

Technical environmental systems

Simulation of Building Energy Performance via Open studio
2017-2018



OpenStudio



POLITECNICO
MILANO 1863

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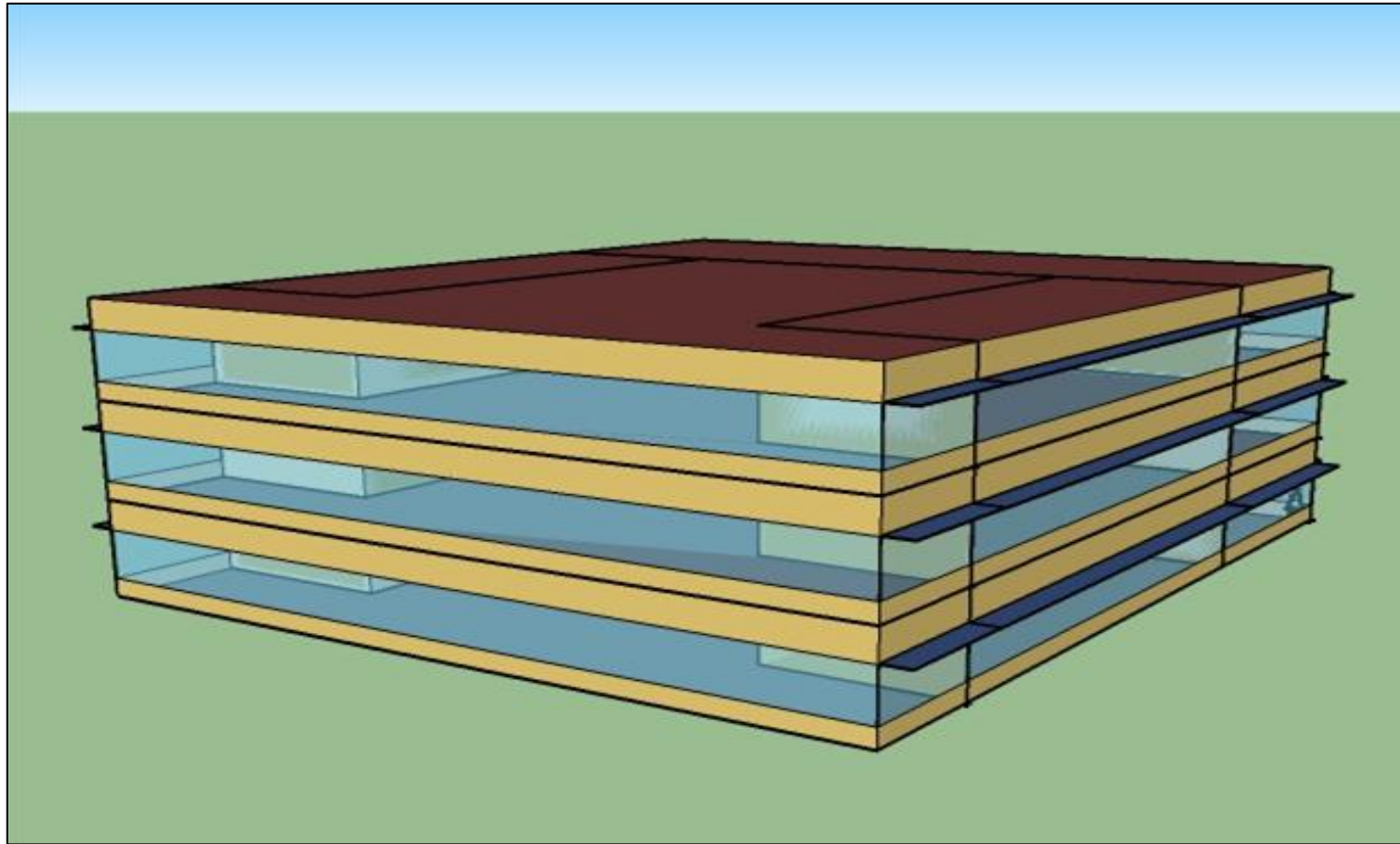
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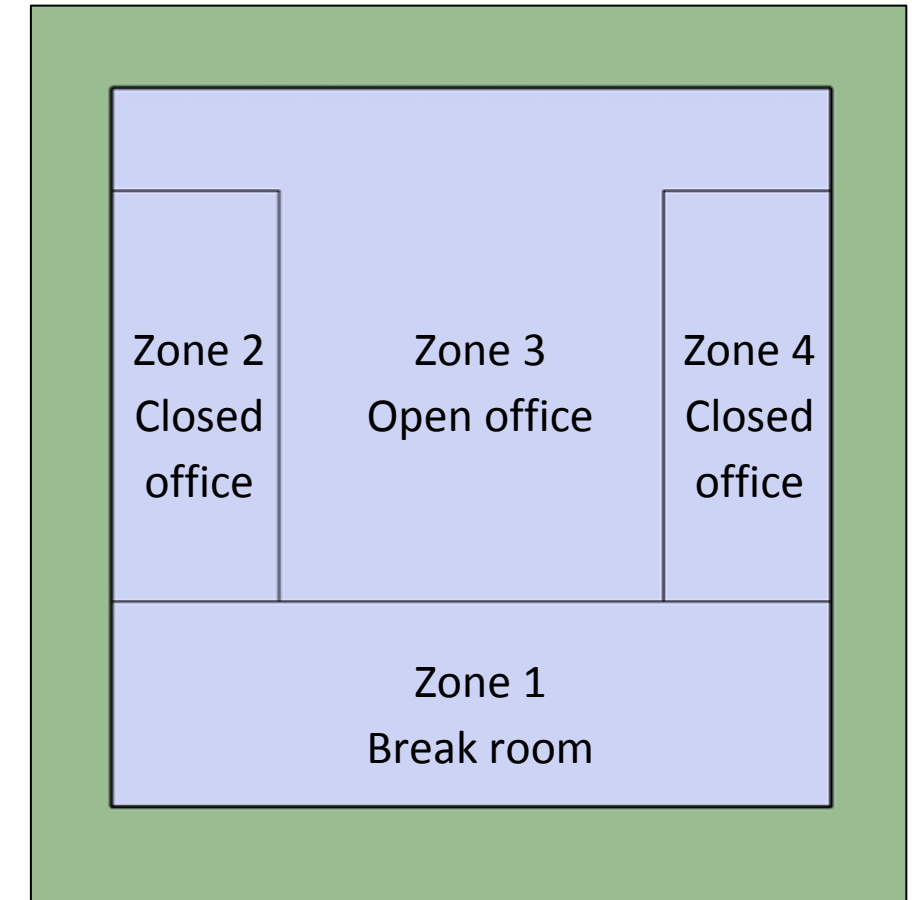
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The building

