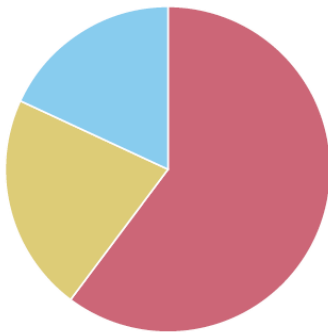
#### SECOND SOLUTION



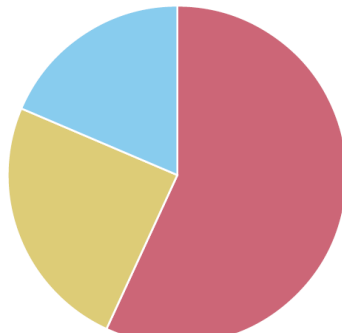
■ Heating  
■ Interior Lighting  
■ Cooling  
■ Interior Equipment

### ENERGY USE

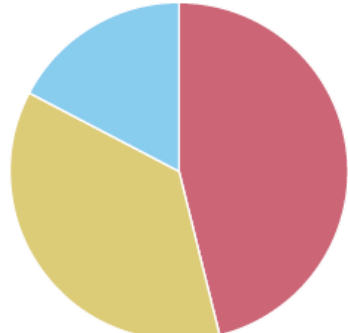
#### EXISTING



#### FIRST SOLUTION



#### SECOND SOLUTION



■ District Heating  
■ Electricity  
■ District Cooling

### EUI

#### EXISTING

2 072.9 kWh/m<sup>2</sup>

#### FIRST SOLUTION

1 828.72 kWh/m<sup>2</sup>

#### SECOND SOLUTION

1 229.3 kWh/m<sup>2</sup>

### DISTRICT COOLING CONSUMPTION [kWh]

Interior:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Tot
Existing					5.91	14.18	32.82	21.04	7.36				82.66
1 <sup>st</sup> Sol.				1.15	6.91	13.33	27.34	17.98	7.19	0.95			74.86
2 <sup>nd</sup> Sol.					3.33	7.54	18.17	11.96	4.62				46.92

### DISTRICT HEATING CONSUMPTION [kWh]

Interior:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Tot
Existing	61.27	46.42	34.74	16.59	2.4				2.18	11.78	33.88	65.45	275.06
1 <sup>st</sup> Sol.	48.85	37.5	28.68	15.04	3.89				3.14	10.86	27.34	52.27	229.14
2 <sup>nd</sup> Sol.	28.88	21.47	16.1	7.3	0.83				0.65	4.51	14.65	30.57	125.01



## CONCLUSION

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As Piacenza encounters a variety of temperature over the year, we see a mayor difference in consumption when the implementation of materials is placed to isolate the external climate. As we compare the existing situation with the two other solutions, thus we have applied different materials for covering the building, the Energy Use Consumption does not vary as the End Use of Heating and Cooling Consumption does. Between the existing situation and the first solution that implements the Wall Insulation, the numbers differ almost in 13,000 kWh of Heating Consumption and 2,000 kWh in Cooling Consumption. But if we implement the second solution, it adds on the Roof Insulation as well as the Wall insulation, and the Energy Consumption in Heating and Cooling differs in almost 50% if compared with the existing situation, concluding that the insolation of walls and roof can save up to half of Energy Consumption in Heating and Cooling in Piacenza.

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## SECOND LOCATION\_BARCELONA [Spain]

### WEATHER SUMMARY

Location	Barcelona
Latitude	41.28
Longitude	2.07
Elevation	6.1 m
Time Zone	UTC +1

### BUILDING SUMMARY

Net Site Energy	90 241.56 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	1397.19 kWh/m <sup>2</sup>

### SPACE TYPE SUMMARY

DEFINITION	VALUE	UNIT	INST. MULTIPLIER
People Definition	0.030	People/m <sup>2</sup>	1,0
Electric Equipment Definition	3.875	W/m <sup>2</sup>	1,0
Lights Definition	10.656	W/m <sup>2</sup>	1,0
Infiltration	0,0446	cfm/ext suf	

## EXISTING SITUATION

### EXISTING EXTERNAL WALL CONSTRUCTION

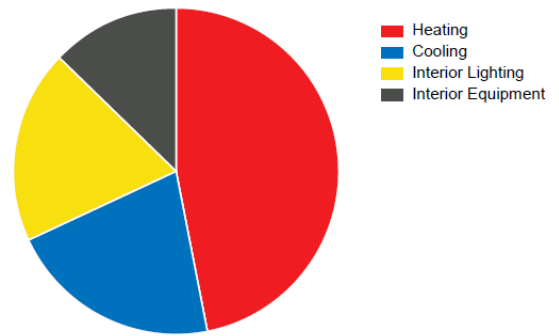
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.6918	1858	837
Concrete	203.3	1.7296	2243	837
Gypsum	12.70	0.1600	784	837

### EXISTING ROOF CONSTRUCTION

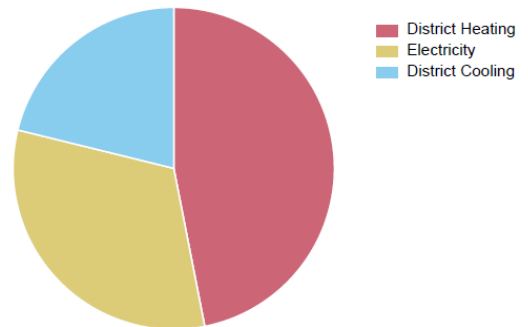
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Metal decking	1.5	45.0060	7680	418,4000

### ANNUAL OVERVIEW

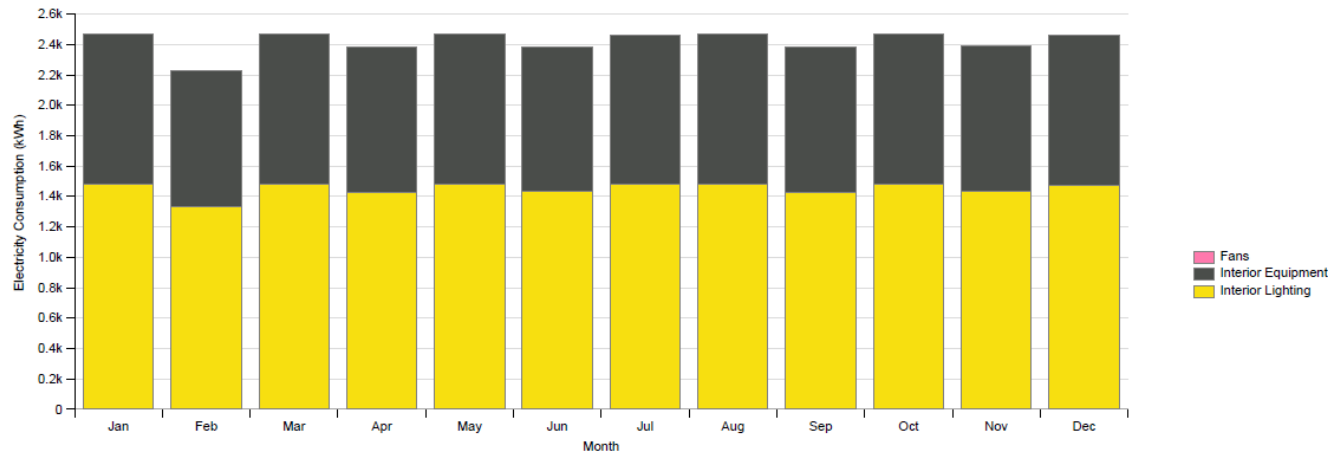
End Use	Consumption [kWh]
Heating	46 352.54
Cooling	20 901.97
Interior Lighting	18 929.34
Interior Equipment	12 588.16



Energy use	Consumption [kWh]
Electricity	31 517.50
District Cooling	20 901.97
District Heating	46 323.04



