Politecnico di Milano – Sede di Piacenza

Technical Environmental Systems

A case study on the environmental impacts of a small-sized office space in the European region

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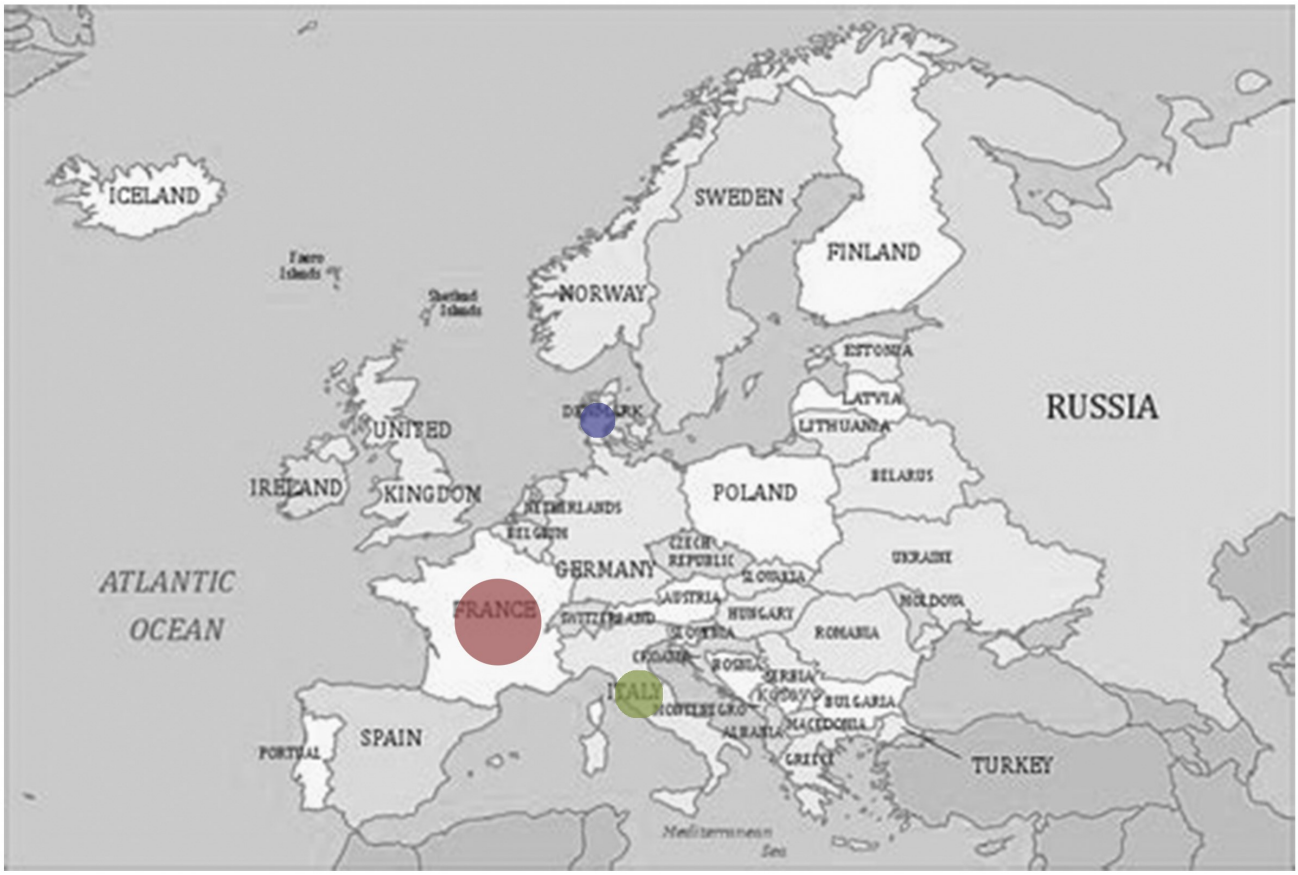
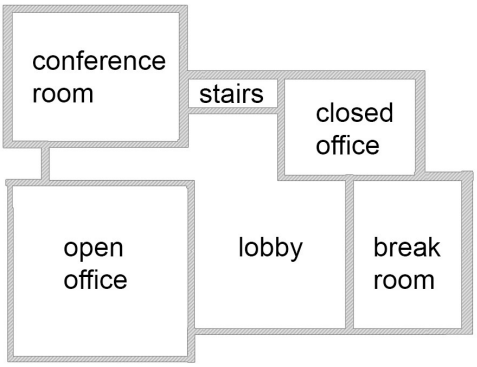
Introduction