It is an office building , it consists of 3 floors, each floor is 4 meters high.
Each floor consists of an open office, two closed offices and a break room.
Shaders were used on the exterior windows, except in the north direction.



3D



Plan

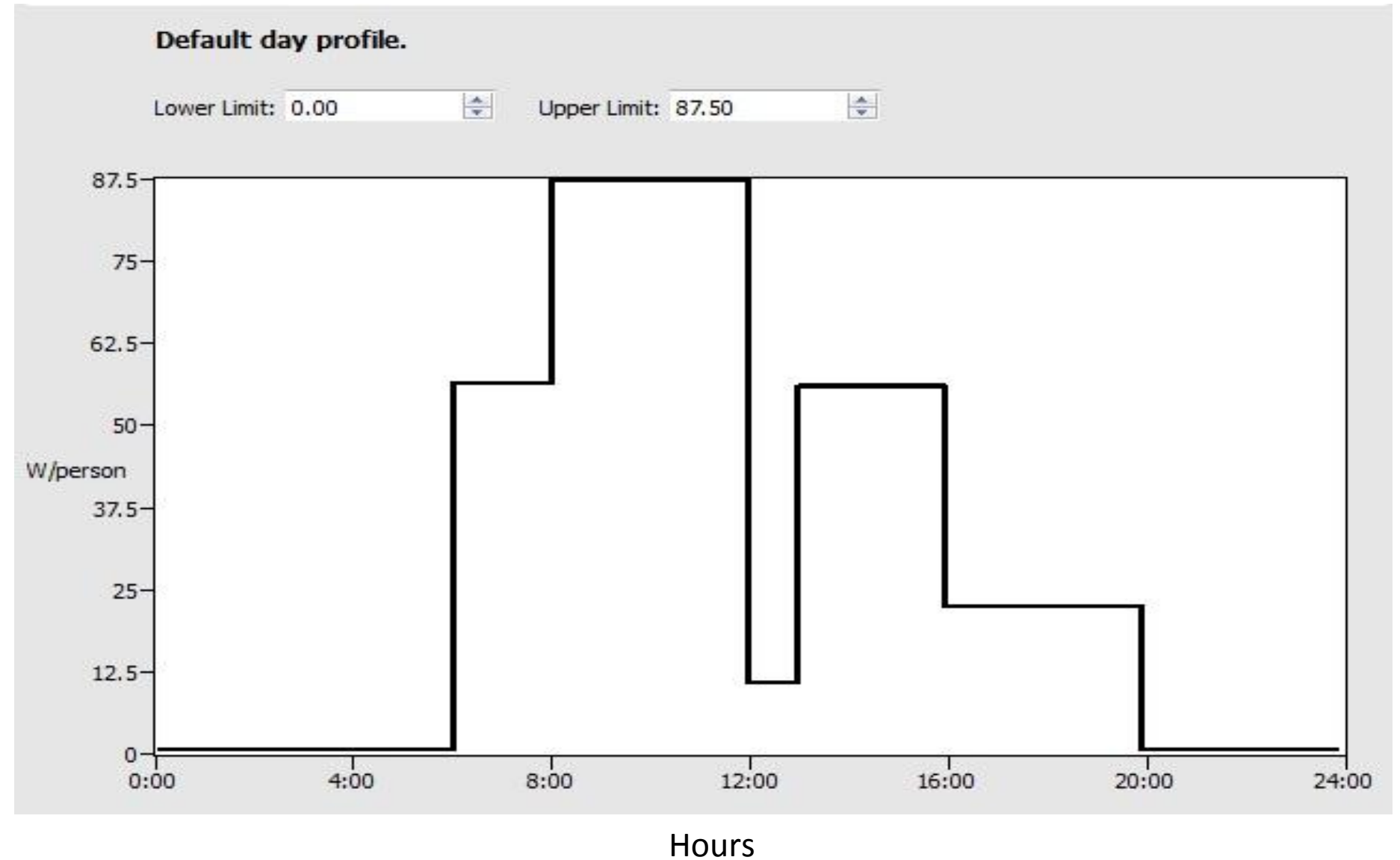
Thermal zones

- The open office:

The office usage starts from 6 a.m. until 8 p.m.

The highest value of usage is between 8 a.m. and 12 p.m.

While the lowest is between 12 p.m. and 1 p.m.