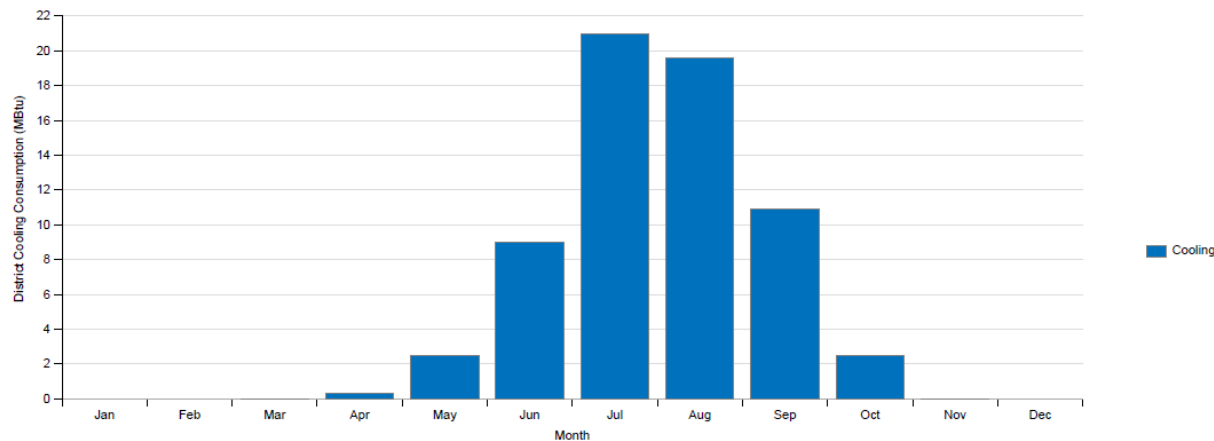
MONTHLY OVERVIEW



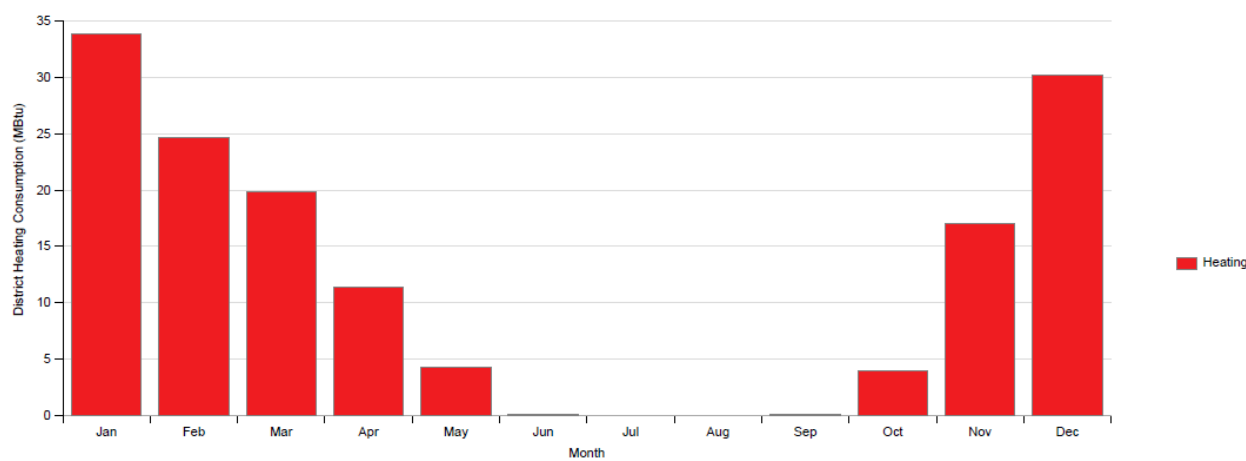
ELECTRICITY CONSUMPTION [kWh]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1483.74	1337.03	1480.44	1430.08	1483.74	1431.54	1478.98	1483.74	1426.79	1483.74	1434.84	1475.69	17430.35
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2468.17	2226.19	2464.87	2382.75	2468.17	2384.21	2463.41	2468.17	2379.46	2468.17	2387.51	2460.12	29021.19

DISTRICT COOLING CONSUMPTION



DISTRICT HEATING CONSUMPTION



## FIRST SOLUTION

### BUILDING SUMMARY

Net Site Energy	90 241.56 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	1317.19 kWh/m <sup>2</sup>

### EXTERNAL WALL CONSTRUCTION

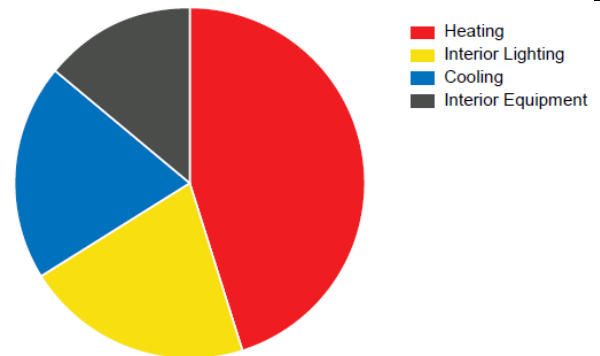
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Stucco	25.3	0.69	1858	837
Concrete HW	203.3	1.7296	2243	837
Wall insulation	33.70	0.0432	91	837
Gypsum	12.70	0.1600	784	830

### ROOF CONSTRUCTION

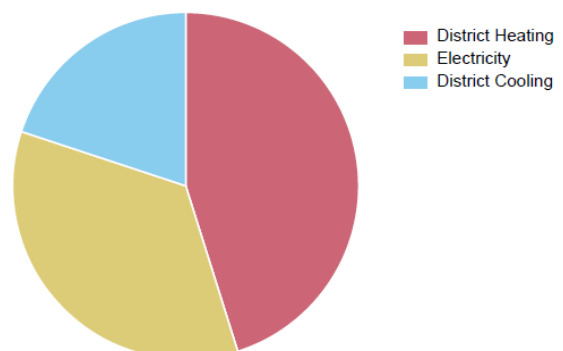
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Metal decking	1.5	45.0060	7680	418.4000

### ANNUAL OVERVIEW

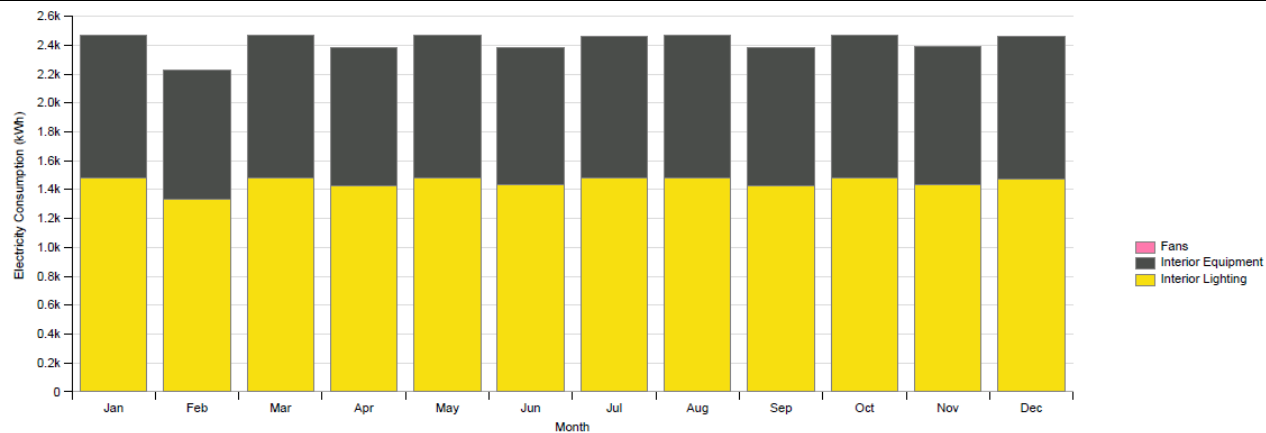
End Use	Consumption [kWh]
Heating	40 733.29
Cooling	17 991.08
Interior Lighting	18 929.34
Interior Equipment	12 588.16



Energy use	Consumption [kWh]
Electricity	31 517.50
District Cooling	17 991.08
District Heating	40 733.29