One of the most important issues which humanity is tackiling in today's day and age is the issue of environmental awareness and sustainability. The world's environmental health has seen a dramatic decrease over the past few decades and the negative statistical outcomes are spiraling out of our control at an extremely alarming rate. Thus, it is our duty as architects, engineers, scientists and as a human race in general to put into consideration the environment in everything that we design, build or interact with. It is fairly safe to assume that every element around us has an impact on our surrounding environment; however, thanks to modern science and advanced computation methods we are now able to determine whether or not those elements have a positive or a negative impact on our environment.

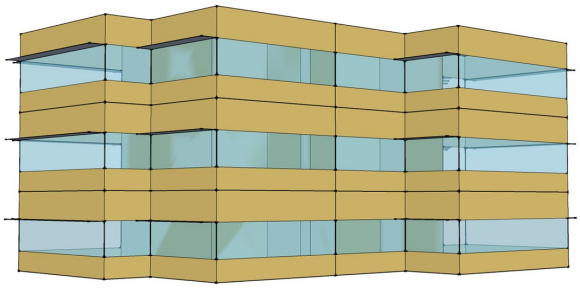
Process

The project is a simple builing with different areas .By using OpenStudio we determinded 6 thermal zones in Naples,Paris and Copenhagen with 3 kind of wall isulation and compare the effect of it.





Plan



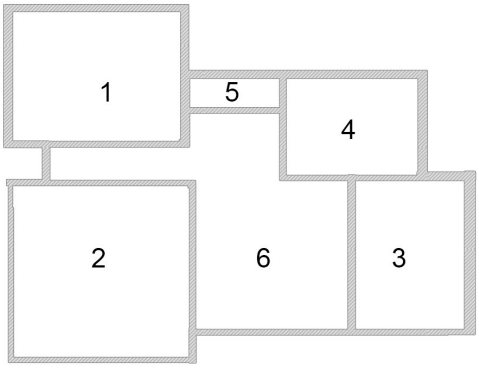
Perspective View

Building Area

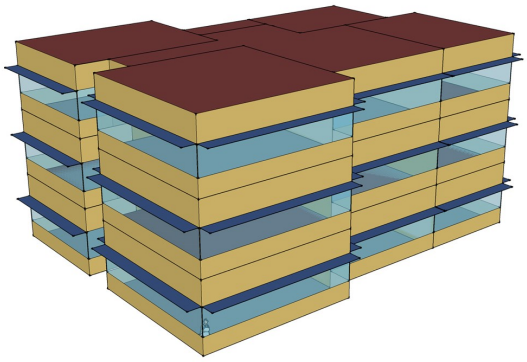
	Area [m2]
Total Building Area	334.53
Net Conditioned Building Area	334.53
Unconditioned Building Area	0.00

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]	1044.00	306.00	216.00	306.00	216.00
Above Ground Wall Area [m2]	1044.00	306.00	216.00	306.00	216.00
Window Opening Area [m2]	417.60	122.40	86.40	122.40	86.40
Gross Window-Wall Ratio [%]	40.00	40.00	40.00	40.00	40.00
Above Ground Window-Wall Ratio [%]	40.00	40.00	40.00	40.00	40.00



