POLITECNICO DI MILANO
SUSTAINABLE ARCHITECTURE AND LANDSCAPE DESIGN

ENERGY PERFORMANCE

TECHNICAL ENVIRONMENTAL SYSTEMS
STUDY ON ENEGY PERFORMANCE OF BUIDINGS

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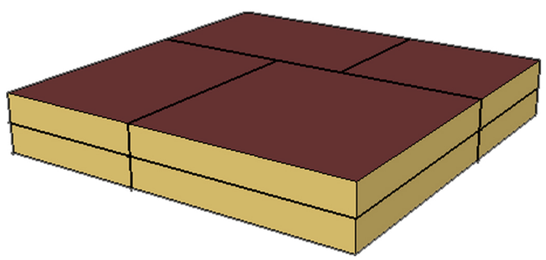
1.INTRODUCTION

This report analysis energy performances of a building:

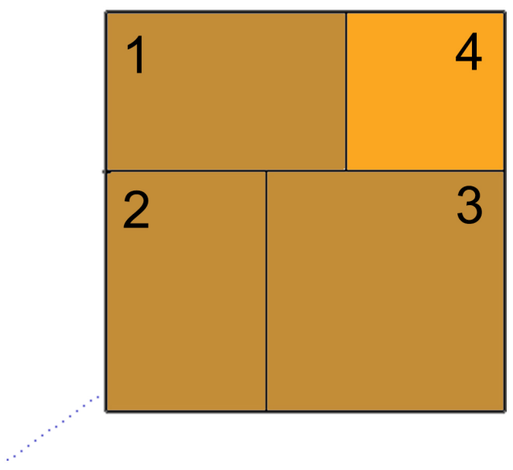
- one city according to different wall types
- one wall type according to three different city; Milan, Chicago and Rio de Janeiro, respectively.

MODEL



Building Area

	Area [m2]
Total Building Area	5000.00
Net Conditioned Building Area	5000.00
Unconditioned Building Area	0.00

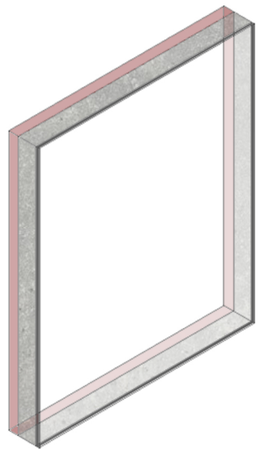


1.Office
2.Office
3.Office
4.Break Room

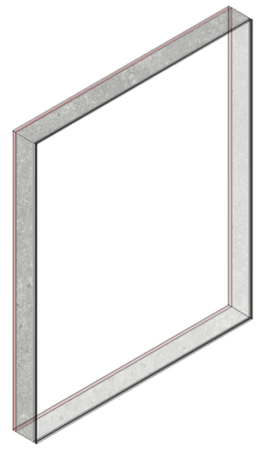
We created small two-story office building model as our research object for the study of energy. We decided focusing on the main issue so we kept the model as simple as possible.

LOCATIONS

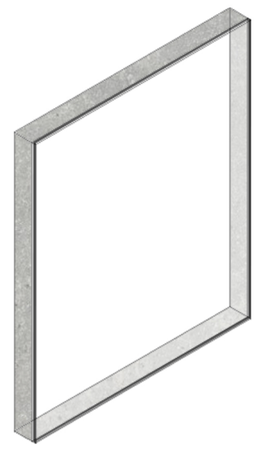
WALL TYPES



Stucco	25 mm
Concrete	200 mm
Insulation	110 mm
Gypsum	12 mm



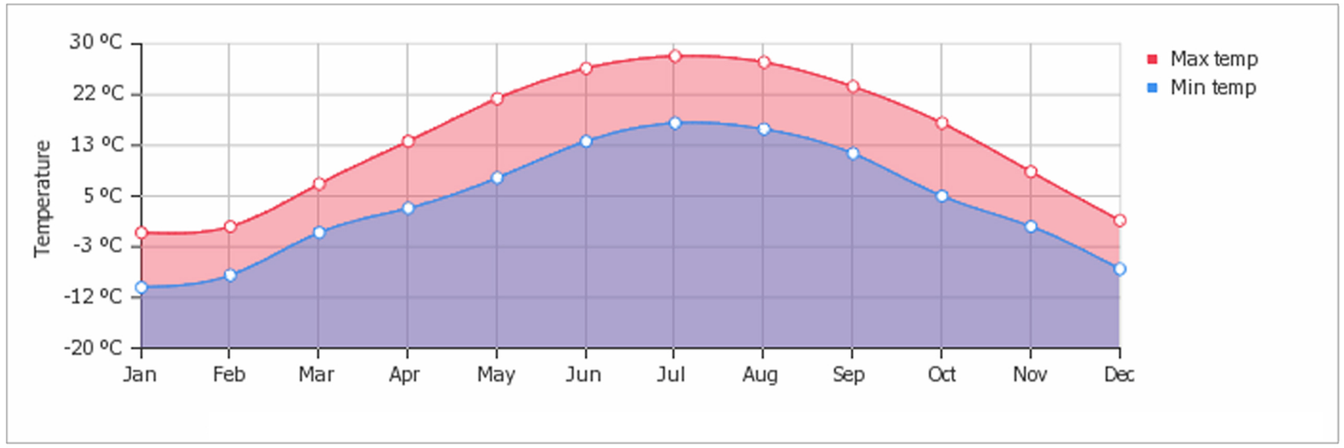
Stucco	25 mm
Concrete	200 mm
Insulation	30 mm
Gypsum	12 mm