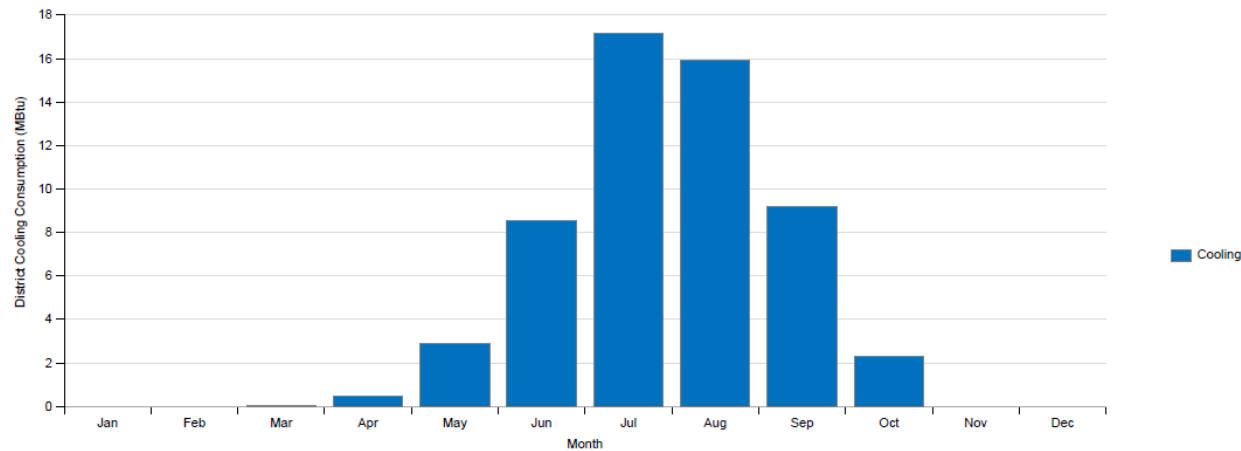
MONTHLY OVERVIEW



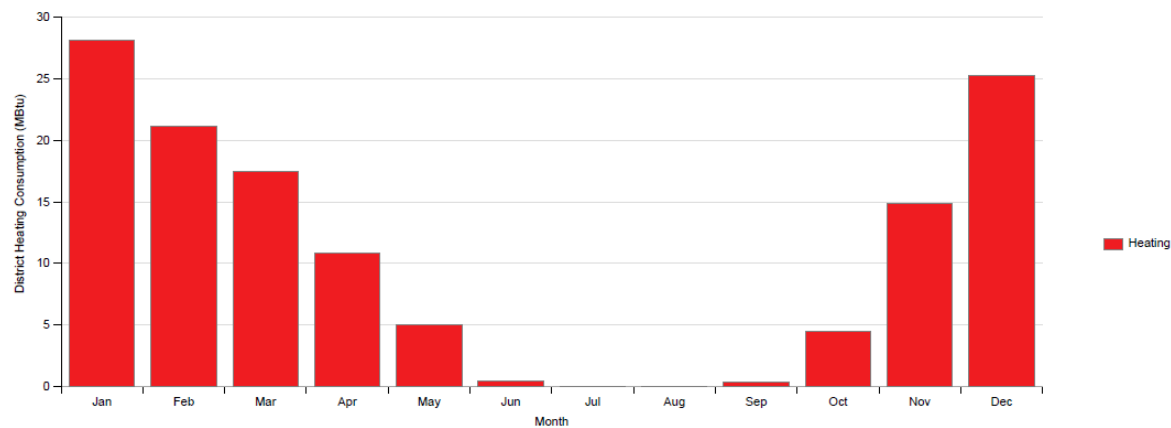
ELECTRICITY CONSUMPTION [kWh]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1483.74	1337.03	1480.44	1430.08	1483.74	1431.54	1478.98	1483.74	1426.79	1483.74	1434.84	1475.69	17430.35
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2468.17	2226.19	2464.87	2382.75	2468.17	2384.21	2463.41	2468.17	2379.46	2468.17	2387.51	2460.12	29021.19

DISTRICT COOLING CONSUMPTION



DISTRICT HEATING CONSUMPTION



SECOND SOLUTION

BUILDING SUMMARY

Net Site Energy	63 149.58 kWh
Total Building Area	600 m²
EUI [based on Net Site Energy and Total Building Area]	977.72 kWh/m²

EXTERNAL WALL CONSTRUCTION

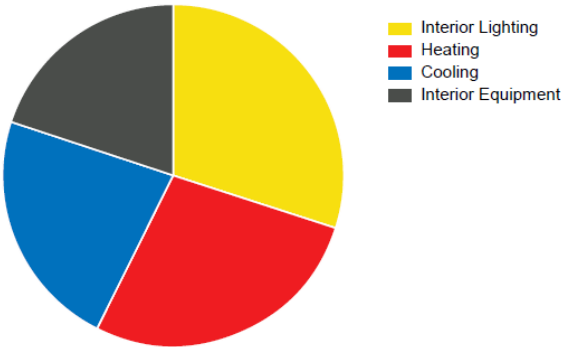
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m³]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.69	1858	837
Concrete HW	203.3	1.7296	2243	837
Wall insulation	33.70	0.0432	91	837
Gypsum	12.70	0.1600	784	830

ROOF CONSTRUCTION

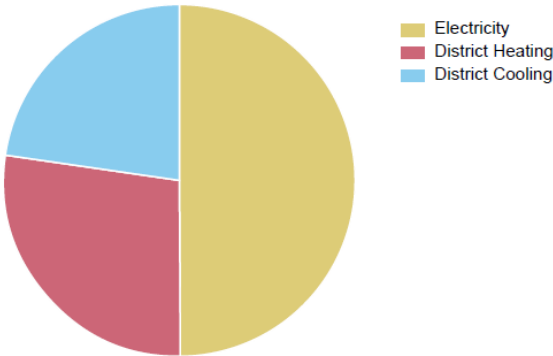
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m³]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Roof insulation	169.3	0.049	265	836.8
Metal decking	1.5	45.006	7680	418.4

ANNUAL OVERVIEW

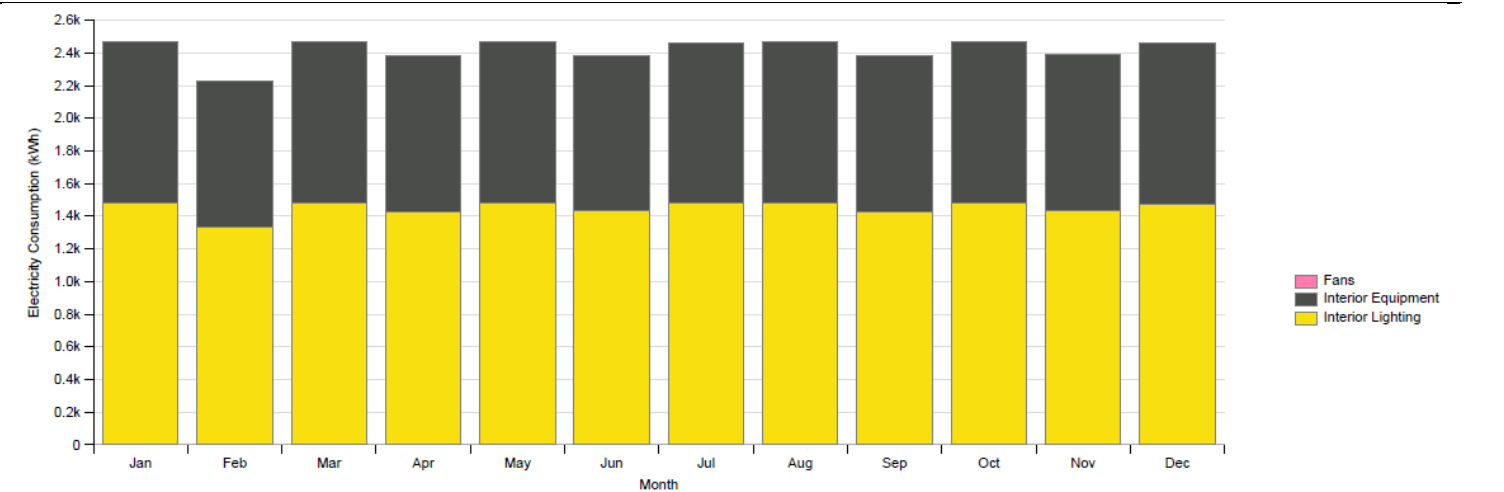
End Use	Consumption [kWh]
Heating	17 294.08
Cooling	14 338
Interior Lighting	18 929.34
Interior Equipment	12 588.16



Energy use	Consumption [kWh]
Electricity	31 517.50
District Cooling	14 338
District Heating	17 294.08