Thermal zone



Window wall ration

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	84.15	Yes	Yes	1009.80	1.00	262.20	104.88	10.6563	19.56	6.8889
THERMAL ZONE 2	94.71	Yes	Yes	1136.49	1.00	121.04	48.42	12.5938	9.29	0.7535
THERMAL ZONE 3	48.51	Yes	Yes	582.07	1.00	198.76	79.50	11.6250	1.86	48.0070
THERMAL ZONE 4	35.63	Yes	Yes	427.59	1.00	145.52	58.21	10.6563	17.70	7.6424
THERMAL ZONE 5	8.53	Yes	Yes	102.34	1.00	58.48	23.39	5.8125		0.0000
THERMAL ZONE 6	63.00	Yes	Yes	756.00	1.00	258.00	103.20	12.5938	1.86	3.9826
Total	334.53			4014.30		1044.00	417.60	11.5867	4.37	10.4713
Conditioned Total	334.53			4014.30		1044.00	417.60	11.5867	4.37	10.4713
Unconditioned Total	0.00			0.00		0.00	0.00			
Not Part of Total	0.00			0.00		0.00	0.00			

Weather Summary

3 cities with 3 attitude . Here are some introduction about their weather.

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

Wall with no insulation
Wall with 3 cm insulation
Wall with 10 cm insulation

Site and Source Energy Naples, Italy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	119955.5 kWh 431.84	1290.90	1290.90
Net Site Energy	119955.5 kWh 431.84	1290.90	1290.90
Total Source Energy	366480.5 kWh 1319.33	3943.89	3943.89
Net Source Energy	366480.5 kWh 1319.33	3943.89	3943.89
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	104627.7 kWh 376.66	1125.96	1125.96
Net Site Energy	104627.7 kWh 376.66	1125.96	1125.96
Total Source Energy	1162.74 kWh 1162.74	3475.79	3475.79
Net Source Energy	1162.74 kWh 1162.74	3475.79	3475.79
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	99450 kWh 358.02	1070.22	1070.22
Net Site Energy	99450 kWh 358.02	1070.22	1070.22
Total Source Energy	308002.7 kWh 1108.81	3314.57	3314.57
Net Source Energy	308002.7 kWh 1108.81	3314.57	3314.57

In naples the three diffrent walls have their effect but not that drastic The difrence between no insulation wall and 10 cm wall's net site energy is 71 GJ

Site and Source Energy Copenhagen, Denmark

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	253725 kWh 913.41	2730.46	2730.46
Net Site Energy	253725 kWh 913.41	2730.46	2730.46
Total Source Energy	900144.4 kWh 3240.52	9686.94	9686.94
Net Source Energy	900144.4 kWh 3240.52	9686.94	9686.94
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	210713.8 kWh 758.57	2267.59	2267.59
Net Site Energy	210713.8 kWh 758.57	2267.59	2267.59
Total Source Energy	745372.2 kWh 2683.34	8021.36	8021.36
Net Source Energy	745372.2 kWh 2683.34	8021.36	8021.36
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	196455.5 kWh 707.24	2114.18	2114.18
Net Site Energy	196455.5 kWh 707.24	2114.18	2114.18
Total Source Energy	693925 kWh 2498.13	7467.70	7467.70
Net Source Energy	693925 kWh 2498.13	7467.70	7467.70

In Copenhagen the three diffrent walls Really show thier changes in energy saving The difrence between no insulation wall and 10 cm wall's net site energy is 206 GJ

Site and Source Energy Paris, France

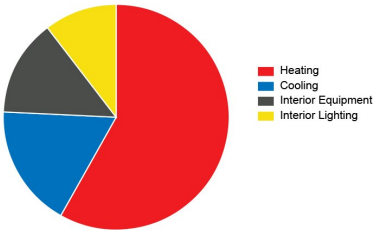
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	194205.5 kWh 699.14	2089.94	2089.94
Net Site Energy	194205.5 kWh 699.14	2089.94	2089.94
Total Source Energy	674900 kWh 2429.64	7262.95	7262.95
Net Source Energy	674900 kWh 2429.64	7262.95	7262.95
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	163627.7 kWh 589.06	1760.87	1760.87
Net Site Energy	163627.7 kWh 589.06	1760.87	1760.87
Total Source Energy	567000 kWh 2041.20	6101.80	6101.80
Net Source Energy	567000 kWh 2041.20	6101.80	6101.80
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	153450 kWh 552.42	1651.35	1651.35
Net Site Energy	153450 kWh 552.42	1651.35	1651.35
Total Source Energy	530755.5 kWh 1910.72	5711.73	5711.73
Net Source Energy	530755.5 kWh 1910.72	5711.73	5711.73

