Politecnico di Milano
Sede di Piacenza

POLITECNICO
MILANO 1863

Tecnical Environemtal Systems

OpenStudio assignment

Ahmadreza Honarmand
Sonja Kostic
Sevin Akin

Introduction

One of the important issues which architects must take in consideration is the criteria which they have for designing or choosing materials for buildings. One of this criteria is optimizing the energy consumption of building. In this assignment we choose a small office to work with and finding out how the energy consumptions changes when we change the location of the building and when we change in the insulation in the exterior walls and how we can balance the choosing of the component and reducing energy use in the building.

Process

First we choose a simple building for our project with a big lobby and to interior patios (which also affect energy consumption). In using OpenStudio we determined 5 thermal zones and applied our building in Naples, Paris and Copenhagen then for each of the cities we have utilized three different walls with three different insulations and compare the effect of the different walls in one city and then the energy consumption of cities together.

Photo 1: Map of the cities choosen for the Case study

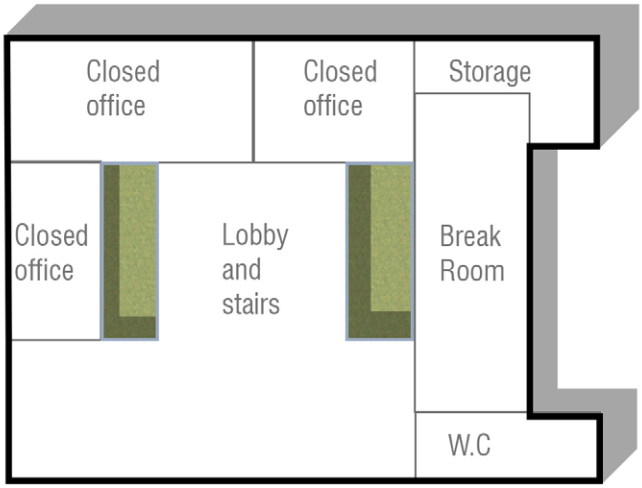


figure 1: Plan of the Case Study

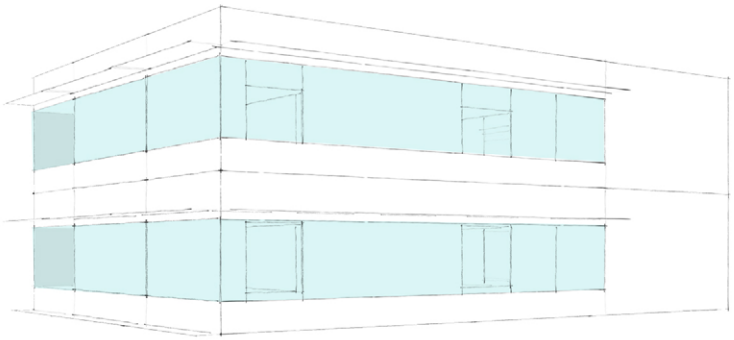


figure 2: Perspective view of Case Study

table 1: Building area

	Area [m2]
Total Building Area	131.86
Net Conditioned Building Area	131.86
Unconditioned Building Area	0.00

table 2: Window-wall ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	462.78	114.48	116.91	114.48	116.91
Above Ground Wall Area [m2]	462.78	114.48	116.91	114.48	116.91
Window Opening Area [m2]	207.80	52.32	53.29	43.74	58.46
Gross Window-Wall Ratio [%]	44.90	45.70	45.58	38.21	50.00
Above Ground Window-Wall Ratio [%]	44.90	45.70	45.58	38.21	50.00