Stucco	25 mm
Concrete	200 mm
Gypsum	12 mm

2.WEATHER

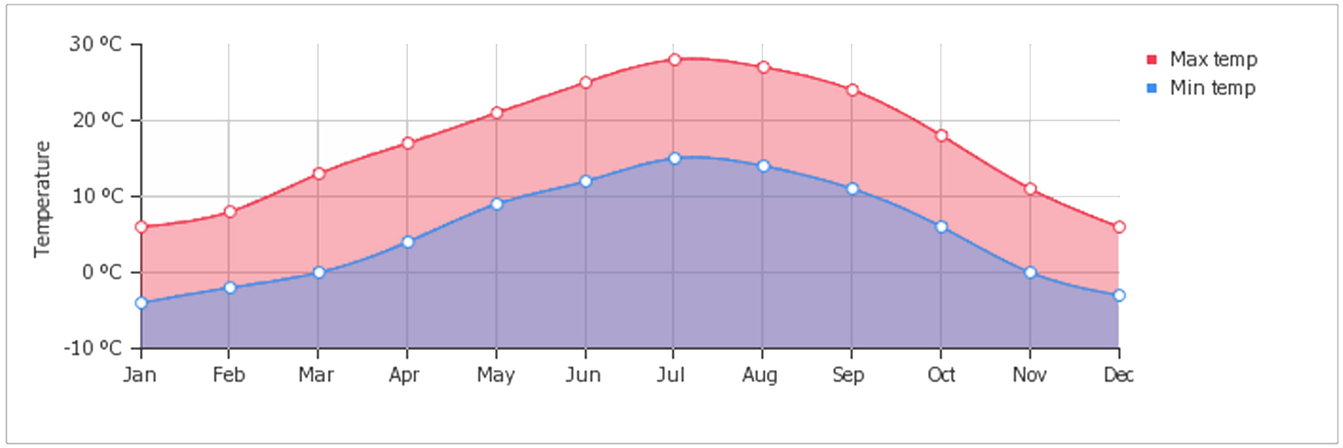
CHICAGO



Winter in Chicago is very variable. The average Chicago winter produces 94 cm (38 inches) of snow. Temperatures can vary wildly within the span of one week, but temperatures can often stay below freezing for several continues days or even weeks in January and February.

The temperature in January averages about - 2 °C (29°F) in the afternoon, and -10 °C (14°F) at night. On a typical summer day, humidity is usually high and temperatures ordinarily reach anywhere between 26°C to 33°C (78°F and 92°F). Overnight temperatures in summer usually drop to around 18°C (65°F). Thunderstorms occur during summer.

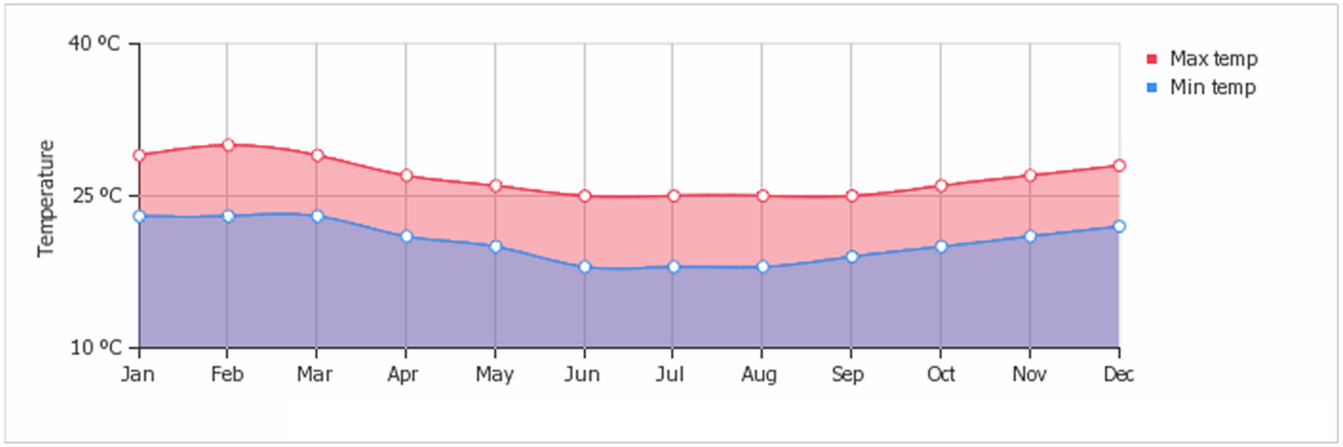
MILAN



Milan can be cold and foggy in winter and very hot and humid in summer. Its climate is typically Mediterranean. Milan is lucky that the mountains to the north shield the city from the worst of the Arctic chills, but there are is the occasional cold weather. In summer Milan is troubled by heat waves. August drives many locals out of town because of the heat.

July is the hottest month in Milan with an average temperature of 25°C (77°F) and the coldest is January at 3°C (37°F) with the most daily sunshine hours at 10 in July. The wettest month is July with an average of 101mm of rain.

