

ENERGETIC SIMULATION OF A BUILDING IN DIFFERENT LOCATIONS

TECHNICAL ENVIRONMENTAL SYSTEMS

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INTRODUCTION

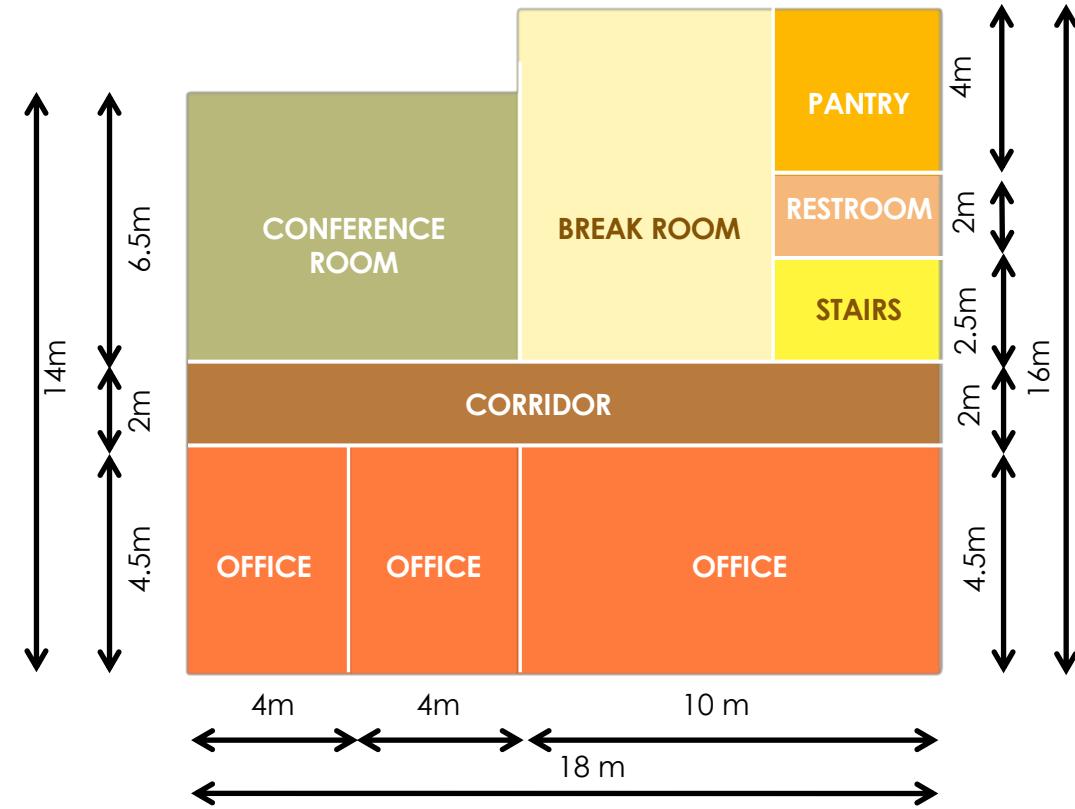
Computer Modelling and Simulation of how a building performs in terms of energy consumption is extremely important for designers, users and especially developers. The key reason is to understand the building condition and run an analysis against utility bills with the aim of reducing the energy consumption of the buildings and achieve a more sustainable and efficient design.

There're many software available, in this case a computer modeled and simulated building was performed in Sketchup, OpenStudio and Energy Plus. Energy Plus provides an integrated simulation for accurate temperature and comfort prediction. The simulation was performed in several locations during the whole year in order to compare the different values between diverse climates. It has a special focus in the city of Oslo, Norway, where bad, normal and good insulation characteristics were included to find the most efficient choice.

The offices modeled building is three stories high and has a standard construction with concrete aggregate exterior walls that vary in insulation properties, drywall interior walls and exterior shading with the exception of the north facade are included in the model. The input data were building constructional records, local climate data, occupancy, internal load, HVAC and lighting component data, equipment data etc. Different thermal zones were taken into consideration in order to achieve a more accurate analysis.