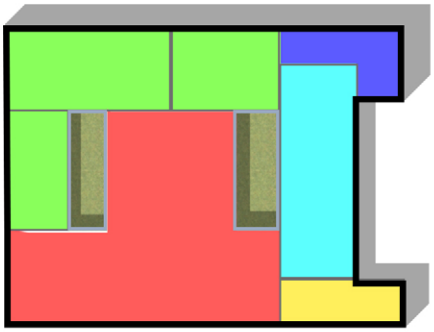


figure 3: Thermal zones

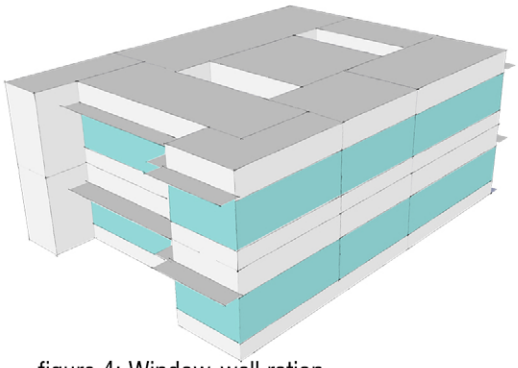


figure 4: Window-wall ration

table 3: Zone summary

	Area [m2]	Conditioned (Y/N)	Part of Total Floor Area (Y/N)	Volume [m3]	Multipliers	Gross Wall Area [m2]	Window Glass Area [m2]	Lighting [W/m2]	People [m2 per person]	Plug and Process [W/m2]
THERMAL ZONE 1	54.02	Yes	Yes	324.14	1.00	150.44	75.22	12.5938	9.29	0.7535
THERMAL ZONE 2	7.76	Yes	Yes	46.54	1.00	47.18	0.00	8.7188	9.29	0.7535
THERMAL ZONE 3	22.10	Yes	Yes	132.58	1.00	64.31	32.16	11.6250	2.00	48.0070
THERMAL ZONE 4	8.29	Yes	Yes	49.73	1.00	53.04	26.52	10.6563	18.58	16.7917
THERMAL ZONE 5	39.70	Yes	Yes	238.17	1.00	147.81	73.91	10.6563	19.56	6.8889
Total	131.86			791.17		462.78	207.80	11.4984	6.54	11.5274
Conditioned Total	131.86			791.17		462.78	207.80	11.4984	6.54	11.5274
Unconditioned Total	0.00			0.00		0.00	0.00			
Not Part of Total	0.00			0.00		0.00	0.00			

Weather Summary

In order to understand how the choise of system depends on location we choose three cities with different altitudes. The following tabels are introducing weather informations about choosen cities.

Table 4: Weather Summary__Naples, Italy

	Value
Weather File	PARIS_ ORLY - FRA IWEC Data WMO#=071490
Latitude	48.73
Longitude	2.40
Elevation	315 (ft) 96.012 (m)
Time Zone	1.00
North Axis Angle	0.00
ASHRAE Climate Zone	

City in southern Europe with higher altitude compare to Paris and Copenhagen

Table 5: Weather Summary__Paris. France

	Value
Weather File	Napoli-Capodichino - ITA IGDG WMO#=162890
Latitude	40.85
Longitude	14.30
Elevation	236 (ft) 71.93 (m)
Time Zone	1.00
North Axis Angle	0.00
ASHRAE Climate Zone	

City in central Europe with medium altitude

Table 6: Weather Summary__Copenhagen; Denmark

	Value
Weather File	COPENHAGEN - DNK IWEC Data WMO#=061800
Latitude	55.63
Longitude	12.67
Elevation	16 (ft) 4.87 (m)
Time Zone	1.00
North Axis Angle	0.00
ASHRAE Climate Zone	

City in northern Europe with low altitude

We choose to compare three types of walls acording to insulation. WALL 1_NO INSULATION
WALL 2_INSULATION 3CM
WALL 3_INSULATION 10CM

Further data will show differences with choosing one of those types. Placing the building in different cities we will be able to understand how location can affect choise of materials.

Table 7: Results for Naples, Italy

	Wall.1		Wall.2		Wall.3		
Information	Values		Values		Values		Units
Net site enegy	175612	51466.79	158380	46416.59	152968	44830.49	kBtu / kW.h
Total building area	1419	131.82	1419	131.82	1419	131.82	Feet^2 / m^2
Eui	123.73	390.43	111.59	352.12	107.77	340.08	kBtu/ft^2 / kW.h/m^2

Table 8: End Use Percentage

	Wall.2	Wall.1	Wall.3
	Percent [%]	Percent [%]	Percent [%]
Interior Lighting	10.54	9.50	10.91
Space Heating	58.03	59.61	57.31
Space Cooling	15.93	16.90	15.73
Fans-Interior	0.00	0.00	0.00
Service Water Heating	0.00	0.00	0.00
Receptacle Equipment	15.51	13.99	16.06
Miscellaneous	0.00	0.00	0.00

The changes in percentage in heating is 2.3 percent from wall.1 to wall.3 and for cooling is 1.7 percent

Wall.1: 36%
Wall.2: 32.5%
Wall.3: 31.5%

Table 9: Results for Paris, France

	Wall.1		Wall.2		Wall.3		
Information	Values		Values		Values		Units
Net site enegy	286,155	83863.75	248,612	72860.98	236,632	69349.99	kBtu / kW.h
Total building area	1419	131.82	1419	131.82	1419	131.82	Feet^2 / m^2
Eui	201.61	636.19	175.16	552.73	166.72	526.09	kBtu/ft^2 / kW.h/m^2

Table 10: End Use Percentage

	Wall.2	Wall.1	Wall.3
	Percent [%]	Percent [%]	Percent [%]
Interior Lighting	6.71	5.83	7.05
Space Heating	80.33	82.73	79.31
Space Cooling	3.08	2.86	3.26
Fans-Interior	0.00	0.00	0.00
Service Water Heating	0.00	0.00	0.00
Receptacle Equipment	9.88	8.58	10.38
Miscellaneous	0.00	0.00	0.00