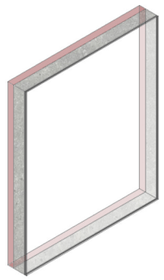
RIO DE JANEIRO

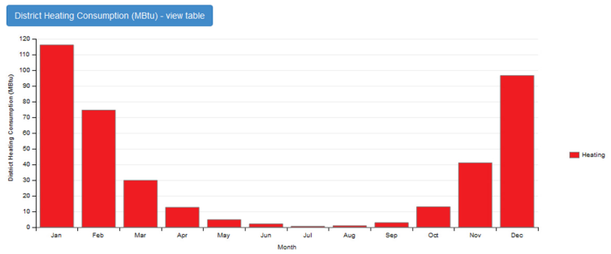


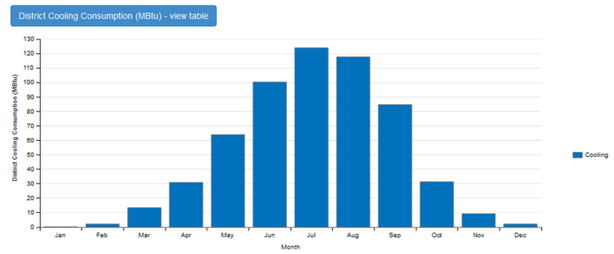
Rio's winter temperatures stay around the 20 °C (70ºF), dipping occasionally below the 15 °C (60ºF). February is the hottest month in Rio de Janeiro with an average temperature of 27°C (81°F) and the coldest is July at 21°C (70°F) with the most daily sunshine hours at 7 in August. The wettest month is December with an average of 169mm of rain.