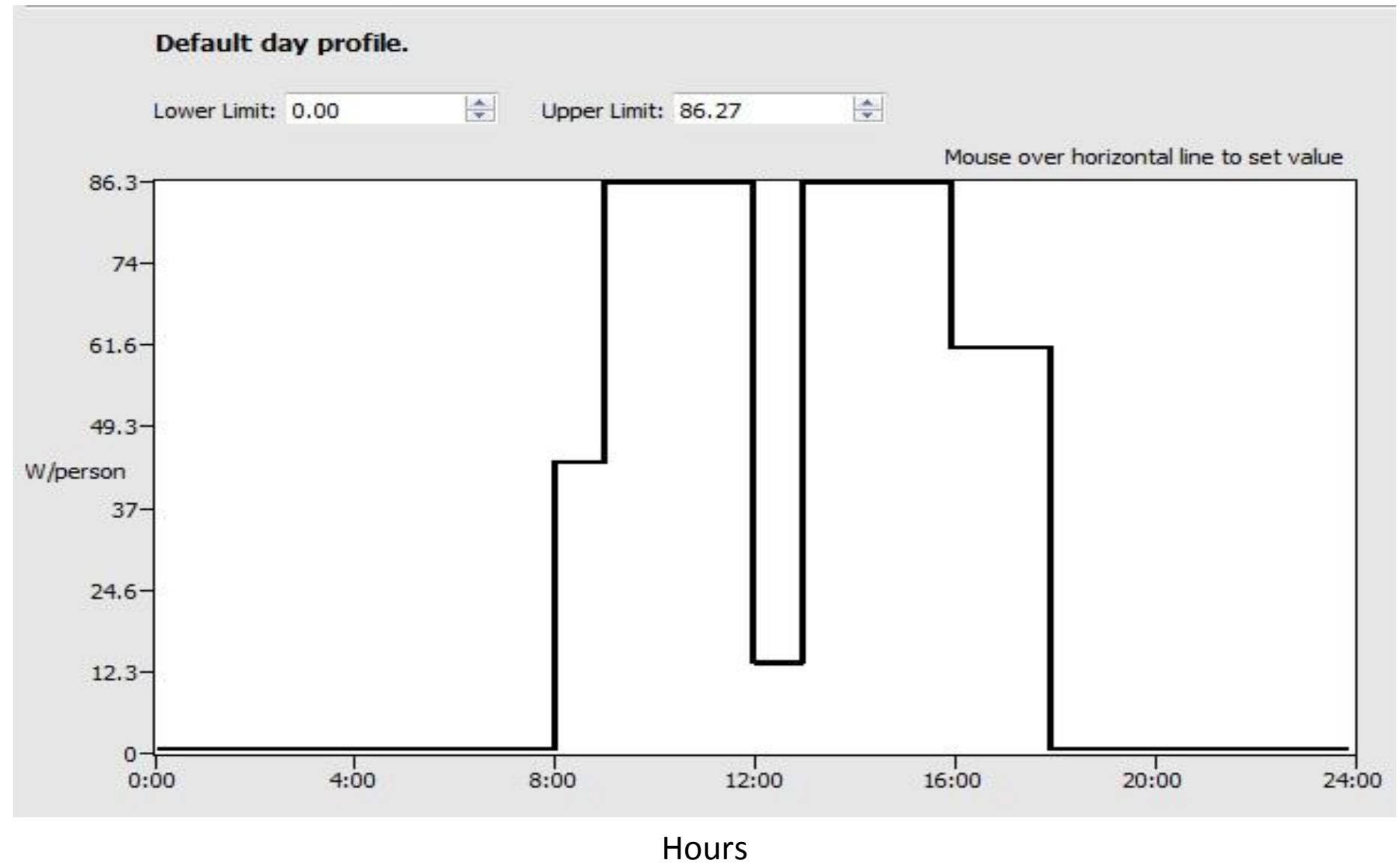
Thermal zones

- The closed office:

The office usage starts from 8 a.m. until 6 p.m.

The highest value of usage is between 9 a.m. and 12 p.m. and between 1 p.m. and 3 p.m..

While the lowest is between 12 p.m. and 1 p.m.