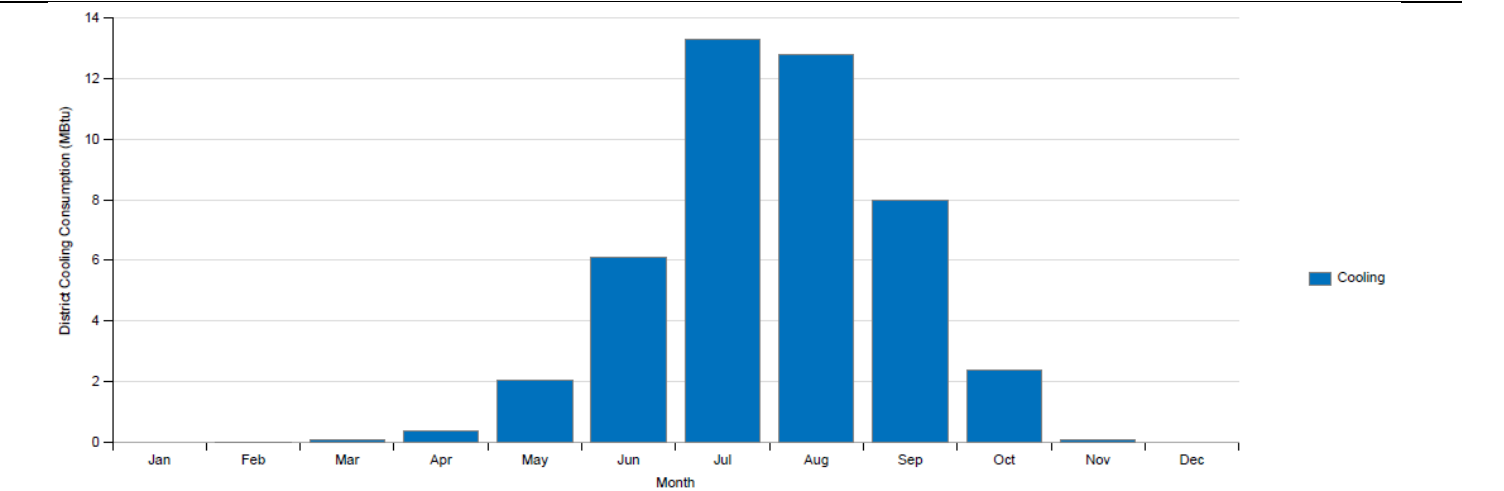
MONTHLY OVERVIEW



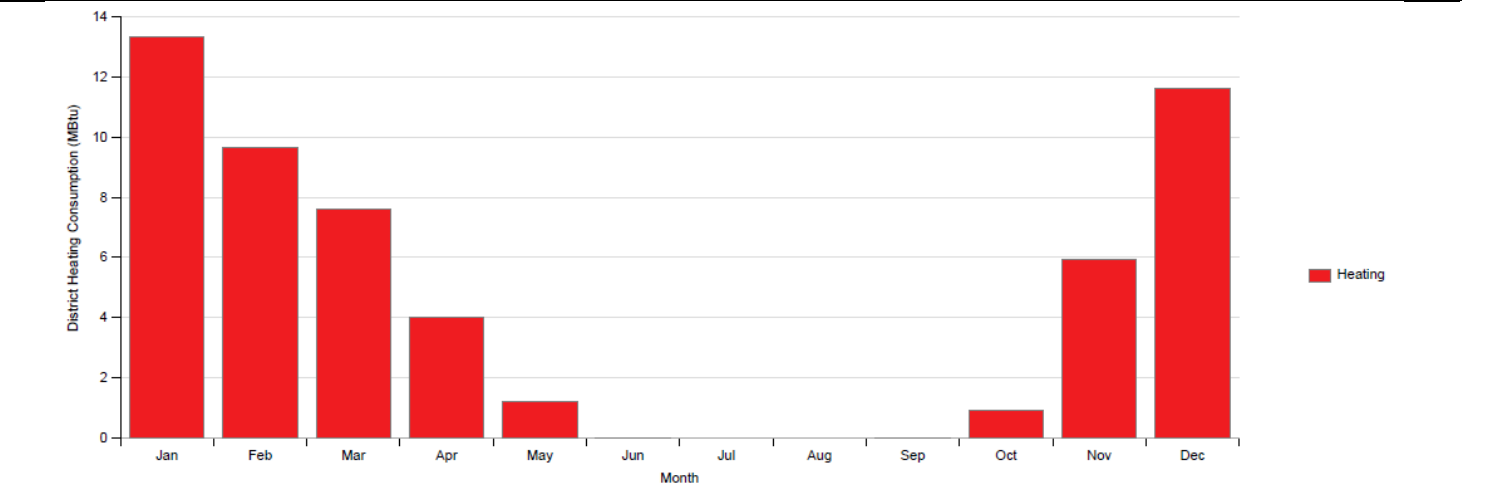
ELECTRICITY CONSUMPTION [kWh]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1483.74	1337.03	1480.44	1430.08	1483.74	1431.54	1478.98	1483.74	1426.79	1483.74	1434.84	1475.69	17430.35
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2468.17	2226.19	2464.87	2382.75	2468.17	2384.21	2463.41	2468.17	2379.46	2468.17	2387.51	2460.12	29021.19

DISTRICT COOLING CONSUMPTION



DISTRICT HEATING CONSUMPTION





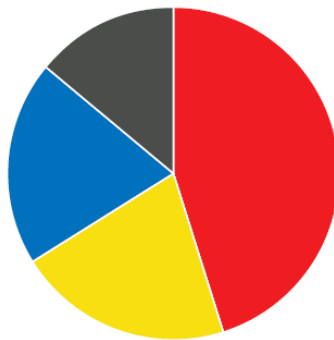
## SECOND LOCATION [BARCELONA]\_SOLUTIONS' COMPARISON

### END USE

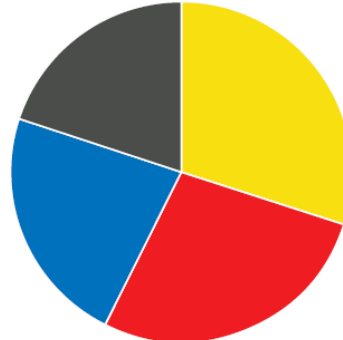
EXISTING



FIRST SOLUTION

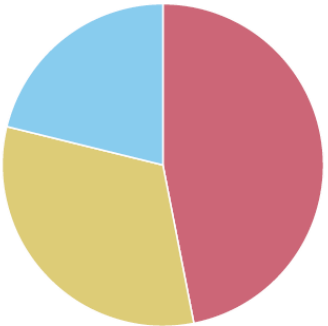


SECOND SOLUTION

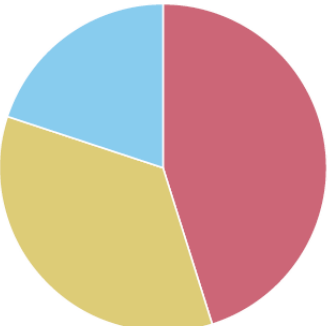


### ENERGY USE

EXISTING



FIRST SOLUTION



SECOND SOLUTION



### EUI

EXISTING

1397.19 kWh/m<sup>2</sup>

FIRST SOLUTION

1317.19 kWh/m<sup>2</sup>

SECOND SOLUTION

977.72 kWh/m<sup>2</sup>

### DISTRICT COOLING CONSUMPTION (kWh)

Interior:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Tot
Existing					2.45	8.98	20.96	19.56	10.93	2.5			65.68
1 <sup>st</sup> Sol.					2.89	8.53	17.14	15.92	9.2	2.32			56.53
2 <sup>nd</sup> Sol.					2.03	6.09	13.29	12.79	7.99	2.36			45.05

### DISTRICT HEATING CONSUMPTION (kWh)

Interior:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Tot
Existing	33.89	24.72	19.85	11.38	4.28					3.96	17.08	30.25	145.55
1 <sup>st</sup> Sol.	28.12	21.15	17.5	10.85	5.0					4.43	14.85	25.31	127.99
2 <sup>nd</sup> Sol.	13.35	9.66	7.6	4.02	1.22					0.92	5.94	11.63	54.34

## CONCLUSION

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Barcelona has a different story if we compared with Piacenza, even so it has the same scenario of two solutions with the same materials, the Electric Use Consumption does not change between both solutions and the existing situation. In comparison with the first solution, the result of the Heating Consumption differs in 6,000 kWh, meanwhile the Cooling varies in almost 3,000 kWh with the existing situation. But if we compared the existing situation with the second solution, the Heating Consumption differs in a 60% with almost 32,000 kWh and a saving of the Cooling system is around 6,000 kWh.