The changes in percentage in heating is 3.42 percent from wall.1 to wall.3 and for cooling is -0.4 percent

Wall.1: 37%
Wall.2: 32%
Wall.3: 30%

Table 11: Results for Copenhagen, Denmark

Naples, Italy	Wall.1		Wall.2		Wall.3		
Information	Values		Values		Values		Units
Net site enegy	373,611	109494.57	319,955	93769.55	302,884	88766.53	kBtu / kW.h
Total building area	1419	131.82	1419	131.82	1419	131.82	Feet^2 / m^2
Eui	263.23	830.63	225.43	711.34	213.40	673.39	kBtu/ft^2 / kW.h/m^2

Table 12: End Use Percentage

	Wall.2	Wall.1	Wall.3
	Percent [%]	Percent [%]	Percent [%]
Interior Lighting	5.22	4.47	5.51
Space Heating	86.39	88.35	85.59
Space Cooling	0.71	0.60	0.79
Fans-Interior	0.00	0.00	0.00
Service Water Heating	0.00	0.00	0.00
Receptacle Equipment	7.68	6.58	8.11
Miscellaneous	0.00	0.00	0.00

The changes in percentage in heating is 2.76 percent from wall.1 to wall.3 and for cooling is -0.19 percent

Wall.1: 37.5%
Wall.2: 32%
Wall.3: 30%

Result:

The overview energy consumption percentage relatively stay the same when we apply different wall in the same city except heating and cooling, also when insulation goes higher in the wall in Naples (south Europe cooling percentage goes up but in Paris and Copenhagen the percentage stay the same.
Also as we see in the previous page difference of percentage the cooling energy in Naples goes down as insulation goes higher but in Paris and Copenhagen it goes up.

Figure 2.1: End Use Pie Graph__Naples, Italy

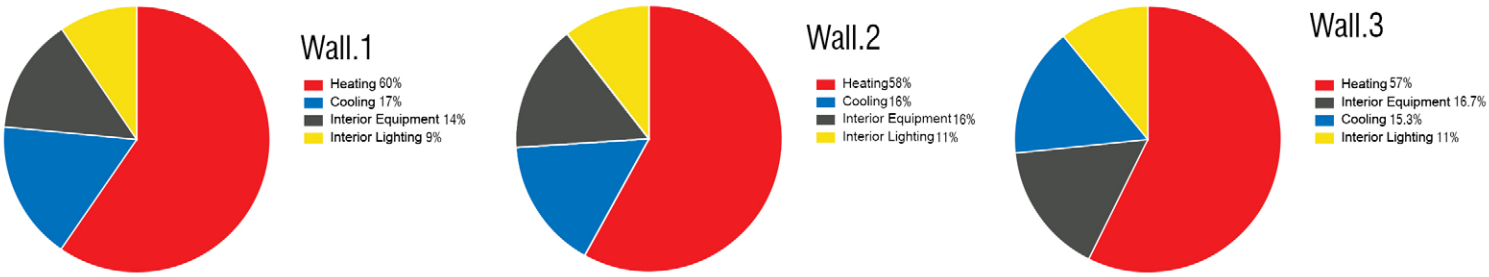


Figure 2.2: End Use Pie Graph__Paris, France

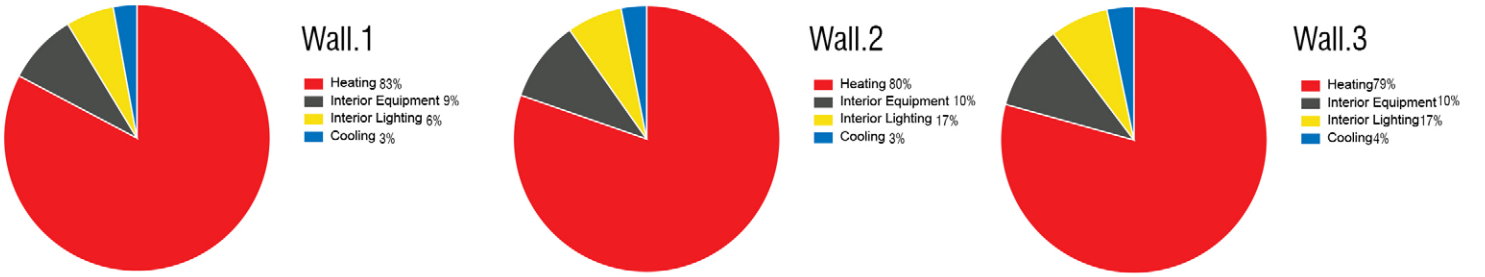
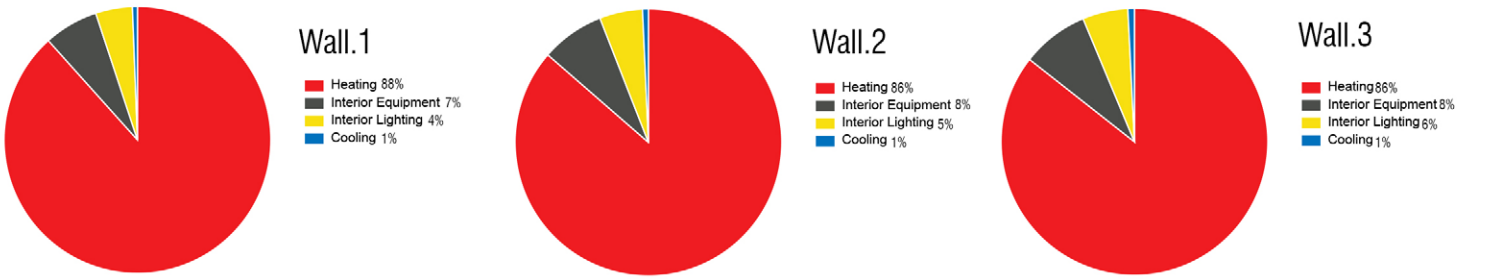