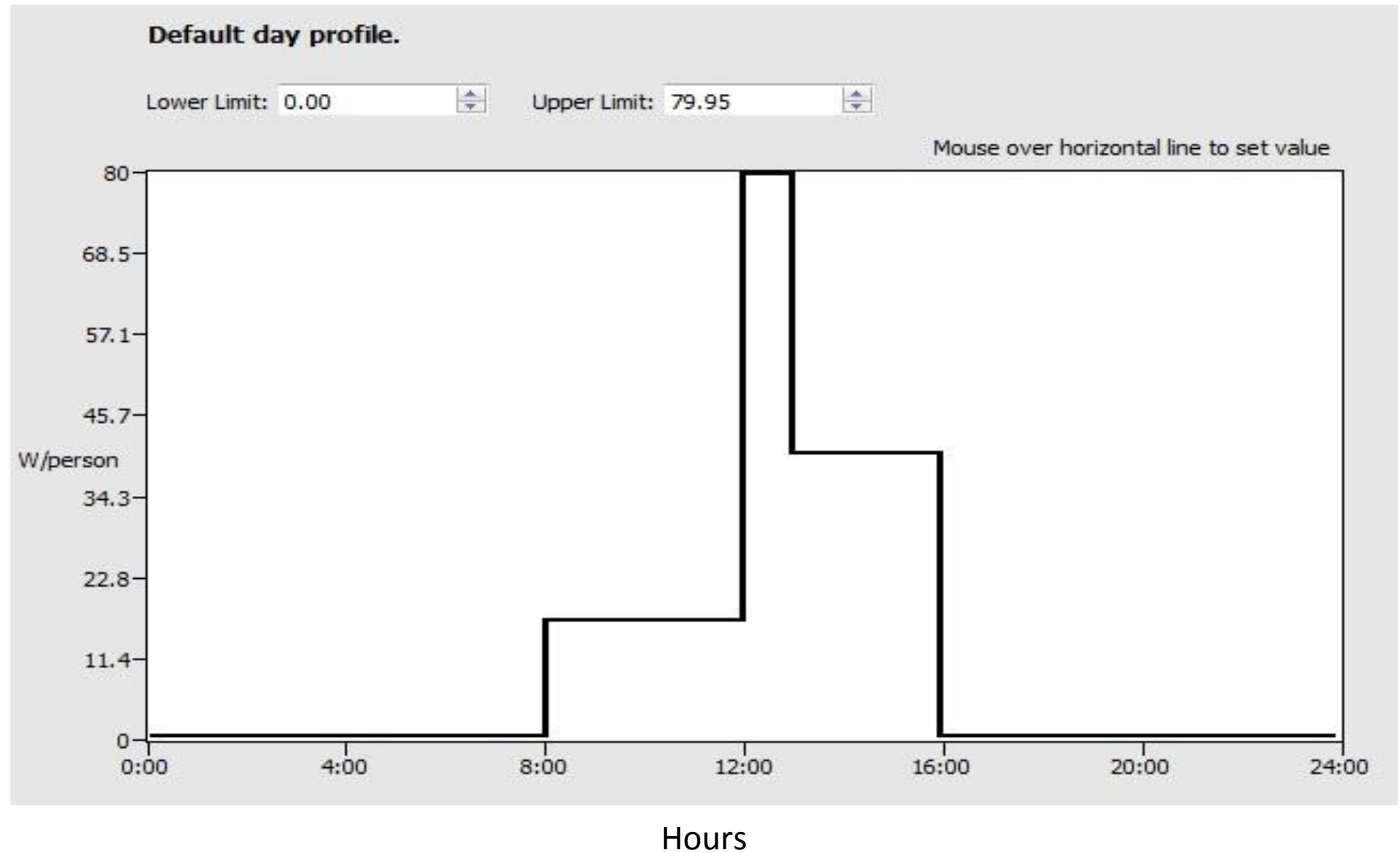
Thermal zones

- The break room:

The room usage starts from 8 a.m. until 4 p.m.

The highest value of usage is between 12 p.m. and 1 p.m., which is the time of the lunch break.

While the lowest is between 8 a.m. and 12 p.m.



Option 1

1st type of walls / Piacenza city, Italy

- Design days:**

Peak time for district heating: 4th of December, for district cooling: 11th of July.

- The materials:**

-For the exterior walls, materials used are:

(1 IN Stucco) 0.0253m thick / (8 IN concrete) 0.2033m thick / wall insulation(44) 0.1104m thick / (½ IN gypsum) 0.0127m thick

-For the interior walls, materials used are:

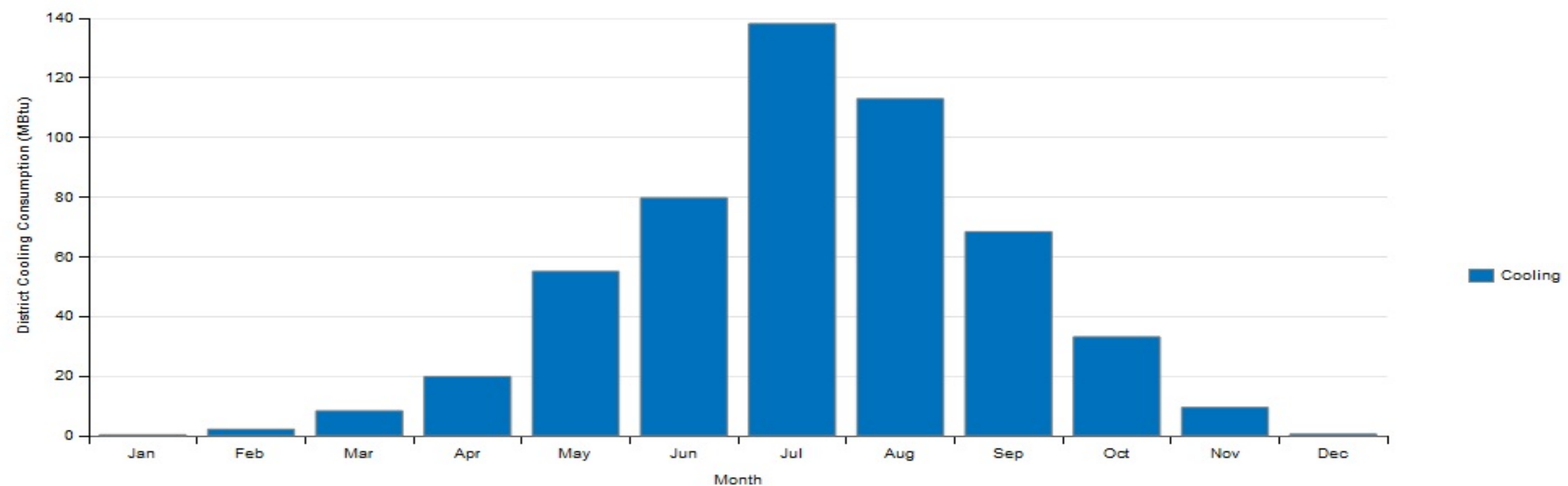
(G05 25mm Wood) 0.0254m thick / (F04 wall air space resistance) 0.15 m².K/W of thermal resistance / (G01a 19mm gypsum board) 0.019m thick

-For the flooring: (interior floor):

(F16 acoustic tiles) 0.0191m thick / (F05 air space resistance) 0.18 m².K/W of thermal resistance / (M11 100mm light weight concrete) 0.1016m thick