In Paris the three diffrent walls have the medium diffrence compare to other cities but closer to Copenhagen The difrence between no insulation wall and 10 cm wall's net site energy is 147 GJ

Annual Overview

Naples, Italy

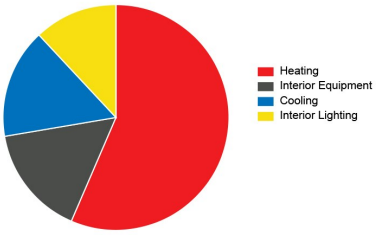
No insulation



EAp2-18. End Use Percentage

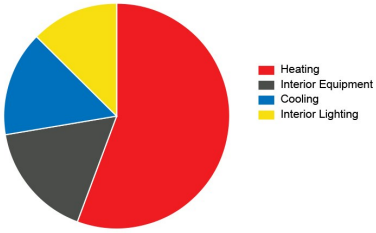
	Percent [%]
Interior Lighting	10.42
Space Heating	58.16
Space Cooling	17.59
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	13.83
Miscellaneous	0.00

3 cm insulation



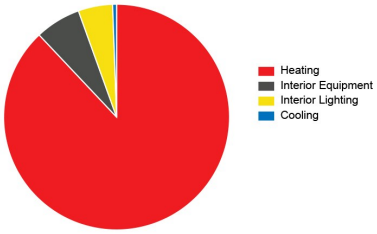
	Percent [%]
Interior Lighting	11.95
Space Heating	56.47
Space Cooling	15.73
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	15.86
Miscellaneous	0.00

10 cm insulation

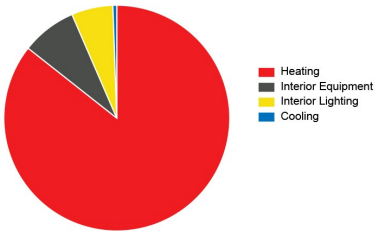


	Percent [%]
Interior Lighting	12.57
Space Heating	55.67
Space Cooling	15.08
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	16.68
Miscellaneous	0.00

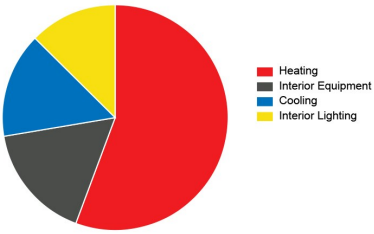
Copenhagen, Denmark



	Percent [%]
Interior Lighting	4.93
Space Heating	87.97
Space Cooling	0.56
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	6.54
Miscellaneous	0.00

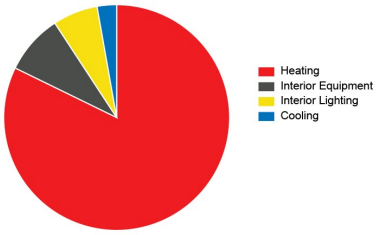


	Percent [%]
Interior Lighting	5.93
Space Heating	85.63
Space Cooling	0.56
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	7.87
Miscellaneous	0.00

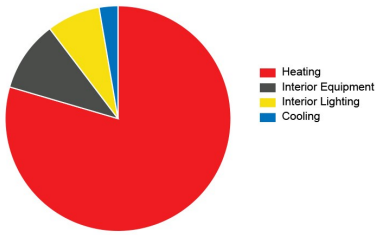


	Percent [%]
Interior Lighting	6.36
Space Heating	84.60
Space Cooling	0.59
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	8.45
Miscellaneous	0.00

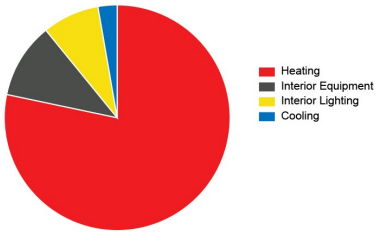
Paris, France



	Percent [%]
Interior Lighting	6.44
Space Heating	82.23
Space Cooling	2.79
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	8.54
Miscellaneous	0.00