Figure 2.3: End Use Pie Graph__Copenhagen, Denmark



HVAC Load Profiles

City: Napels, Italy

Table 13: Monthly Load Profiles__WALL 1

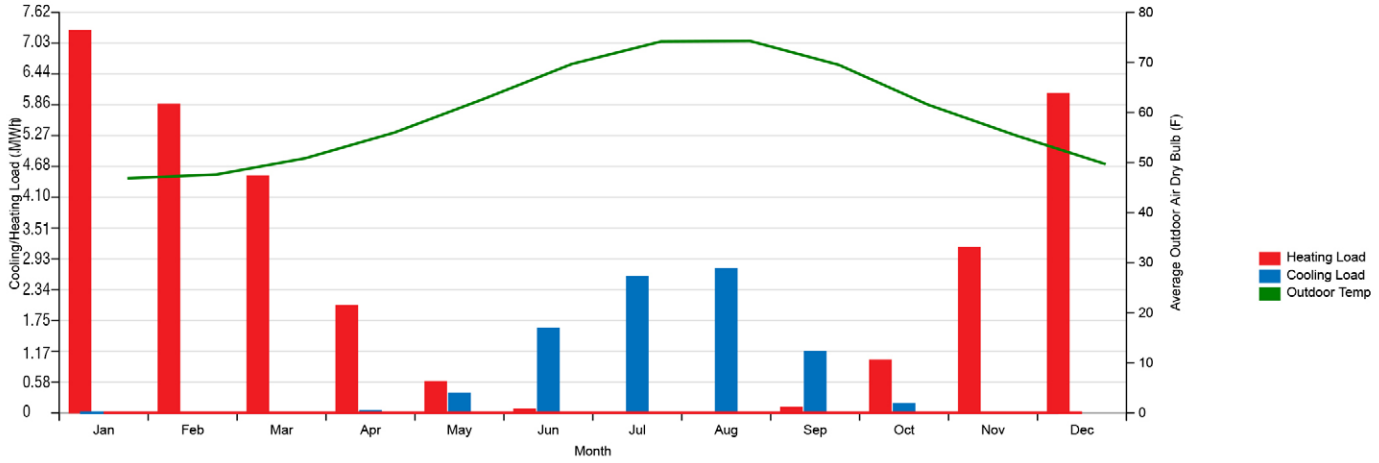


Table 14: Monthly Load Profiles__WALL 2

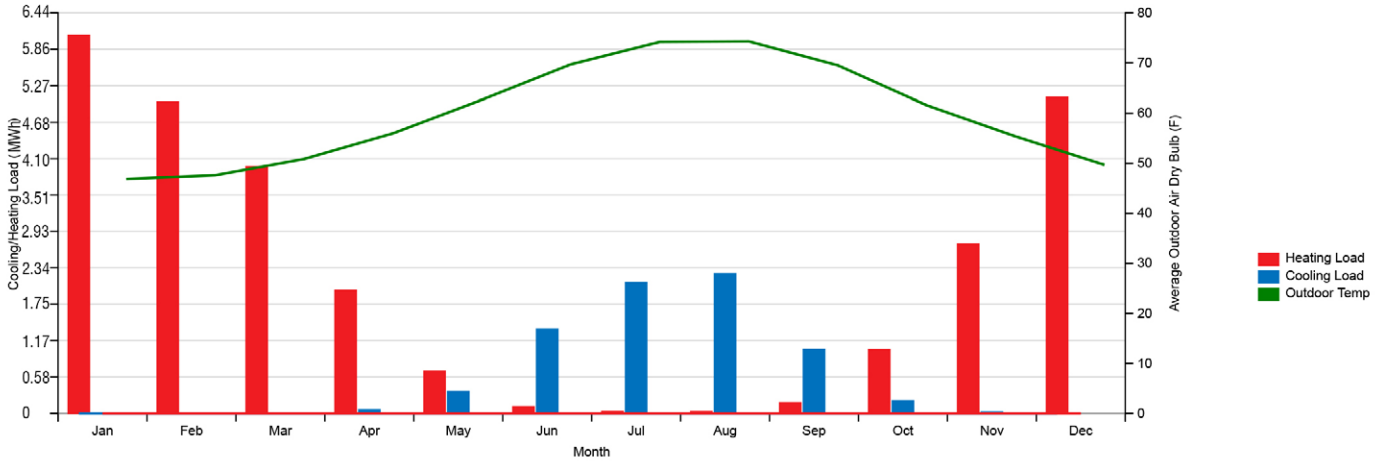
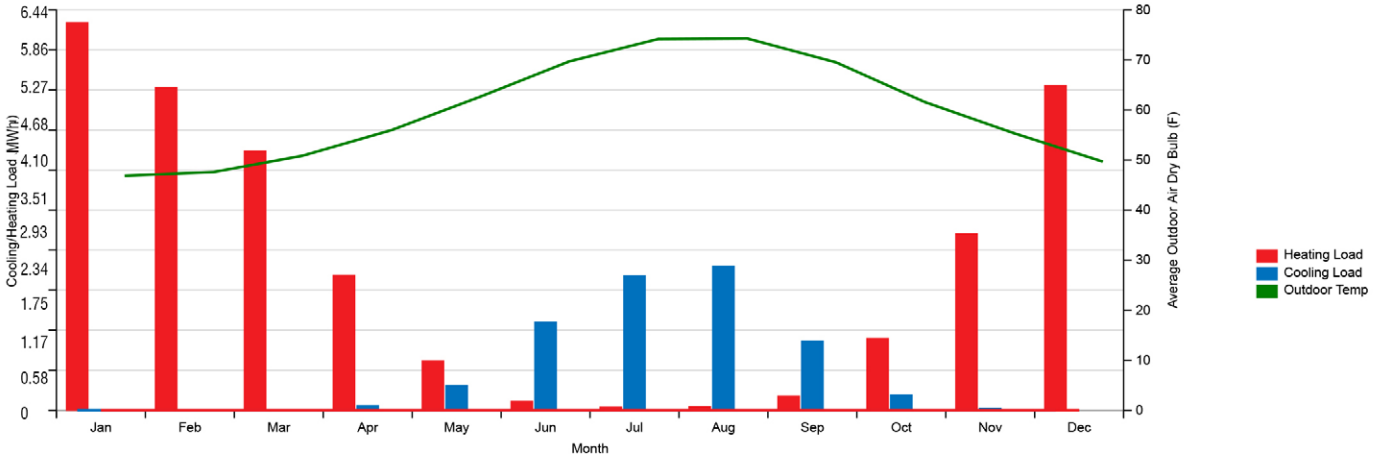