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## THIRD LOCATION\_OSLO [Norway]

### WEATHER SUMMARY

Location	Oslo
Latitude	59.90
Longitude	10.62
Elevation	17.07 m
Time Zone	UTC +1

### BUILDING SUMMARY

Net Site Energy	190 323.67 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	2846.84 kWh/m <sup>2</sup>

### SPACE TYPE SUMMARY

DEFINITION	VALUE	UNIT	INST. MULTIPLIER
People Definition	0.030	People/m <sup>2</sup>	1,0
Electric Equipment Definition	3.875	W/m <sup>2</sup>	1,0
Lights Definition	10.656	W/m <sup>2</sup>	1,0
Infiltration	0,0446	cfm/ext suf	

## EXISTING SITUATION

### EXISTING EXTERNAL WALL CONSTRUCTION

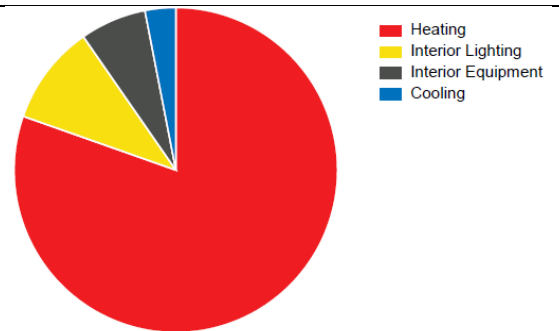
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.6918	1858	837
Concrete	203.3	1.7296	2243	837
Gypsum	12.70	0.1600	784	837

### EXISTING ROOF CONSTRUCTION

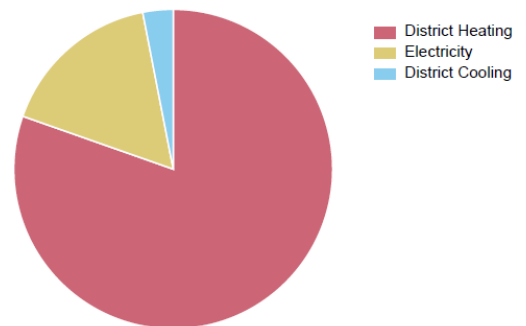
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Metal decking	1.5	45.0060	7680	418,4000

### ANNUAL OVERVIEW

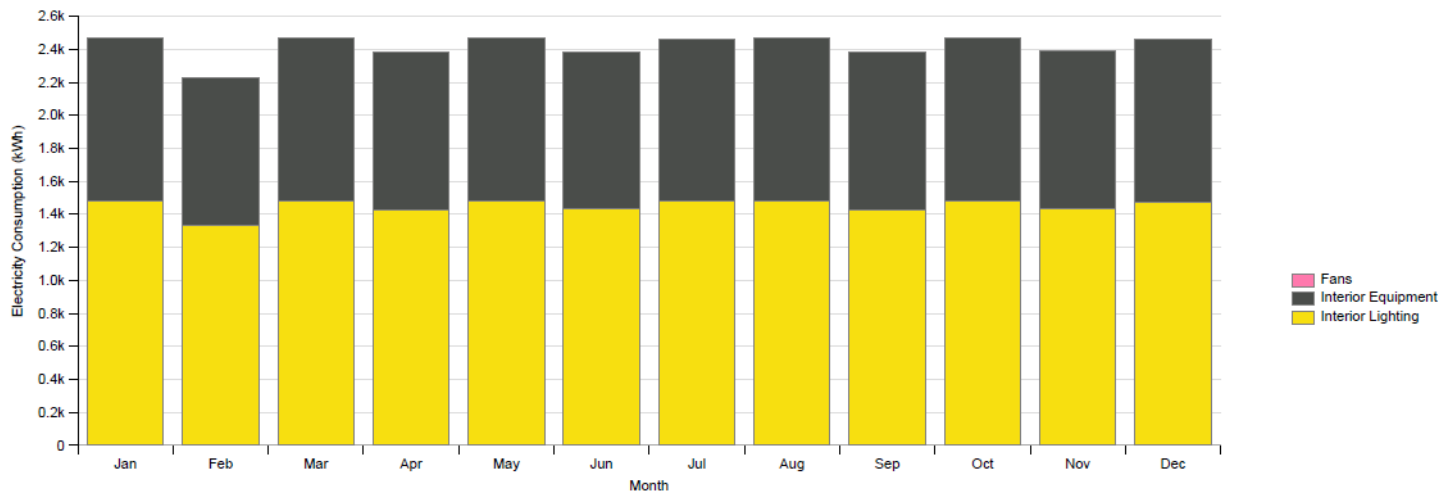
End Use	Consumption [kWh]
Heating	152 965.94
Cooling	5 840.22
Interior Lighting	50 756.20
Interior Equipment	12 588.16



Energy use	Consumption [kWh]
Electricity	31 517.50
District Cooling	5 840.22
District Heating	152 965.94



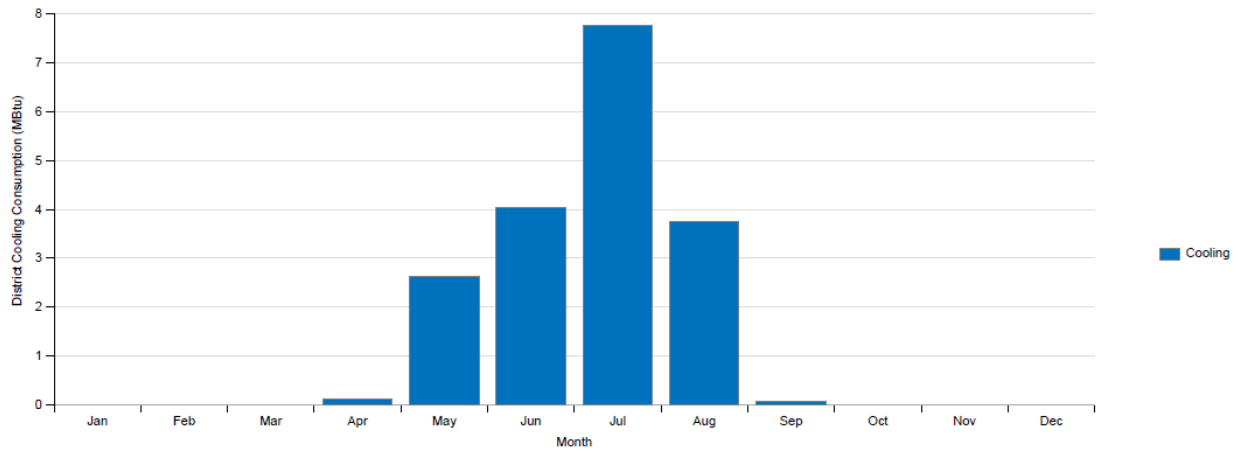
## MONTHLY OVERVIEW



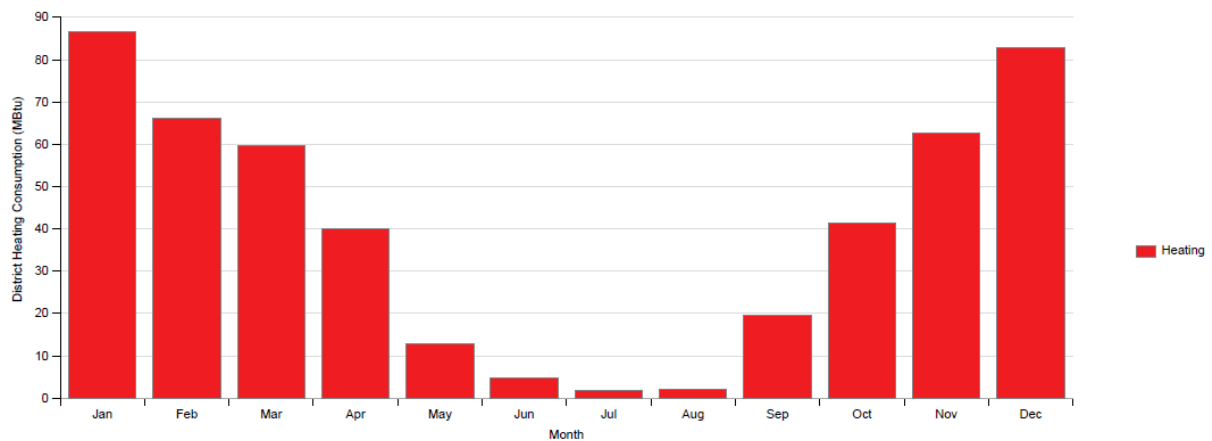
## ELECTRICITY CONSUMPTION [kWh]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1483.74	1337.03	1480.44	1430.08	1483.74	1431.54	1478.98	1483.74	1426.79	1483.74	1434.84	1475.69	17430.35
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
<b>Total</b>	<b>2468.17</b>	<b>2226.19</b>	<b>2464.87</b>	<b>2382.75</b>	<b>2468.17</b>	<b>2384.21</b>	<b>2463.41</b>	<b>2468.17</b>	<b>2379.46</b>	<b>2468.17</b>	<b>2387.51</b>	<b>2460.12</b>	<b>29021.19</b>