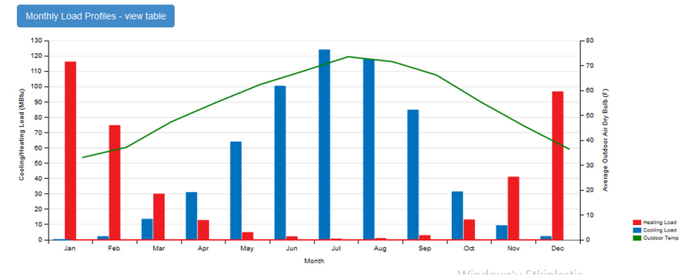
3. EXPERIMENTAL RESULTS - ONE CITY(MILAN) THREE DIFFERENT WALL TYPES

DISTRICT COOLING CONSUMPTIONS DISTRICT HEATING CONSUMPTIONS MONTHLY LOAD PROFILES

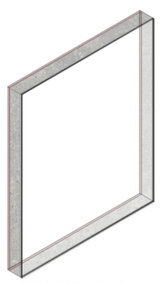


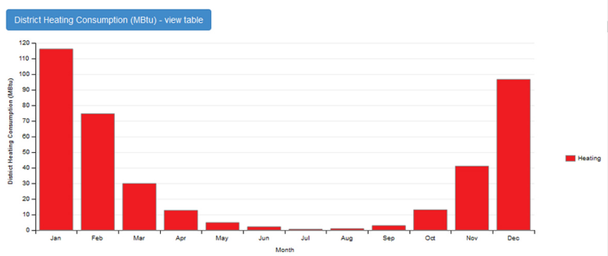


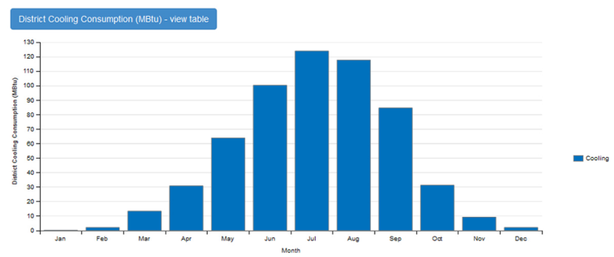


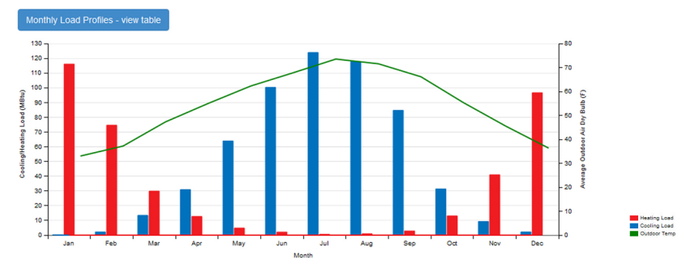


WALL WITH 110 mm INSULATION

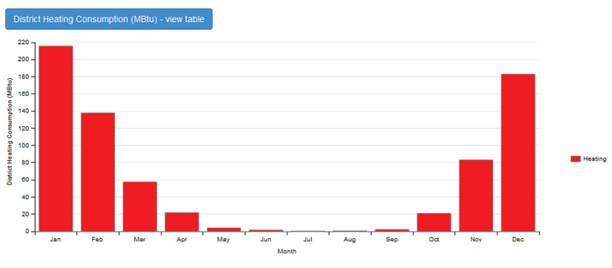


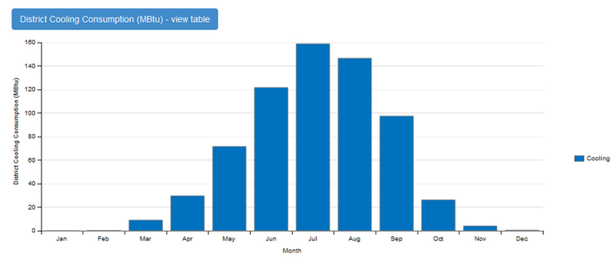


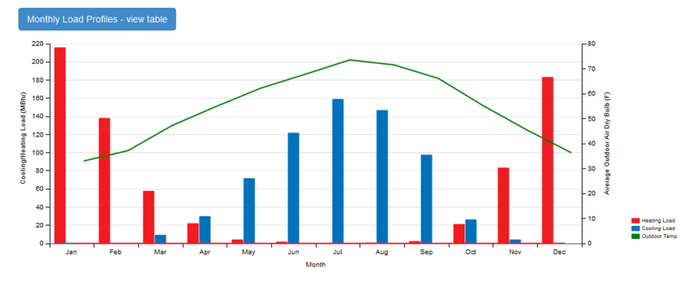




WALL WITH 30 mm INSULATION







WALL WITHOUT INSULATION

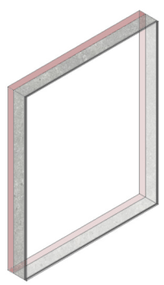
District cooling consumptions and district heating consumptions charts are almost identical with all three different wall types. On the other hand, if we compare monthly load profiles charts cooling load and heating load is lower with wall without insulation.