Table 15: Monthly Load Profiles__WALL 3



HVAC Load Profiles

City: Paris, France

Table 16: Monthly Load Profiles__WALL 1

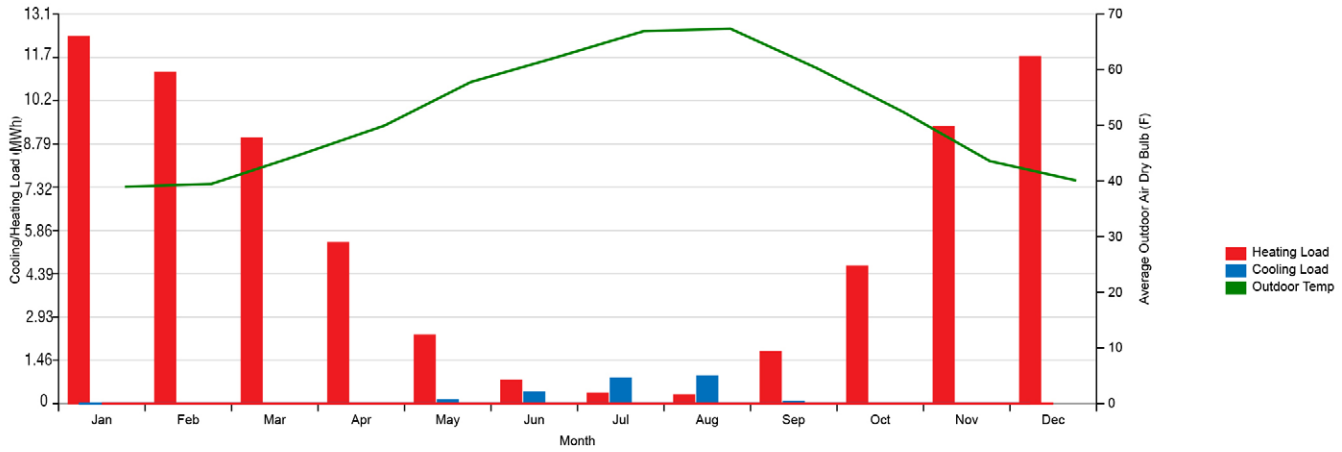


Table 17: Monthly Load Profiles__WALL 2

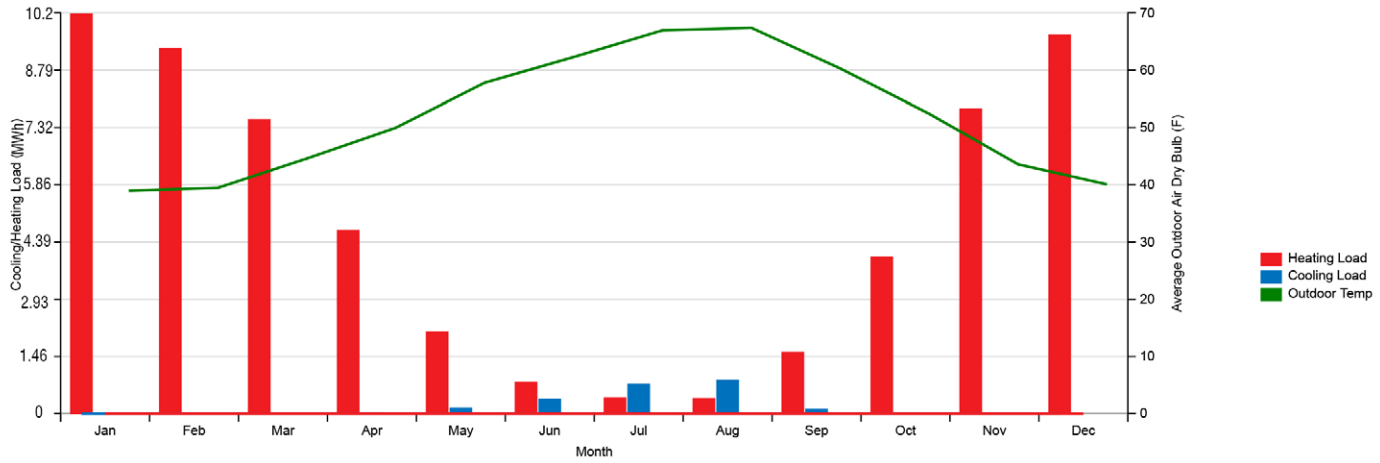
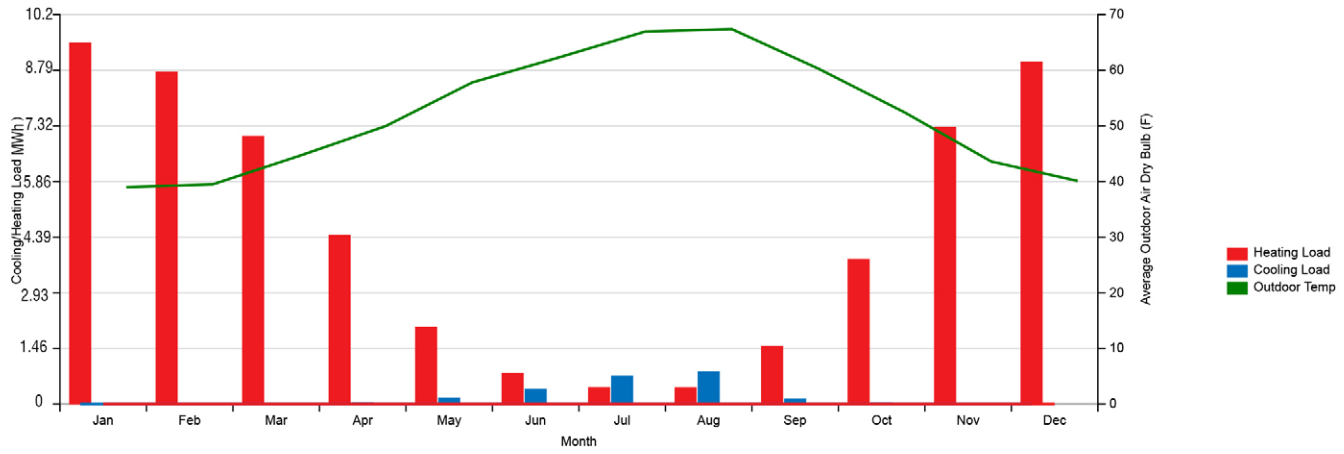