## DISTRICT COOLING CONSUMPTION



## DISTRICT HEATING CONSUMPTION



## FIRST SOLUTION

### BUILDING SUMMARY

Net Site Energy	161 738.38 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	2 504.45 kWh/m <sup>2</sup>

### EXTERNAL WALL CONSTRUCTION

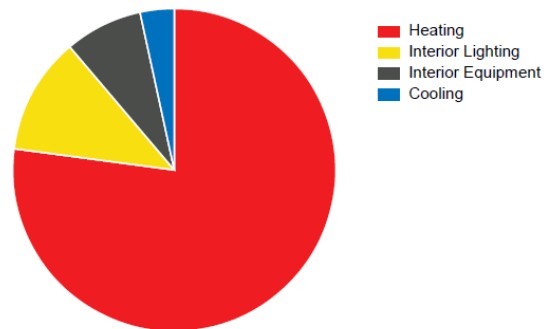
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.69	1858	837
Concrete HW	203.3	1.7296	2243	837
Wall insulation	33.70	0.0432	91	837
Gypsum	12.70	0.1600	784	830

### ROOF CONSTRUCTION

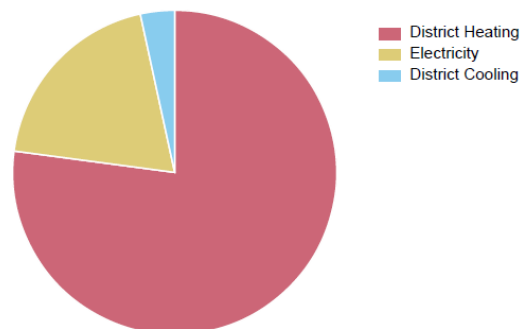
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Metal decking	1.5	45.0060	7680	418.4000

### ANNUAL OVERVIEW

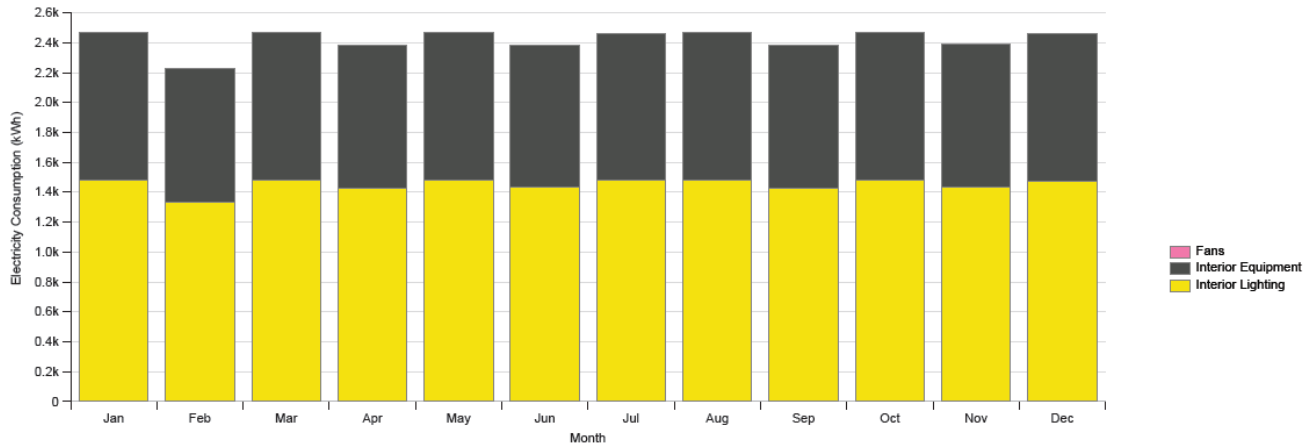
End Use	Consumption [kWh]
Heating	124 709.42
Cooling	5 511.45
Interior Lighting	18 929.34
Interior Equipment	12 588.16



Energy use	Consumption [kWh]
Electricity	31 517.50
District Cooling	5 511.45
District Heating	124 709.42



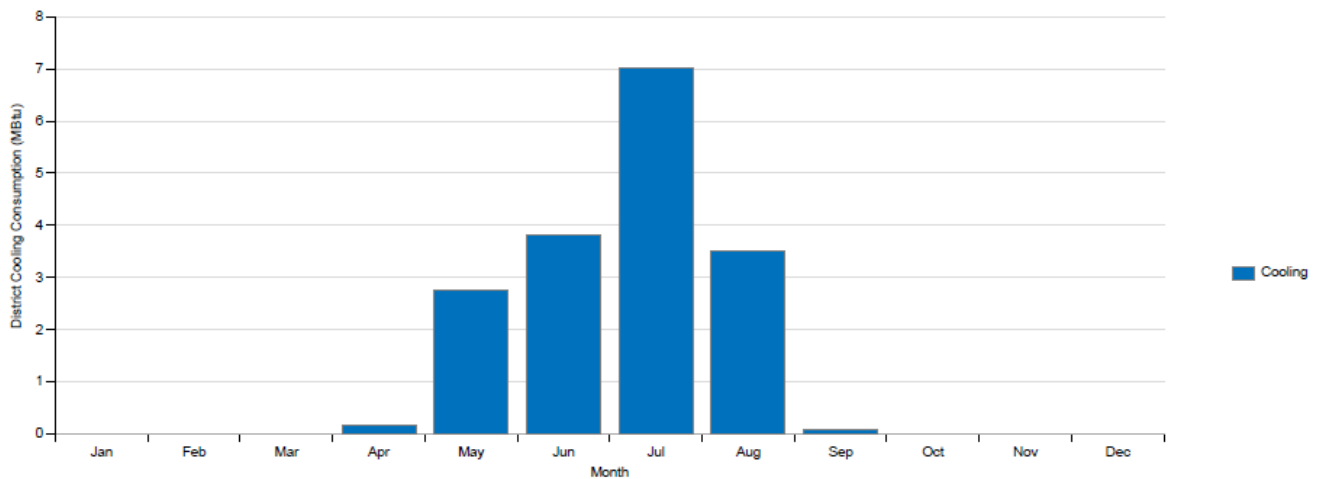
## MONTHLY OVERVIEW



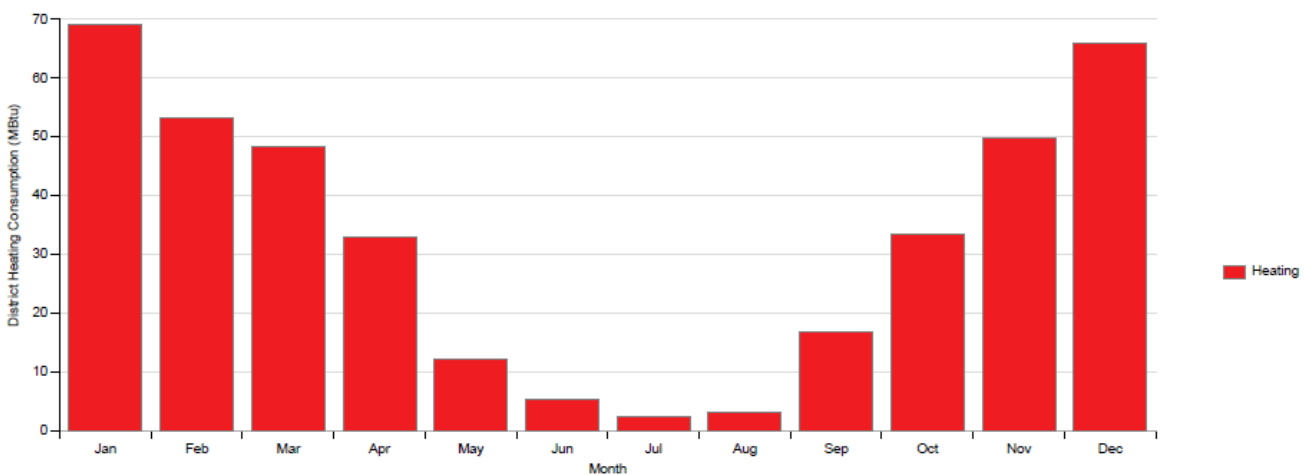
## ELECTRICITY CONSUMPTION [KWH]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1483.74	1337.03	1480.44	1430.08	1483.74	1431.54	1478.98	1483.74	1426.79	1483.74	1434.84	1475.69	17430.35
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
<b>Total</b>	<b>2468.17</b>	<b>2226.19</b>	<b>2464.87</b>	<b>2382.75</b>	<b>2468.17</b>	<b>2384.21</b>	<b>2463.41</b>	<b>2468.17</b>	<b>2379.46</b>	<b>2468.17</b>	<b>2387.51</b>	<b>2460.12</b>	<b>29021.19</b>