3. EXPERIMENTAL RESULTS

END USE TABLES

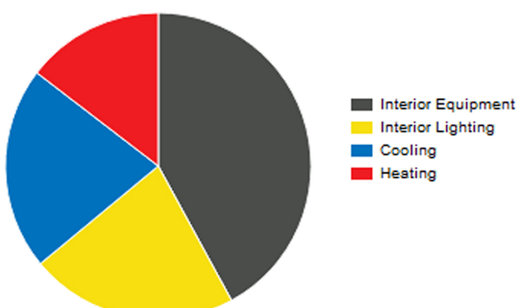
ENERGY USE TABLES

EUI-ELECTRICITY TABLE

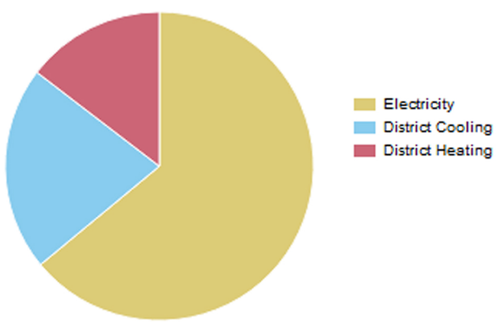


WALL WITH
110 mm INSULATION

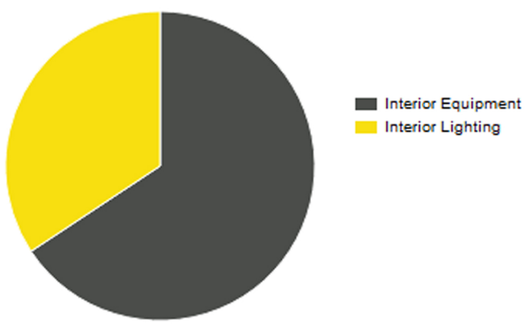
End Use - view table

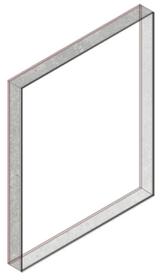


Energy Use - view table



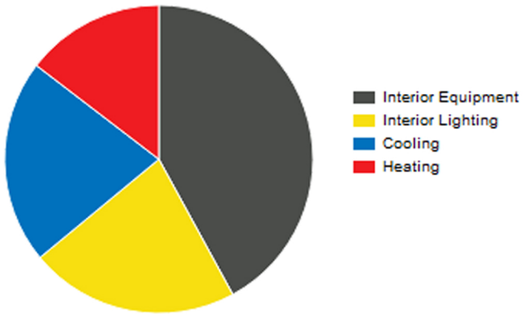
EUI - Electricity - view table



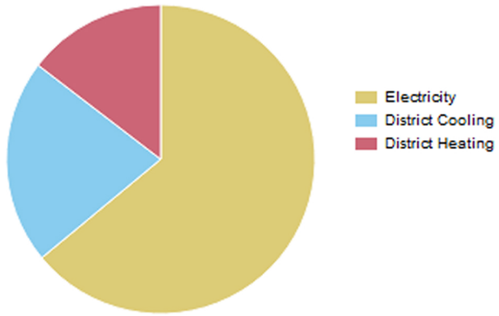


WALL WITH
30 mm INSULATION

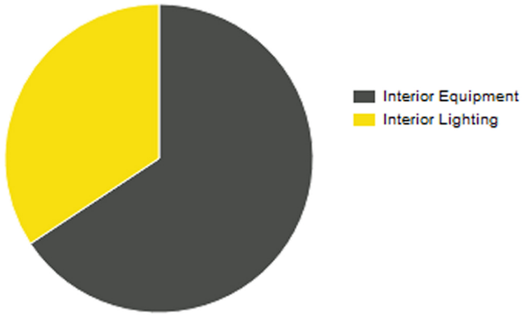
End Use - view table



Energy Use - view table

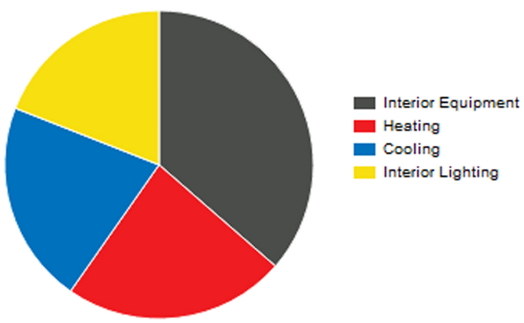


EUI - Electricity - view table

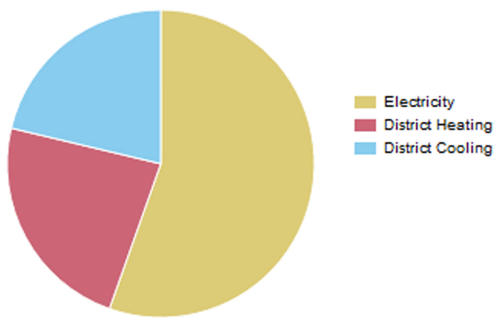


WALL WITHOUT
INSULATION

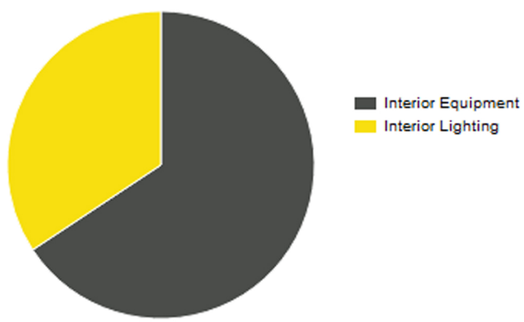
End Use - view table



Energy Use - view table

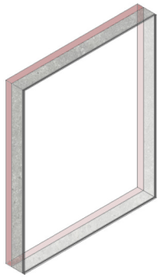


EUI - Electricity - view table



3. EXPERIMENTAL RESULTS - MILAN

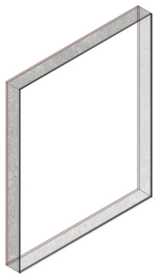
SITE AND SOURCE ENERGY



WALL WITH
110 mm INSULATION

	Total Energy (kBtu)	Energy Per Total Building Area (kBtu/ft^2)	Energy Per Total Conditioned Building Area (kBtu/ft^2)
Total Site Energy	2710207,23	542,04	542,04
Net Site Energy	2710207,23	542,04	542,04
Total Source Energy	7534349,94	1506,87	1506,87
Net Source Energy	7534349,94	1506,87	1506,87

SITE AND SOURCE ENERGY



WALL WITH
30 mm INSULATION

	Total Energy (kBtu)	Energy Per Total Building Area (kBtu/ft^2)	Energy Per Total Conditioned Building Area (kBtu/ft^2)
Total Site Energy	2710207,23	542,04	542,04
Net Site Energy	2710207,23	542,04	542,04
Total Source Energy	7534349,94	1506,87	1506,87
Net Source Energy	7534349,94	1506,87	1506,87

SITE AND SOURCE ENERGY

WALL WITHOUT
INSULATION

	Total Energy (kBtu)	Energy Per Total Building Area (kBtu/ft^2)	Energy Per Total Conditioned Building Area (kBtu/ft^2)
Total Site Energy	3129142,40	625,82	625,82
Net Site Energy	3129142,40	625,82	625,82
Total Source Energy	8829504,12	1765,90	1765,90
Net Source Energy	8829504,12	1765,90	1765,90

Site and source energy charts show that thickness of the insulation does not affect the energy of the building. If we compare wall with insulation and wall without insulation, it is obvious that wall without insulation needs more energy.

4. EXPERIMENTAL RESULTS - ONE WALL TYPE THREE DIFFERENT CITIES

USING 8IN CONCRETE WITHOUT INSULATION

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	3,591,042	kBtu
Total Building Area	53,820	ft^2
EUI (Based on Net Site Energy and Total Building Area)	66.72	kBtu/ft^2
OpenStudio Standards Building Type		

CHICAGO

Weather Summary

	Value
Weather File	Chicago/Midway IL USA TMY--14819 WMO#=725340
Latitude	41.78
Longitude	-87.8
Elevation	614 (ft)
Time Zone	-6.0
North Axis Angle	0.00
ASHRAE Climate Zone	

CHICAGO

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	3,838,318	kBtu
Total Building Area	53,820	ft^2
EUI (Based on Net Site Energy and Total Building Area)	71.32	kBtu/ft^2
OpenStudio Standards Building Type		

RIO DE JANEIRO

Weather Summary

	Value
Weather File	Rio De Janeiroo-Gale►o►Jobim I RJ BRA TRY Brazil WMO#=837460
Latitude	-22.8
Longitude	-43.3
Elevation	16 (ft)
Time Zone	-3.0
North Axis Angle	0.00
ASHRAE Climate Zone	

RIO DE JANEIRO

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	3,129,142	kBtu
Total Building Area	53,820	ft^2
EUI (Based on Net Site Energy and Total Building Area)	58.14	kBtu/ft^2
OpenStudio Standards Building Type		

MILANO

Weather Summary

	Value
Weather File	Milano-Linate - ITA IGDG WMO#=160800
Latitude	45.43
Longitude	9.28
Elevation	338 (ft)
Time Zone	1.00
North Axis Angle	0.00
ASHRAE Climate Zone	