	Percent [%]
Interior Lighting	7.64
Space Heating	79.53
Space Cooling	2.69
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	10.14
Miscellaneous	0.00

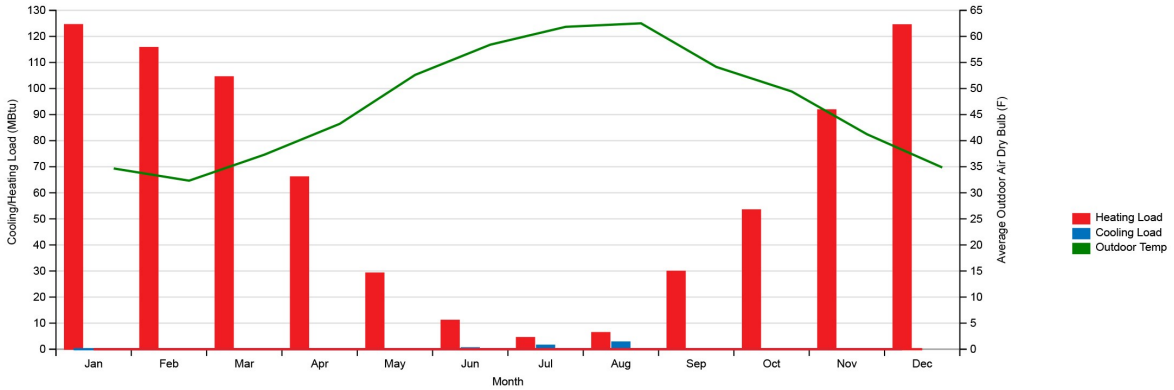


	Percent [%]
Interior Lighting	8.15
Space Heating	78.31
Space Cooling	2.73
Fans-Interior	0.00
Service Water Heating	0.00
Receptacle Equipment	10.81
Miscellaneous	0.00