PERSPECTIVE



	Area (sqm)
Total Building Area	1096,42
Net Conditioned Building Area	1096,42
Unconditional Building Area	0,00

NUMBER OF FLOORS: 4

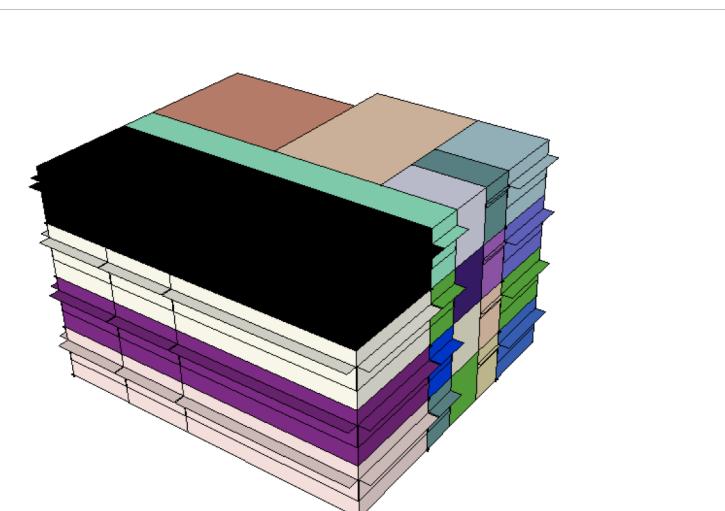
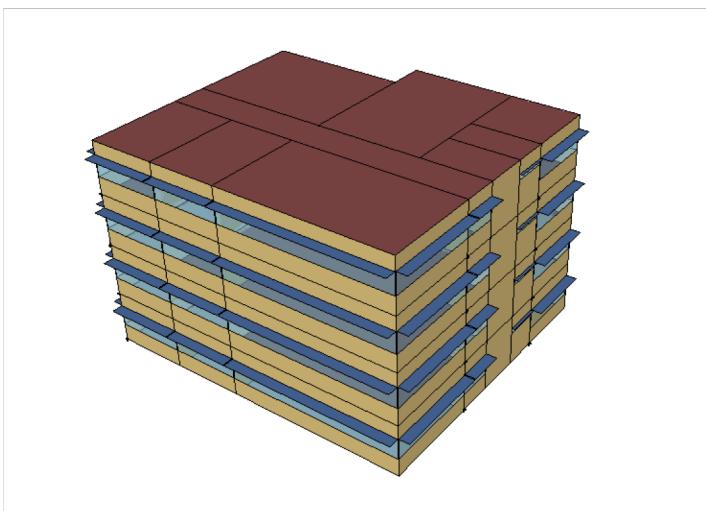
FLOOR HEIGHT: 3 m

WINDOW TO WALL RATIO: 0,5

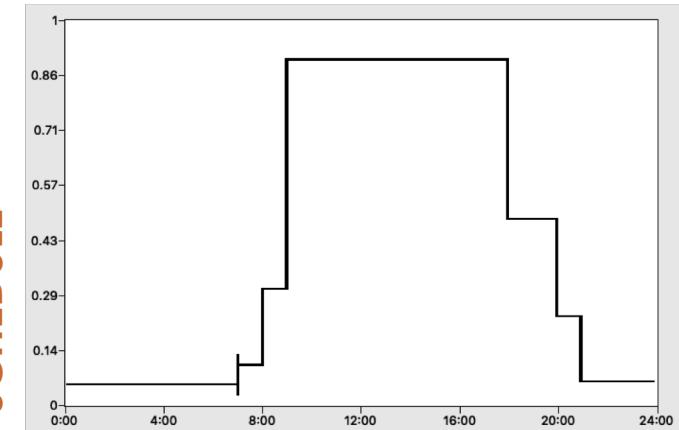
OFFSET ABOVE FLOOR: 1m

OVERHANGS PROJECTION FACTOR: 0,5m

TOTAL THERMAL ZONES : 21



SCHEDULE



CITIES

DESIGN

1st LOCATION

2nd LOCATION

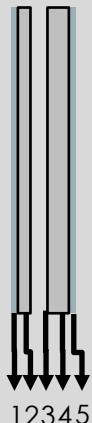
3rd LOCATION

PIACENZA MANILA QUEBEC

DESIGN 1

Double wall without insulation

EXT. WALL

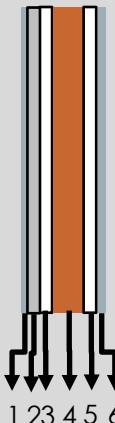


- 1_Stucco: 0.0253m
- 2_Lightweight Concrete: 0.1016m
- 3_Air Gap: 0.02m
- 4_Concrete: 0.2033m
- 5_Stucco: 0.0253m