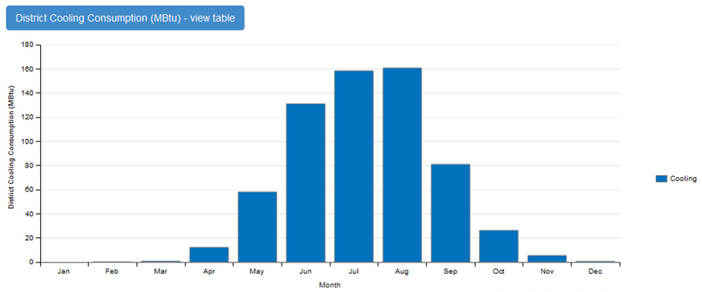
MILANO

4. EXPERIMENTAL RESULTS

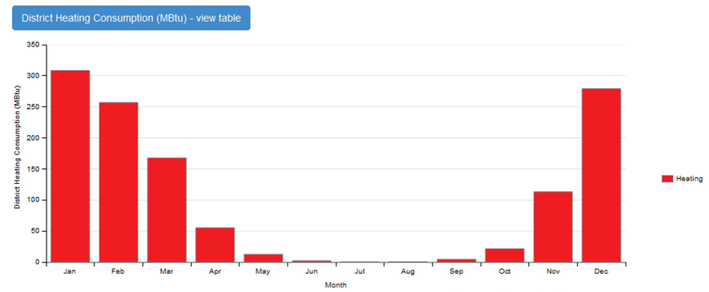
DISTRICT COOLING CONSUMPTIONS

DISTRICT HEATING CONSUMPTIONS

MONTHLY LOAD PROFILES



CHICAGO



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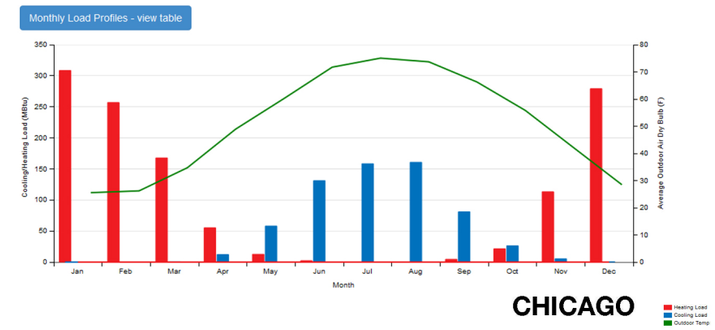

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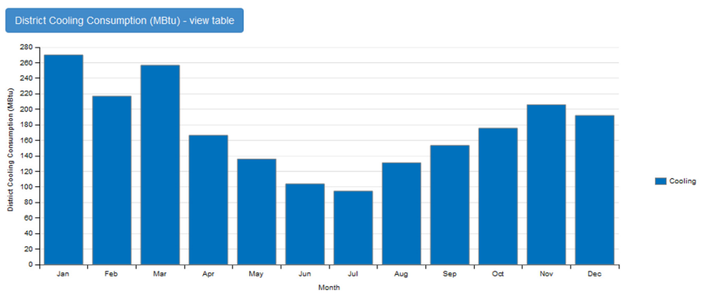
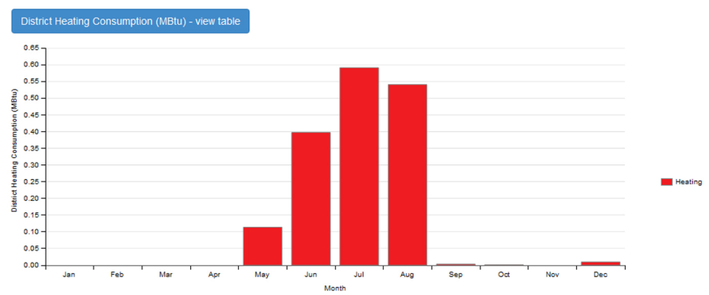
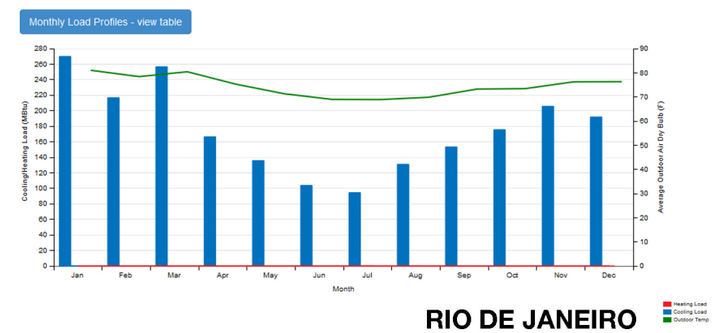