District cooling : Monthly overview

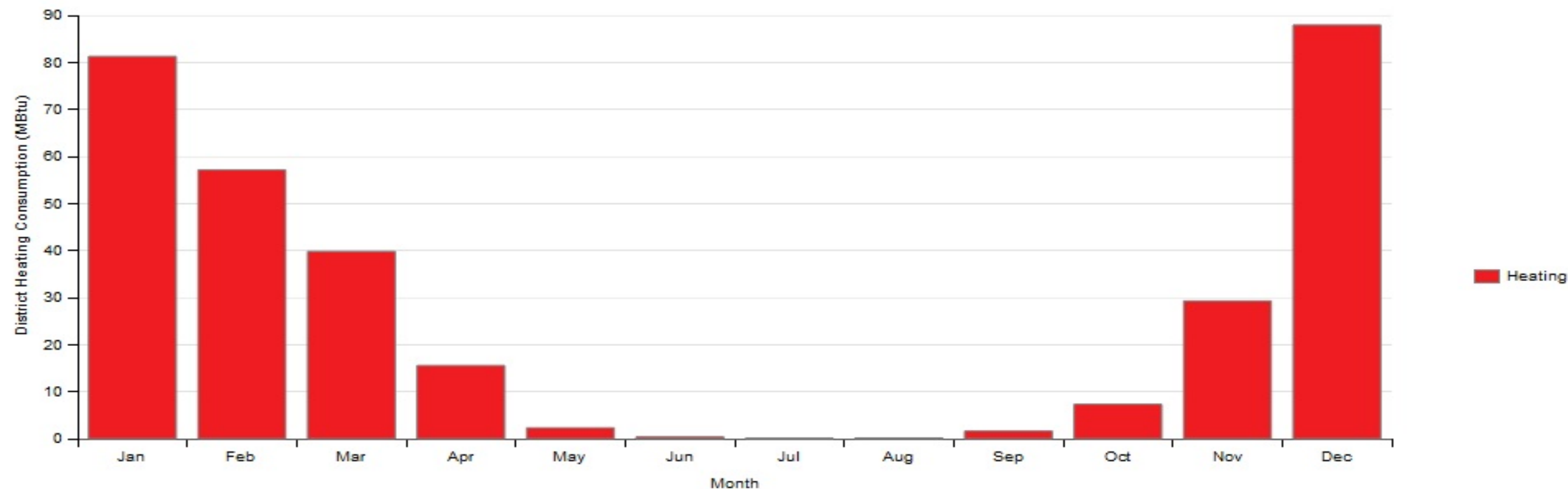
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cooling MBTU	0.33	2.19	8.37	19.88	55.11	79.77	138.17	113.01	68.41	33.17	9.49	0.56	528.45
kW.h	96.71	641.83	2453.004	5826.25	16151.15	23378.28	40493.63	33120	20049	9721.17	2781.24	164.12	154873.41



We can see from the results that the highest consumption value is in July with 40493.63 kW.h, while the lowest is in January with 96.71 kW.h

District heating : Monthly overview

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating MBTU	81.27	57.12	39.82	15.57	2.32	0.39	0.09	0.15	1.63	7.32	29.28	87.94	322.9
kW.h	23817.89	16766.6	11670.1	4563.12	679.92	114.3	26.38	43.9	477.71	2145.28	8581.12	25772.67	94632.65



We can see from the results that the highest consumption value is in December with 25772.67 kW.h, while the lowest is in July with 26.38 kW.h.

For this option, we conclude that the cooling process consume more energy than the heating process.

Option 2

1st type of walls / Cairo city, Egypt

- Design days:**

Peak time for district heating: 2nd of January, for district cooling: 23th of August.

- The materials:**

-For the exterior walls, materials used are:

(1 IN Stucco) 0.0253m thick / (8 IN concrete) 0.2033m thick / wall insulation(44) 0.1104m thick / (½ IN gypsum) 0.0127m thick

-For the interior walls, materials used are:

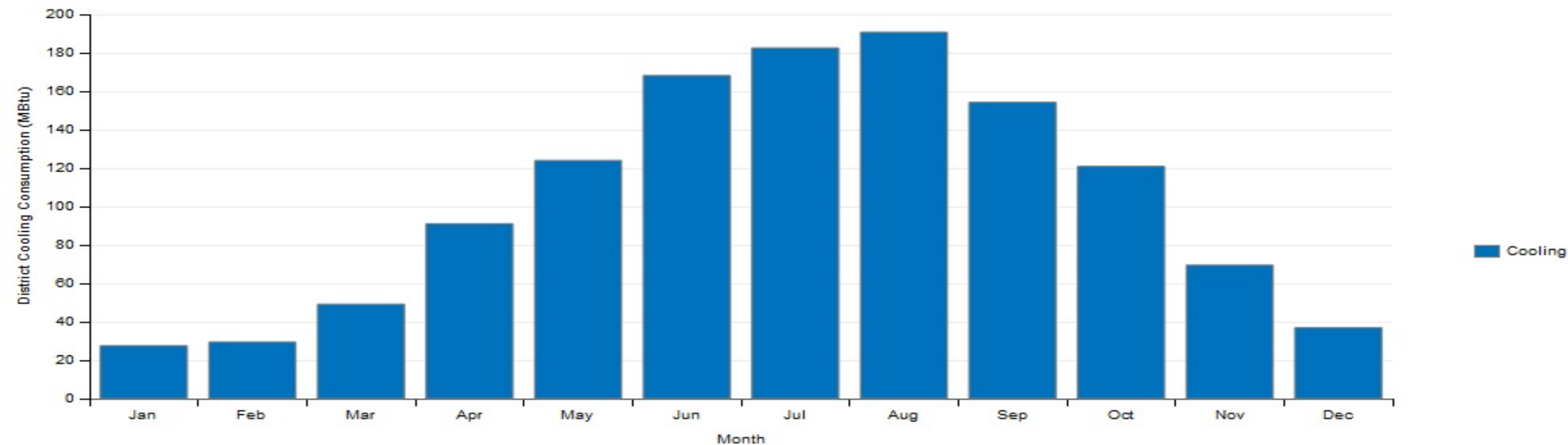
(G05 25mm Wood) 0.0254m thick / (F04 wall air space resistance) 0.15 m².K/W of thermal resistance / (G01a 19mm gypsum board) 0.019m thick

-For the flooring: (interior floor):

(F16 acoustic tiles) 0.0191m thick / (F05 air space resistance) 0.18 m².K/W of thermal resistance / (M11 100mm light weight concrete) 0.1016m thick