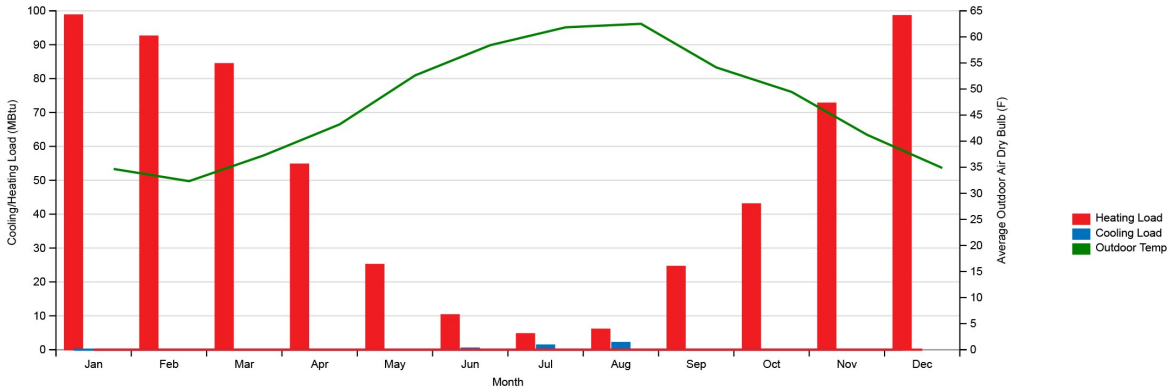
HVAC Load Profiles

City : Copenhagen , Denmark

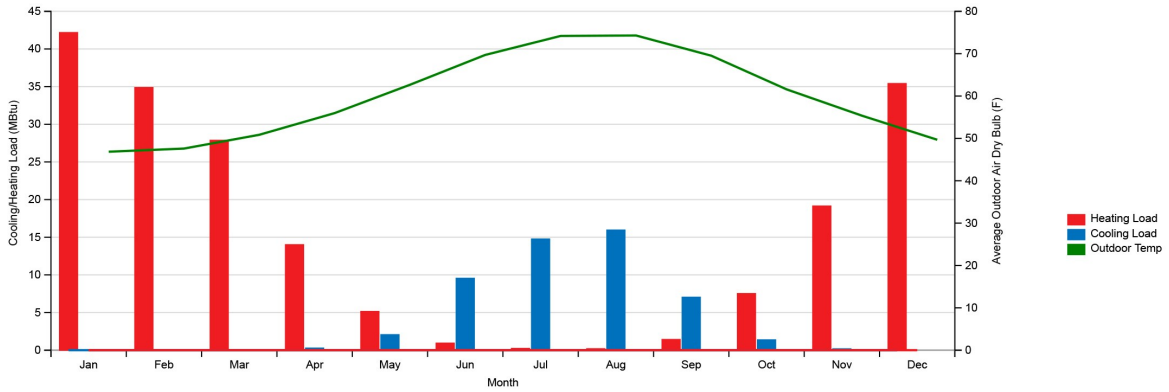
Monthly Load Profiles



Wall wih no isolation



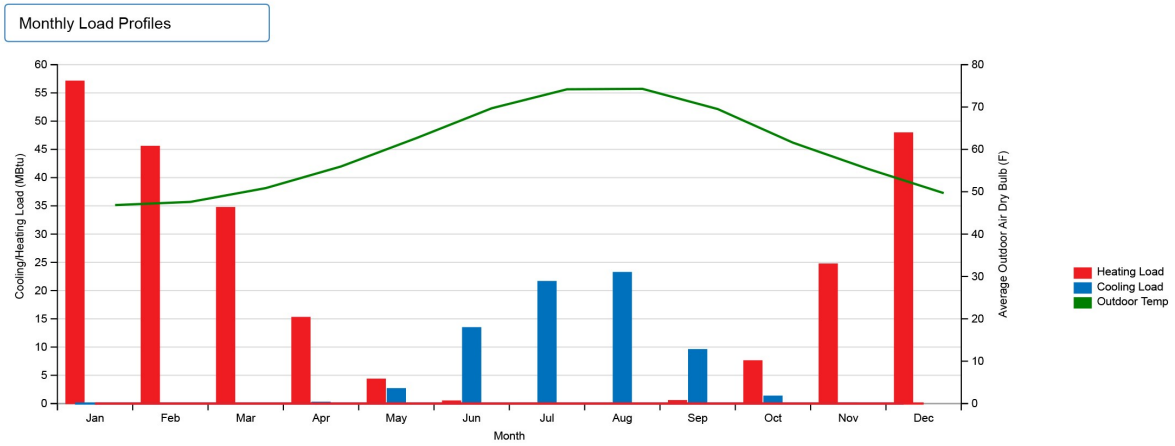
Wall wih 3cm isolation



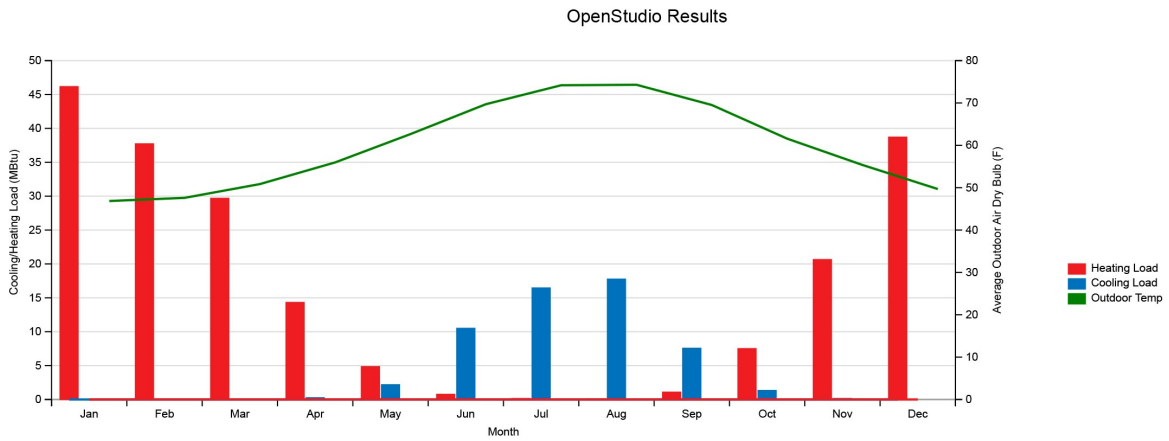
Wall wih 10cm isolation

HVAC Load Profiles

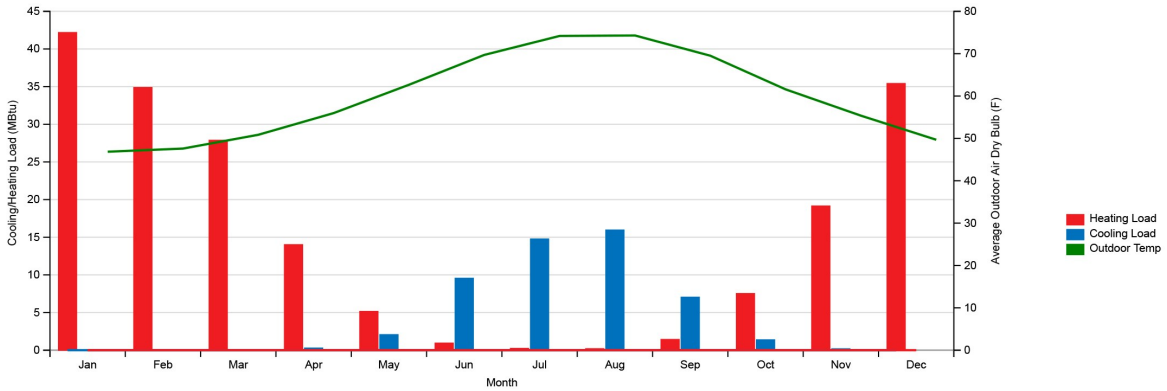
City : Napoli , Italy



Wall wih no isolation



Wall wih 3cm isolation

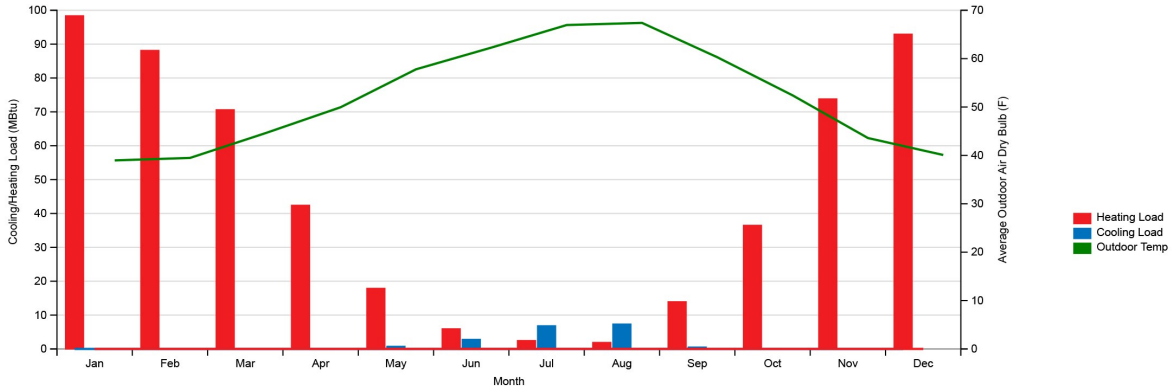


Wall wih 10cm isolation

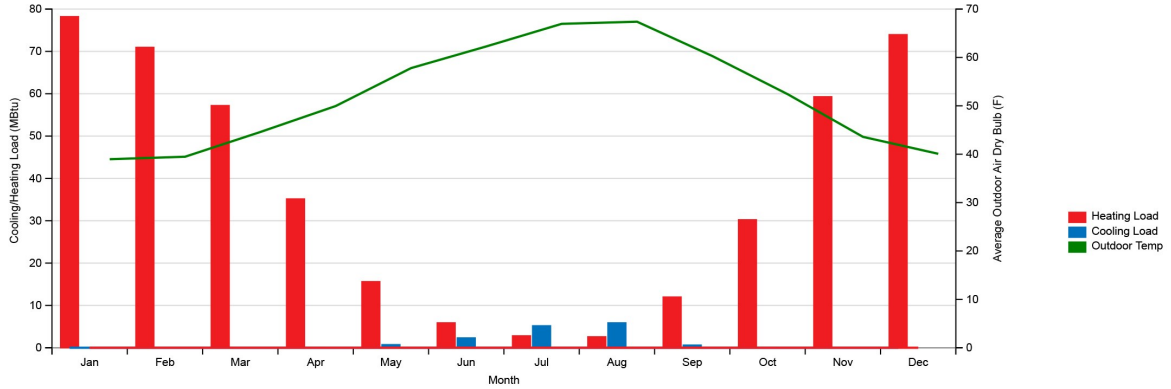
HVAC Load Profiles

City : Paris , France

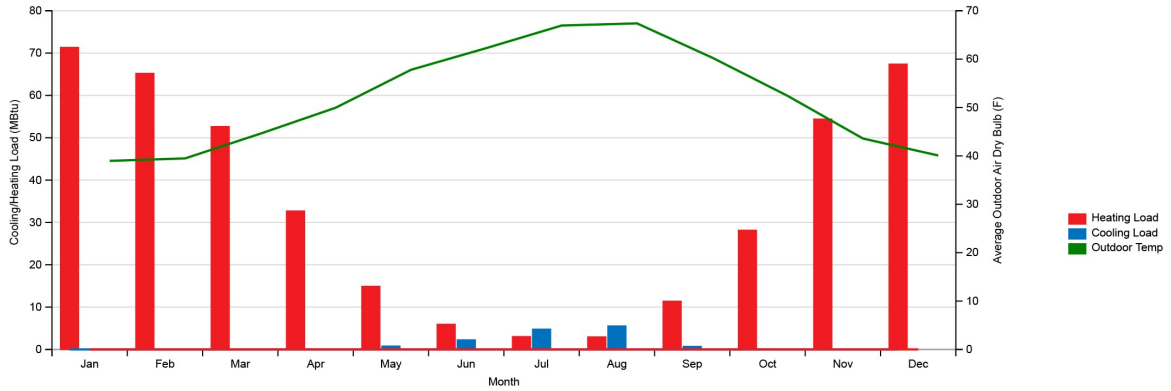
Monthly Load Profiles



Wall wih no isolation



Wall wih 3cm isolation



Wall wih 10cm isolation