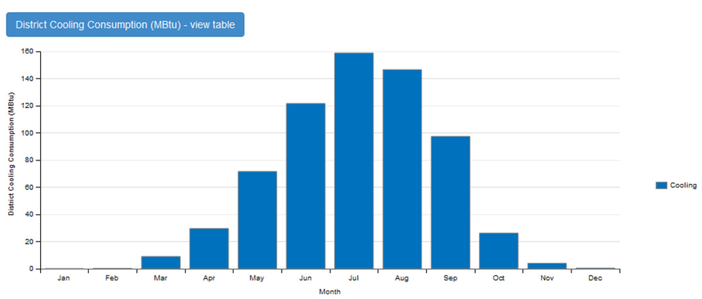
RIO DE JANEIRO



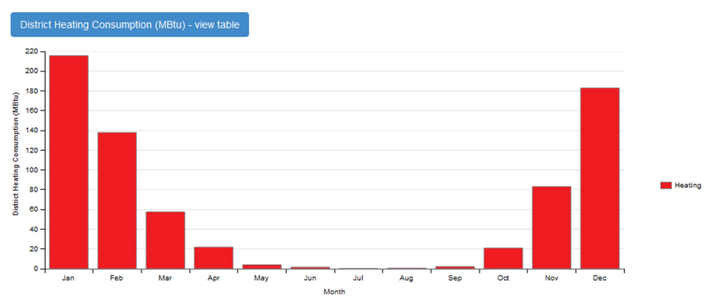
RIO DE JANEIRO



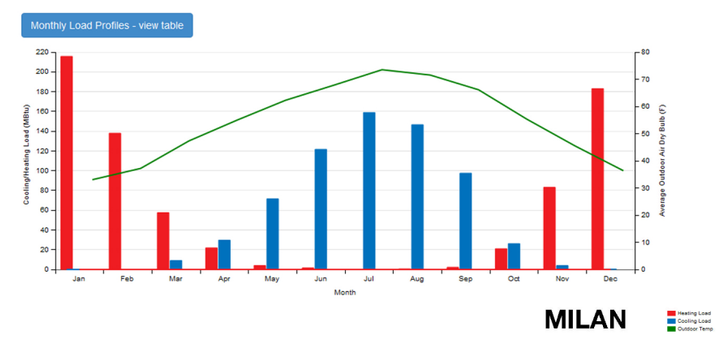
RIO DE JANEIRO



MILAN



MILAN



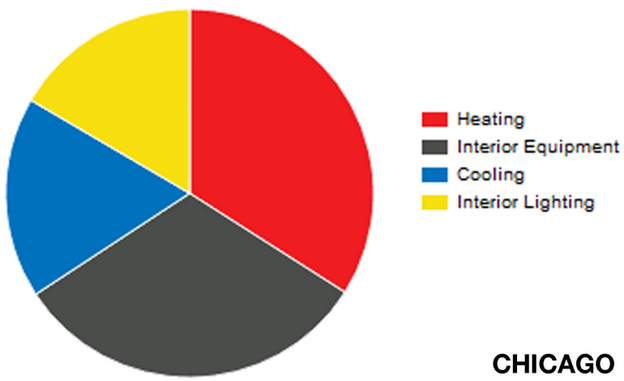
MILAN

District cooling consumption chart shows that the city which has the warmest weather (Rio De Janeiro) has highest cooling consumption. Thus, Rio has the highest cooling load. If we compare Milan and Chicago, they both have same charts according to district cooling consumptions, district heating consumptions and monthly load profiles datas; In Milan, cooling load is higher than Chicago and in Chicago heating load is higher than Milan slightly.