District cooling : Monthly overview

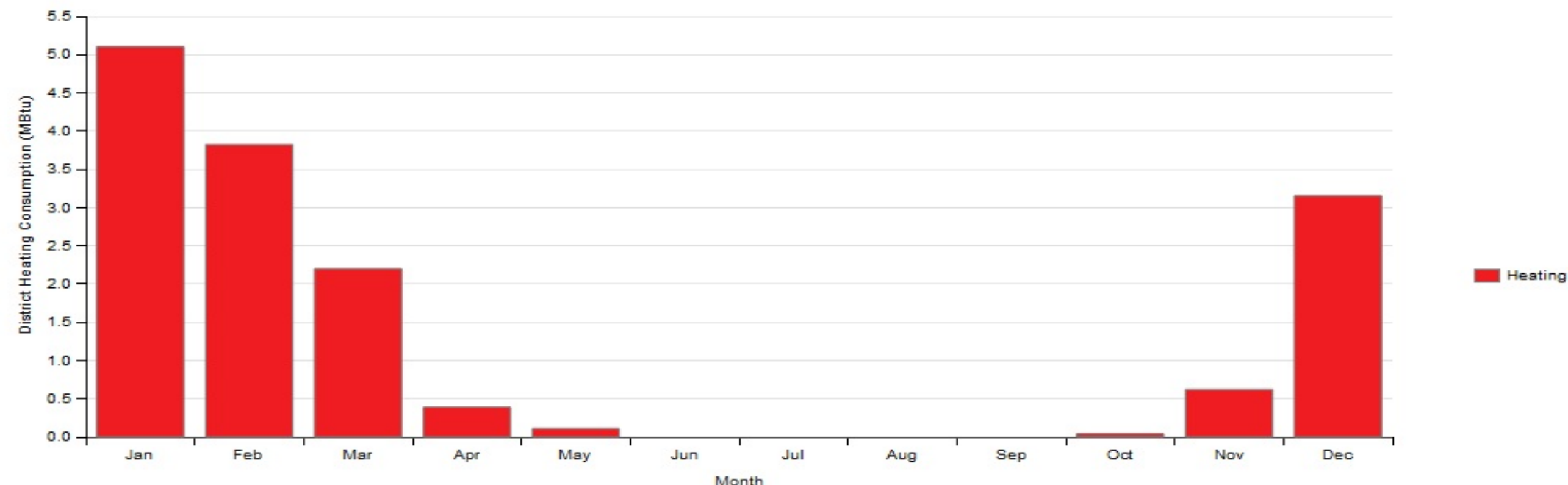
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cooling MBTU	27.52	29.42	49.18	91.05	123.96	168.14	182.55	190.7	154.22	120.9	69.46	36.91	1244.01
kW.h	8065.32	8622.51	14413.24	26684.12	36329.09	49276.97	53500.12	55888.65	45197.42	35432.29	20356.72	10817.25	364583.34



We can see from the results that the highest consumption value is in August with 55888.65 kW.h, while the lowest is in January with 8065.32 kW.h.

District heating : Monthly overview

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating MBTU	5.1	3.83	2.2	0.39	0.11	0	0	0	0	0.04	0.62	3.16	15.45
kW.h	1494.66	1122.46	644.76	114.3	32.24	0	0	0	0	11.72	181.7	926.1	4527.95



We can see from the results that the highest consumption value is in January with 1494.66 kW.h, while the lowest is in June, July, August& September with 0 kW.h.

For this option, we conclude that the cooling process consume more energy than the heating process.

Option 3

1st type of walls / Rio de Janeiro city, Brazil

- Design days:**

Peak time for district heating: 15th of July, for district cooling: March.

- The materials:**

-For the exterior walls, materials used are:

(1 IN Stucco) 0.0253m thick / (8 IN concrete) 0.2033m thick / wall insulation(44) 0.1104m thick / (½ IN gypsum) 0.0127m thick

-For the interior walls, materials used are:

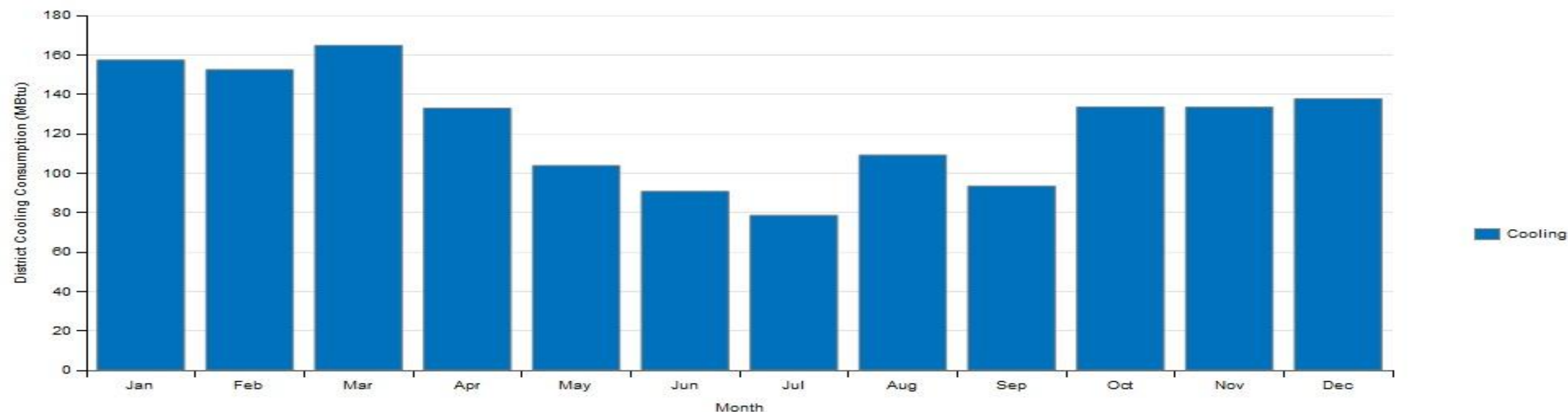
(G05 25mm Wood) 0.0254m thick / (F04 wall air space resistance) 0.15 m².K/W of thermal resistance / (G01a 19mm gypsum board) 0.019m thick