cities comparison	Wall.1	Wall.2	Wall.3
City	Value kwh	Value kwh	Value kwh
Copenhagen	253725	210713.8	196455.5
Paris	194205.5	163427.7	153450
Napoli	119955.5	104627.7	99450

Copenhagen

Utility Use Per Conditioned Floor Area

	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	134.53	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	12.70	1941.81	0.00
Other	178.55	0.00	0.00	0.00	0.00	0.00
Total	313.08	0.00	0.00	12.70	1941.81	0.00

Paris

Utility Use Per Conditioned Floor Area

	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	134.53	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	47.34	1400.45	0.00
Other	178.55	0.00	0.00	0.00	0.00	0.00
Total	313.08	0.00	0.00	47.34	1400.45	0.00

Napoli

Utility Use Per Conditioned Floor Area

	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	134.53	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	177.08	635.79	0.00
Other	178.55	0.00	0.00	0.00	0.00	0.00
Total	313.08	0.00	0.00	177.08	635.79	0.00

By comparing above tables we can find how changing location could affect district intensities of our utility uses and how architects can be innovative by using different materials in constructing in utility and expenses.

With comparing 3 different wall (no isolation,3cm isolation and 10cm isolation) in 3 different cities we got different result to decide which kind of material is more effective to use for our builing.for example in copenhagen the diferences between wall 1 and wall 3 is higher than other two cities.