4. EXPERIMENTAL RESULTS - MILAN

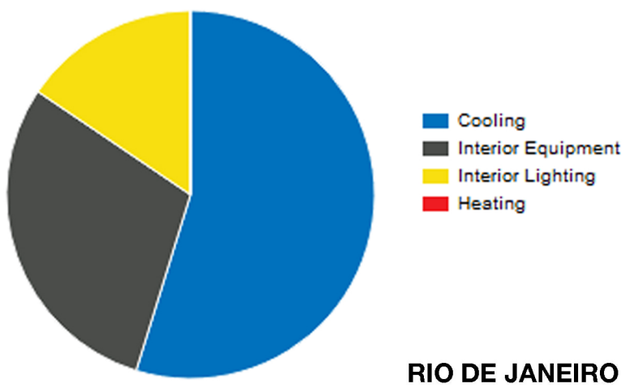
END USE TABLES

End Use - view table



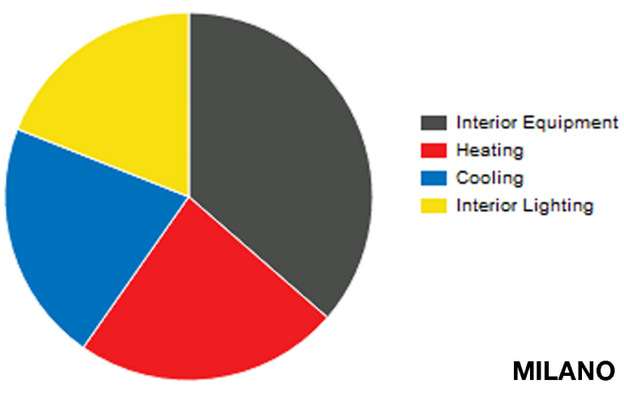
CHICAGO

End Use - view table



RIO DE JANEIRO

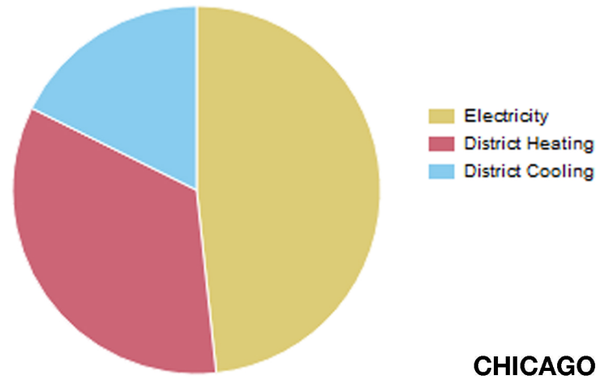
End Use - view table



MILANO

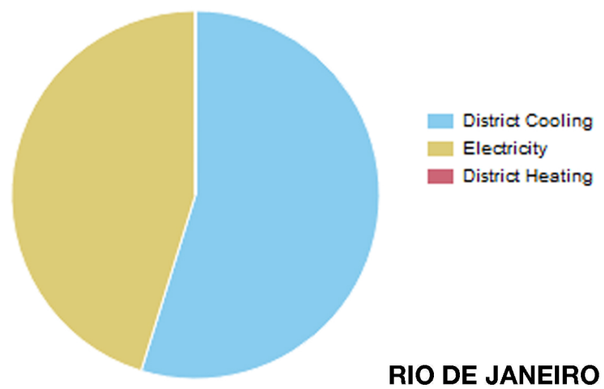
ENERGY USE TABLES

Energy Use - view table



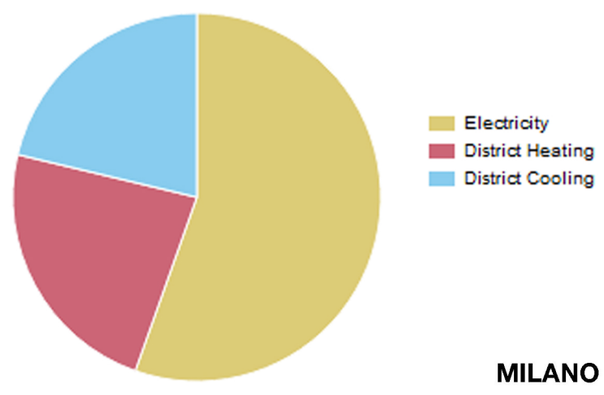
CHICAGO

Energy Use - view table



RIO DE JANEIRO

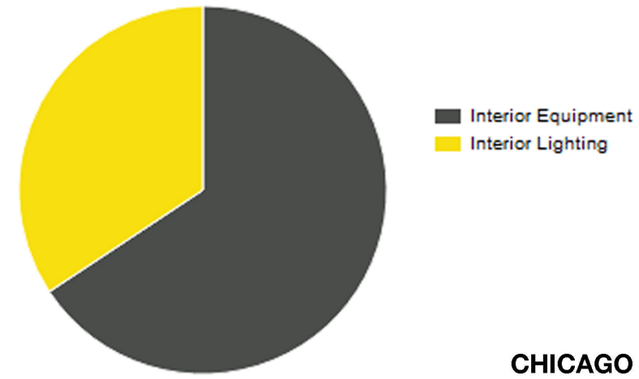
Energy Use - view table



MILANO

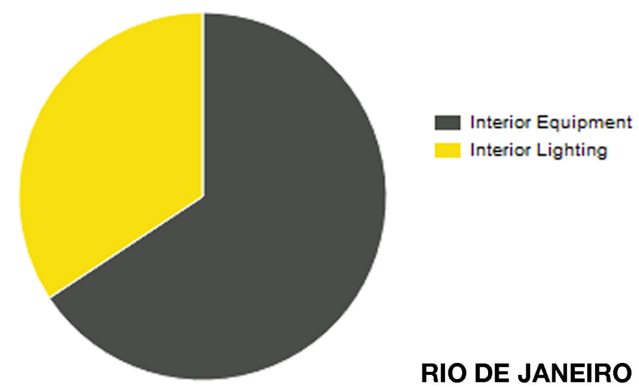
EUI-ELECTRICITY TABLE

EUI - Electricity - view table



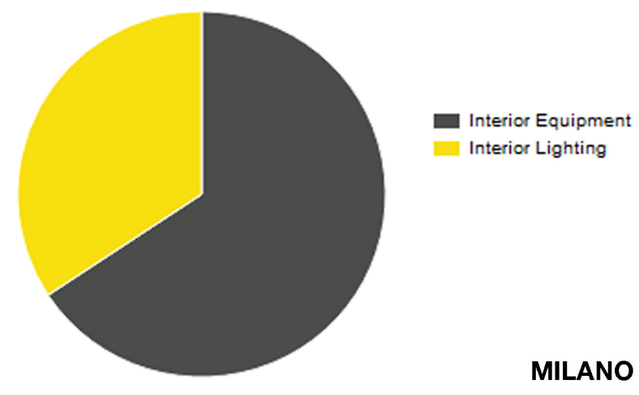
CHICAGO

EUI - Electricity - view table



RIO DE JANEIRO

EUI - Electricity - view table



MILANO

5. CONCLUSION

In this report, the data was obtained from Open Studio software.

Firstly, we created three different types of walls and we used weather conditions of Milan to compare energy performance of the insulations. This exercise shows that when heating and cooling consumptions are similar with or without insulation but cooling load of wall without insulation is lower than wall with insulation. Also "End Use" of energy is higher in wall without insulation as we expected.

Secondly, we choose the wall without insulation and compare it with three different cities which are Milan, Chicago and Rio De Janeiro. This study indicate that the city which has the warmest weather (Rio De Janeiro) has the highest cooling consumption. Thus, Rio has the highest cooling load. If we compare Milan and Chicago, they both have same charts according to district cooling consumptions, district heating consumptions and monthly load profiles datas; In Milan, cooling load is higher than Chicago and in Chicago heating load is higher than Milan slightly.