-For the flooring: (interior floor):

(F16 acoustic tiles) 0.0191m thick / (F05 air space resistance) 0.18 m².K/W of thermal resistance / (M11 100mm light weight concrete) 0.1016m thick

District cooling : Monthly overview

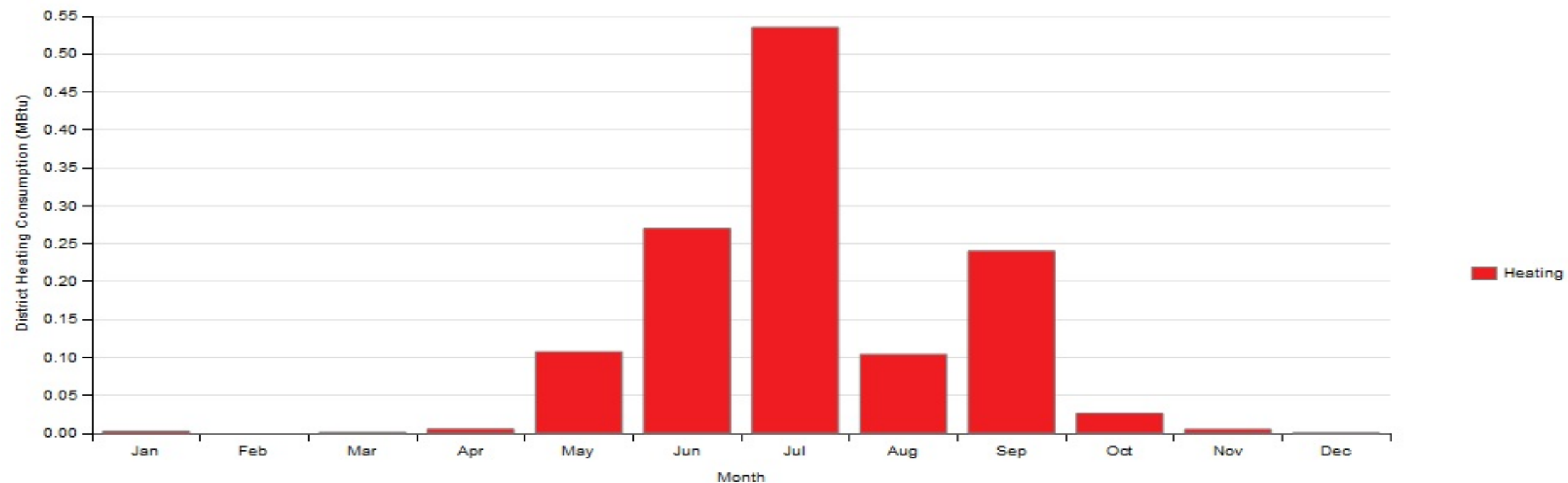
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cooling MBTU	157.33	152.45	164.78	132.93	103.79	90.7	78.56	109.15	93.43	133.56	133.4	137.73	1487.81
kW.h	46108.87	44678.68	48292.25	38957.94	30417.85	26581.55	23023.66	31988.71	27381.63	39142.57	39095.68	40364.68	436034.07



We can see from the results that the highest consumption value is in March with 48292.25 kW.h, while the lowest is in July with 23023.66 kW.h.

District heating : Monthly overview

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating MBTU	0	0	0	0.01	0.11	0.27	0.54	0.1	0.24	0.03	0.01	0	1.3
kW.h	0	0	0	2.93	32.24	79.13	158.26	29.31	70.34	8.8	2.93	0	380.99



We can see from the results that the consumption of energy for heating in Rio de Janeiro city is very low. The highest consumption value is in July with 158.26 kW.h, while the lowest is in January, February, March& December with 0 kW.h. For this option, we conclude that the cooling process consume more energy than the heating process.

Option 4

2nd type of walls / Piacenza, Italy

- Design days:**

Peak time for district heating: 4th of December, for district cooling: 11th of July.

- The materials:**

-For the exterior walls, materials used are:

(F08 Metal Surface) 0.0008m thick / (I01 25mm insulation board) 0.0254m thick / F04 Wall air space resistance of 0.15 m².k/w thermal resistance / (G01a 19mm gypsum board) 0.0127m thick

-For the interior walls, materials used are:

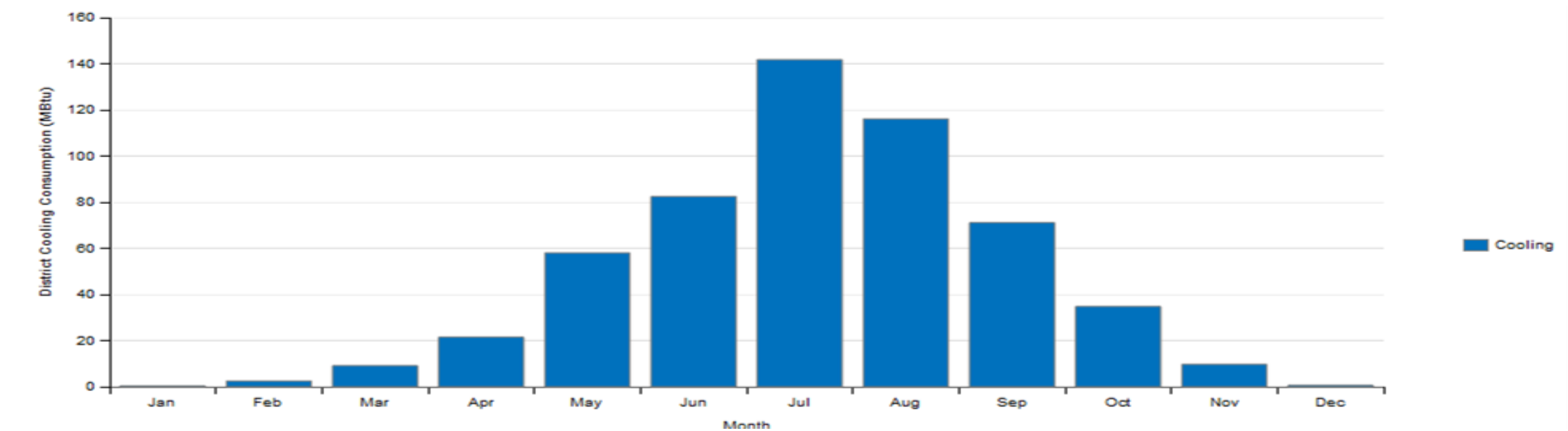
(G01a 19mm gypsum board) 0.002m thick/ (F04 wall air space resistance) 0.15 m².K/W of thermal resistance / (G01a 19mm gypsum board) 0.002m thick