Table 18: Monthly Load Profiles__WALL 3



HVAC Load Profiles

City: Copenhagen, Denmark

Table 19: Monthly Load Profiles__WALL 1

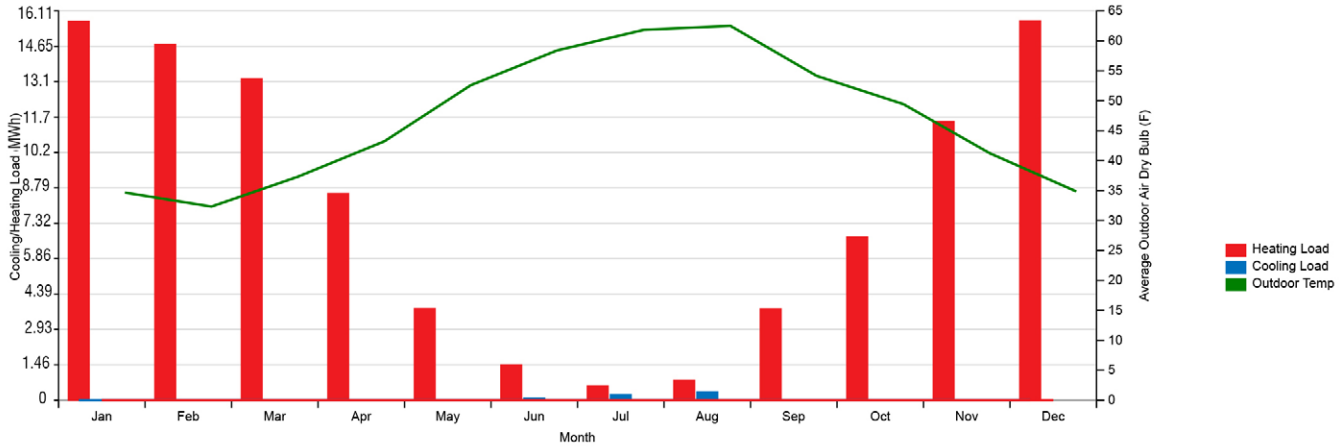


Table 20: Monthly Load Profiles__WALL

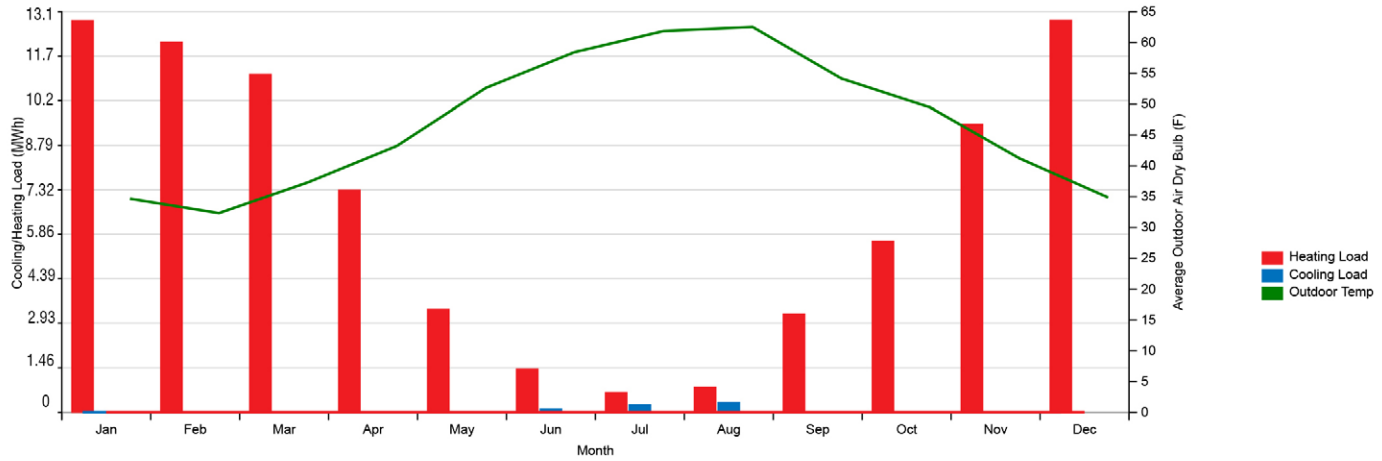


Table 21: Monthly Load Profiles__W

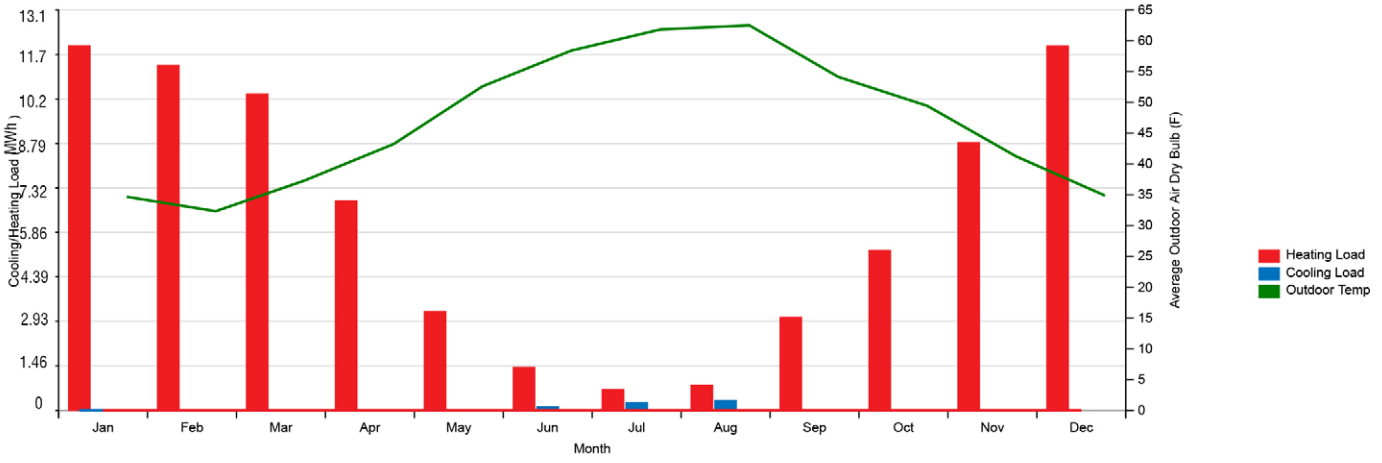


Table 22
cities comparison

City	Wall.1		Wall.2		Wall.3	
	Value kwh	Percentage	Value kwh	Percentage	Value kwh	Percentage
Naples	51466.79	21%	46416.59	21.7%	44830.49	22%
Paris	83863.75	34.25%	72860.98	34%	69349.99	34%
Copenhagen	109494.57	44.7%	93769.55	44%	88766.53	43.7%

In this table we see how these three cities net site energy differs and moreover how our three types walls work diffrently in each city as it shows in the percentages.

Table 23 Utility use per conditioned floor area for Naples with wall. 2

	Electricity Intensity [MJ/m2]	Natural Gas Intensity [MJ/m2]	Additional Fuel Intensity [MJ/m2]	District Cooling Intensity [MJ/m2]	District Heating Intensity [MJ/m2]	Water Intensity [m3/m2]
Lighting	133.51	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	201.82	735.35	0.00
Other	196.56	0.00	0.00	0.00	0.00	0.00
Total	330.07	0.00	0.00	201.82	735.35	0.00

Table 24 Utility use per conditioned floor area for Paris with wall. 2

	Electricity Intensity [MJ/m2]	Natural Gas Intensity [MJ/m2]	Additional Fuel Intensity [MJ/m2]	District Cooling Intensity [MJ/m2]	District Heating Intensity [MJ/m2]	Water Intensity [m3/m2]
Lighting	133.51	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	61.28	1597.83	0.00
Other	196.56	0.00	0.00	0.00	0.00	0.00
Total	330.07	0.00	0.00	61.28	1597.83	0.00

Table 25 Utility use per conditioned floor area for Copenhagen with wall. 2

	Electricity Intensity [MJ/m2]	Natural Gas Intensity [MJ/m2]	Additional Fuel Intensity [MJ/m2]	District Cooling Intensity [MJ/m2]	District Heating Intensity [MJ/m2]	Water Intensity [m3/m2]