## DISTRICT COOLING CONSUMPTION



## DISTRICT HEATING CONSUMPTION



## SECOND SOLUTION

### BUILDING SUMMARY

Net Site Energy	104 419.79 kWh
Total Building Area	600 m <sup>2</sup>
EUI [based on Net Site Energy and Total Building Area]	1 616.80 kWh/m <sup>2</sup>

### EXTERNAL WALL CONSTRUCTION

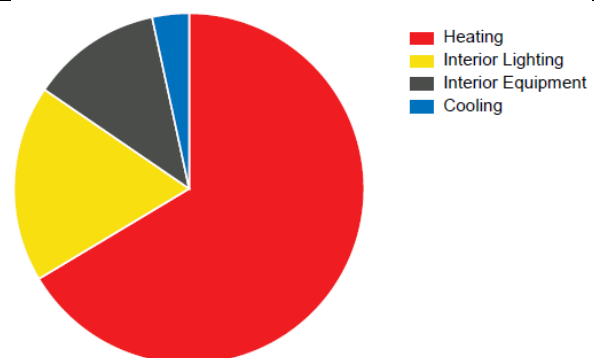
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Stucco	25.3	0.69	1858	837
Concrete HW	203.3	1.7296	2243	837
Wall insulation	33.70	0.0432	91	837
Gypsum	12.70	0.1600	784	830

### ROOF CONSTRUCTION

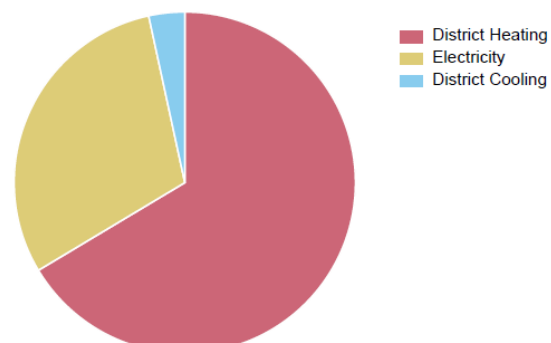
DESCRIPTION	THICKNESS [mm]	CONDUCTIVITY [W/mk]	DENSITY [kg/m <sup>3</sup> ]	SPECIFIC HEAT [J/kg K]
Roof membrane	9.5	0.16	1121.2900	1460
Roof insulation	169.3	0.049	265	836.8
Metal decking	1.5	45.006	7680	418.4

### ANNUAL OVERVIEW

End Use	Consumption [kWh]
Heating	69 354.86
Cooling	3 550.60
Interior Lighting	18 929.34
Interior Equipment	12 588.16

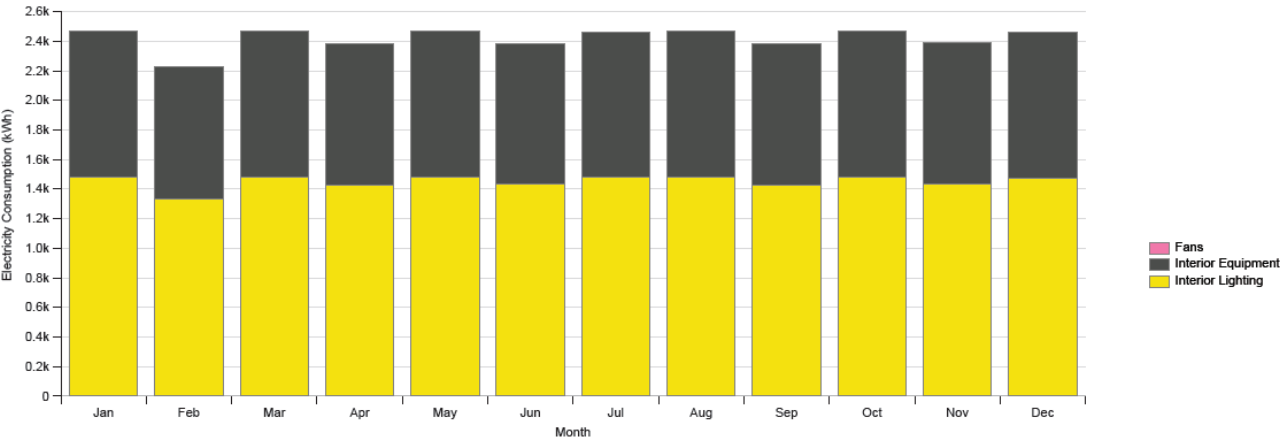


Energy use	Consumption [kWh]
Electricity	31 517.50
District Cooling	3 550.60
District Heating	69 354.86





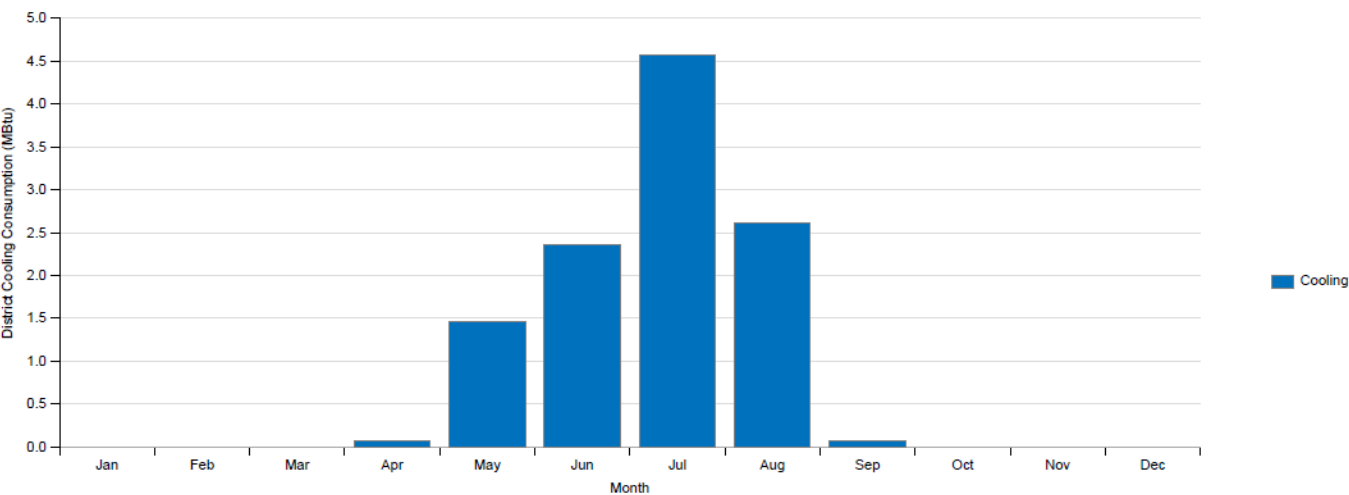
MONTHLY OVERVIEW



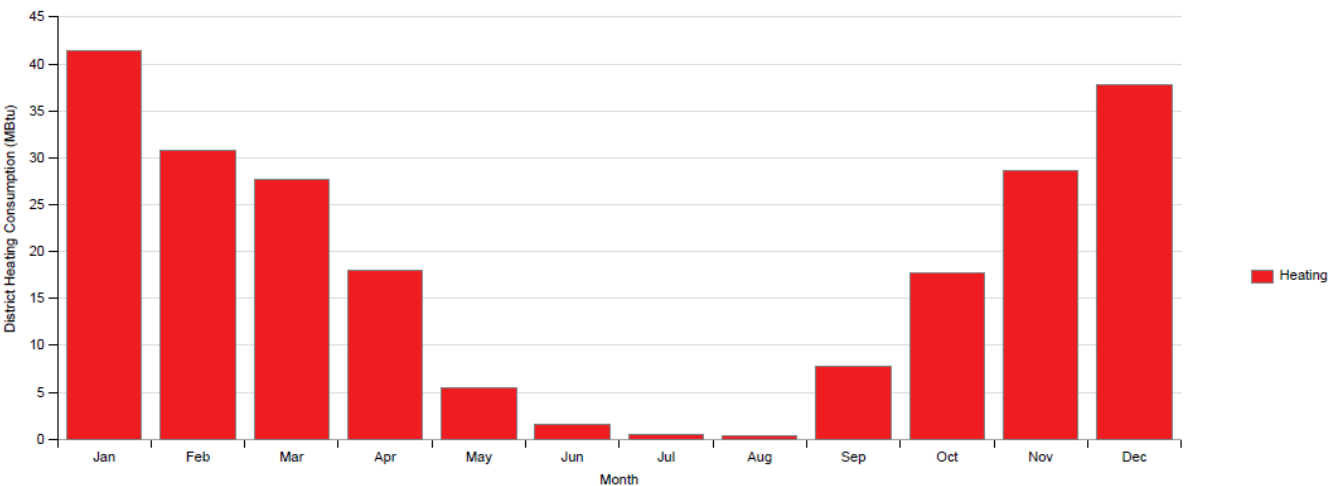
ELECTRICITY CONSUMPTION [KWH]