-For the flooring: (interior floor):

(F16 acoustic tiles) 0.0191m thick / (F05 air space resistance) 0.18 m².K/W of thermal resistance / (M11 100mm light weight concrete) 0.1016m thick

District cooling : Monthly overview

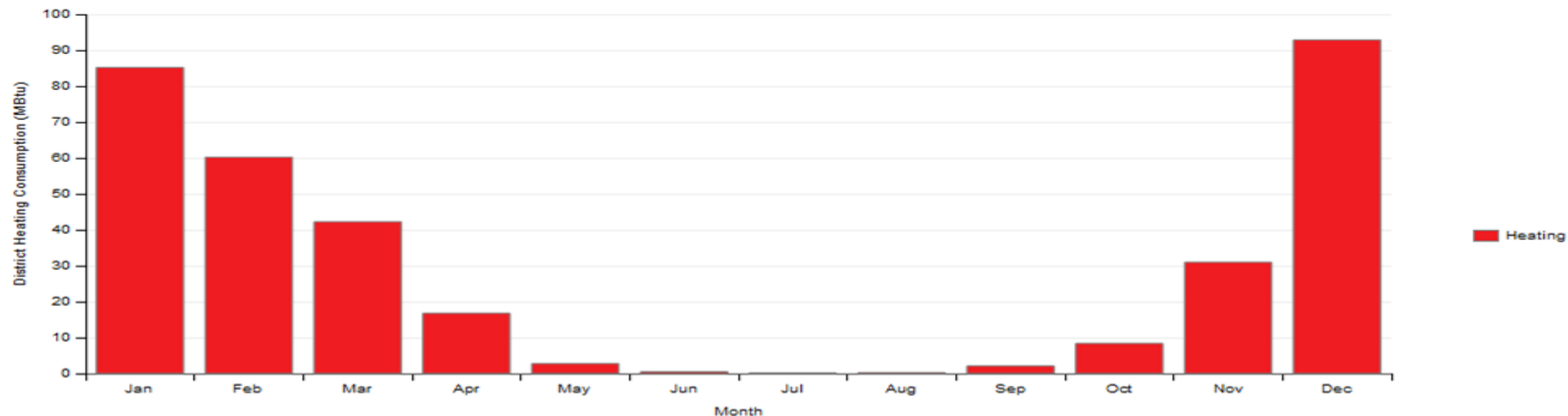
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cooling MBTU	0.39	2.5	9.13	21.49	58.05	82.5	141.8	116.1	71.12	34.78	9.69	0.62	548.16
kW.h	114.3	732.68	2675.74	6298.1	17012.78	24178.36	41557.48	34025.55	20843.21	10193.01	2839.86	181.7	160649.84



We can see from the results that the highest consumption value is in July with 41557.48 kW.h, while the lowest is in January with 114.3 kW.h.

District heating : Monthly overview

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating MBTU	85.18	60.2	42.26	16.75	2.73	0.51	0.12	0.25	2.09	8.36	30.98	92.85	342.29
kW.h	24963.79	17642.88	12385.18	4908.94	800.08	149.47	35.17	73.27	612.52	2450.07	9079.34	27211.65	100315.3



We can see from the results that the highest consumption value is in December with 27211.65 kW.h, while the lowest is in July with 35.17 kW.h.

For this option, we conclude that the cooling process consume more energy than the heating process.

Outputs

	Total yearly consumption for <u>cooling</u>	Total yearly consumption for <u>heating</u>
Option 1 Piacenza	557.54 GJ	340.67 GJ
	154873.41 kW.h	94632.65 kW.h
Option 2 Cairo	1312.50 GJ	16.30 GJ
	364583.34 kW.h	4527.95 kW.h
Option 3 Rio de Janeiro	1569.72 GJ	1.37 GJ
	436034.07 KW.h	380.99 KW.h
Option 4 Piacenza	578.34 GJ	361.14 GJ
	160649.84 KW.H	100315.3 KW.h

Option 3 has the highest value of energy consumption for cooling process, therefore the most expensive in terms of cooling costs.

Option 4 has the highest value of energy consumption for heating process, therefore the most expensive in terms of heating costs.

Conclusion

From the results of the first type of materials used, we conclude that for the three cities the consumption of energy for the cooling is higher than the heating. Therefore, building's energy costs are higher in the cooling process.

And for both cities of Cairo and Rio de Janeiro, in terms of the interior cooling, the type of materials used caused the consumption of greater levels of energy required for the cooling of the building.

When we compare between option 1 and option 4, where we used two different types of materials in Piacenza city, we can see that the energy consumption for both heating and cooling was lower in option 1. Which means that the first type of materials used is the ideal one for this type of building in Piacenza's weather and costs less in terms of energy consumption.