Lighting	133.51	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	18.24	2211.69	0.00
Other	196.56	0.00	0.00	0.00	0.00	0.00
Total	330.07	0.00	0.00	18.24	2211.69	0.00

As we compare tables 23, 24 and 25 together we find out how changing the location affects the district intensities of our utility uses and what and architect can innovate by being knowledgable of these effects, for example what type of material to use both in construction and in utility so the annual price of a building and expences be reduced

Conclusion:

We made three different wall with no insulation (wall.1), with 3cm insulation (wall.2) and with 10cm insulation(wall.3) and we applied them to 3 different cities, Naples (south Europe), Paris (central Europe), Copenhagen (north Europe). Our building is two stores with 5 thermal zones.
When comparing the results of each city for Naples we understand that the wall 2 and wall 3 net site energy doesn't differ that much also in Paris but in Copenhagen wall 3 differs more compere to wall 2. Also when we compere cities together we see that wall 3 is more effective in Copenhagen than to other cities. But when we make the insulation better the effect in Naples is that for cooling energy consumption goes down as well but in Copenhagen it has opposite results.

In conclusion, we can see that different variables result in different outcomes in the system's environmental performance. For instance, in cahnging the location of the building we can see that how much is it important
for an architect to design the building suitable to the location when comparing same wall in 3 cities then when we compare diffrent walls for one building in one location how it's impactfull for our energy consumption in all around the year.