Interior:	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
-Lightning	1483.74	1337.03	1480.44	1430.08	1483.74	1431.54	1478.98	1483.74	1426.79	1483.74	1434.84	1475.69	17430.35
-Equipment	984.43	889.16	984.43	952.67	984.43	952.67	984.43	984.43	952.67	984.43	952.67	984.43	11590.84
Total	2468.17	2226.19	2464.87	2382.75	2468.17	2384.21	2463.41	2468.17	2379.46	2468.17	2387.51	2460.12	29021.19

DISTRICT COOLING CONSUMPTION

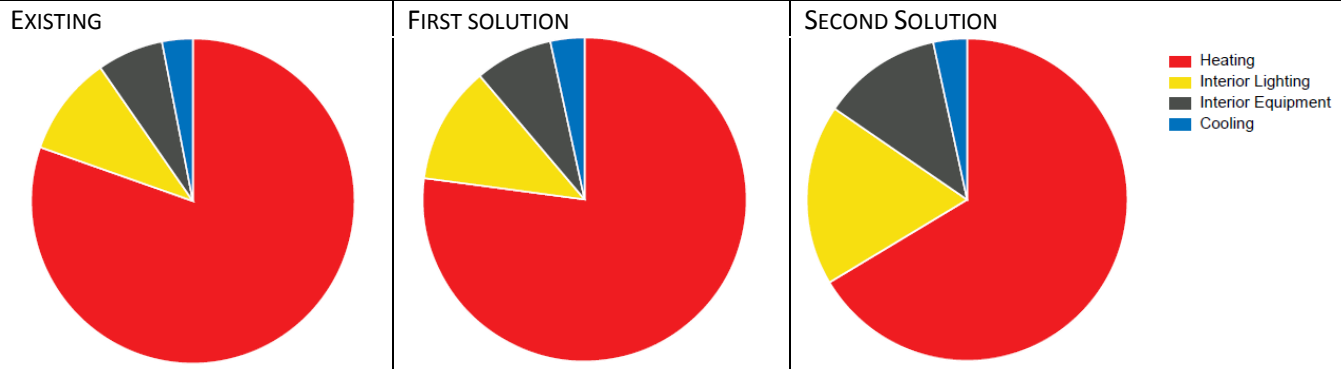


DISTRICT HEATING CONSUMPTION

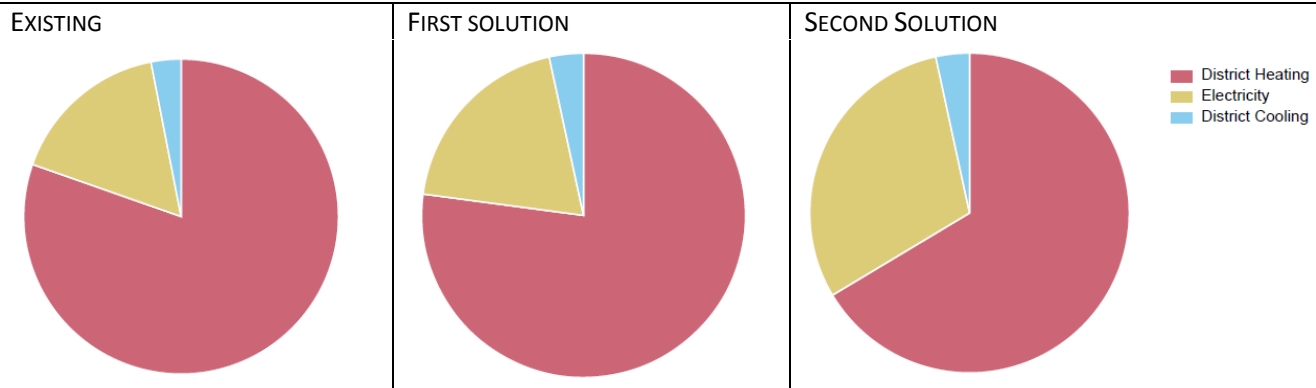


## SECOND LOCATION [OSLO]\_SOLUTIONS' COMPARISON

### END USE



### ENERGY USE



### EUI

EXISTING	FIRST SOLUTION	SECOND SOLUTION
2 846.84 kWh/m <sup>2</sup>	2 504.45 kWh/m <sup>2</sup>	1 616.80 kWh/m <sup>2</sup>

### DISTRICT COOLING CONSUMPTION (kWh)

Interior:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Tot
Existing					2.62	4.03	7.77	3.75					18.35
1 <sup>st</sup> Sol.					2.74	3.81	7.03	3.52					17.32
2 <sup>nd</sup> Sol.					1.47	2.36	4.58	2.61					11.15

### DISTRICT HEATING CONSUMPTION (kWh)

Interior:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Tot
Existing	86.7	66.04	59.69	40.12	12.86	4.65	1.89	2.12	19.61	41.46	62.54	82.93	480.62
1 <sup>st</sup> Sol.	69	53.07	48.39	32.97	12.16	5.28	2.39	3.01	16.68	33.42	49.71	66.77	391.84
2 <sup>nd</sup> Sol.	41.45	30.77	27.75	18.05	5.46	1.61			7.78	17.7	28.61	37.78	217.91

## CONCLUSION

In comparison with the two other cities, Oslo sky rockets in the Heating Energy Consumption because of the extreme cold weather. In this condition the first solution plays a key role while saving a consumption of 28,000 kWh, meanwhile the Cooling system is not a priority in these situations saving less than 5% with the existing condition. Nonetheless, if it's compared with the second solution, together the roof and wall insulated brings a saving of 81,000 kWh in Heating Energy Consumption, leaving the Cooling Consumption with only 2,000 kWh of redeemable.

## GENERAL CONCLUSION

ANNUAL OVERVIEW	SOLUTION	PIACENZA [kWh]	BARCELONA [kWh]	OSLO [kWh]	DIF %
HEATING CONSUMPTION	<b>Existing</b>	80 611.25	46 352.54	15 2965.94	Piacenza: 0% Barcelona: <b>-42.5%</b> Oslo: <b>+89.8%</b>
	<b>First solution</b> [external wall insulation]	67 155,48 <b>[-16.7%]</b>	40 733.29 <b>[-12.1%]</b>	124 709.42 <b>[-18.5%]</b>	Piacenza: 0% Barcelona: <b>-39.3%</b> Oslo: <b>+85.7%</b>
	<b>Second solution</b> [external wall and roof insulation]	39 788.98 <b>[-50.6%]</b>	17 294.08 <b>[-62.7%]</b>	69 354,86 <b>[-54.7%]</b>	Piacenza: 0% Barcelona: <b>-56.5%</b> Oslo: <b>+74.3%</b>
COOLING CONSUMPTION	<b>Existing</b>	24 224.96	20 901.97	5 840.22	Piacenza: 0% Barcelona: <b>-13.7%</b> Oslo: <b>-75.9%</b>
	<b>First solution</b> [external wall insulation]	21 939.01 <b>[-9.4%]</b>	17 991.08 <b>[-13.9%]</b>	5 511.42 <b>[-5.6%]</b>	Piacenza: 0% Barcelona: <b>-18%</b> Oslo: <b>-74.9%</b>
	<b>Second solution</b> [external wall and roof insulation]	14 932.20 <b>[-38.4%]</b>	14 338.00 <b>[-31.4%]</b>	3 550.60 <b>[-39.2%]</b>	Piacenza: 0% Barcelona: <b>-4.0%</b> Oslo: <b>-76.2%</b>

As we compare the three cities, we can say that the one of them performs with less consumption of Energy with the roof and wall Insolation is Barcelona because of its climate. With a 17,000 kWh of heating consumption and a 14,000 kWh of Cooling Consumption leaving behind both cities, meanwhile Oslo in terms of raw data, takes the less Consumption of Cooling also because of the weather. Nevertheless, we can conclude that the best performance despite of the level of Consumption, saving in the best scenario a 50% in both heating and cooling consumption is Piacenza, making it the best performing with the Isolation materials proposed.