DESIGN 2

Wall with insulation

EXT. WALL

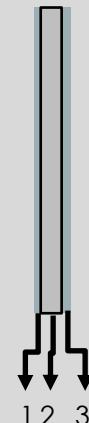


- 1_Stucco: 0.0253m
- 2_Concrete: 0.2033m
- 3_Gypsum: 0.019m
- 4_Insulation: 0.0941m
- 5_Gypsum: 0.0127m
- 6_Stucco: 0.0253m

DESIGN 3

One layer wall

EXT. WALL



- 1_Stucco: 0.0253m
- 2_Lightweight Concrete: 0.1016m
- 3_Stucco: 0.0253m



1st LOCATION : PIACENZA - IT



SITE CHARACTERISTICS

- Summer Design Day: 21 | Aug
- Winter Design Day: 21 | Jan
- Max. Temperature: 33.1° C
- Min. Temperature: -6.1 °C
- Latitude: 44.92°
- Longitude: 9.73°
- Elevation: 134 meters above sea

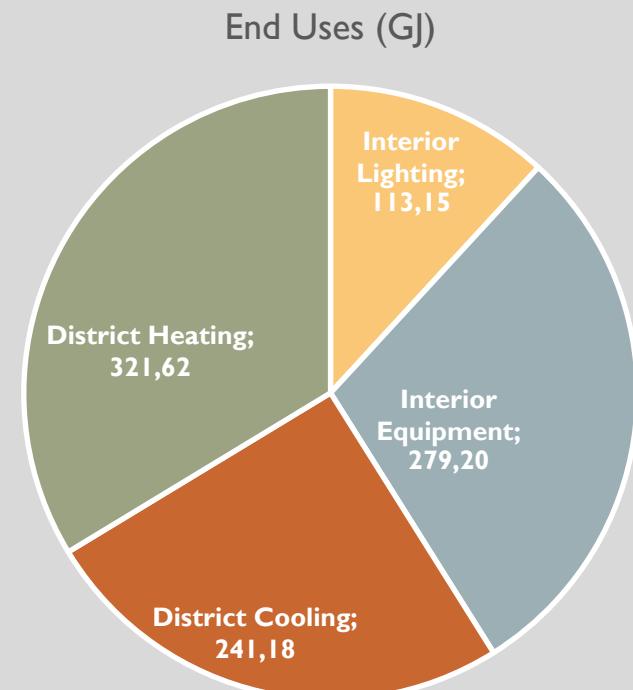
DESIGN 1

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m³]
Heating	0.00	0.00	0.00	0.00	321.62	0.00
Cooling	0.00	0.00	0.00	241.18	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	241.18	321.62	0.00

Note: District heat appears to be the principal heating source based on energy usage.

TOTAL ENERGY
955,14 GJ



DESIGN 2

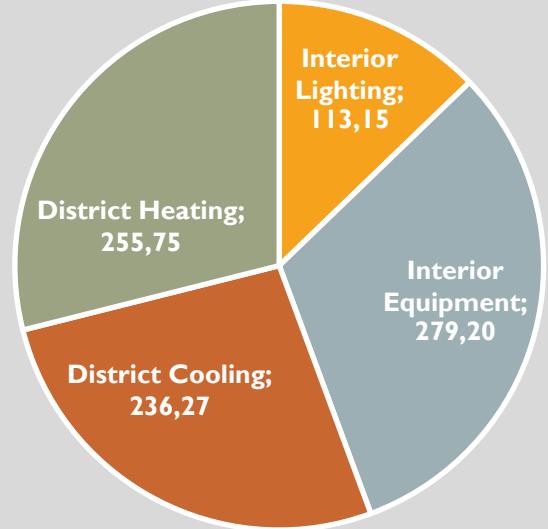
**TOTAL ENERGY
884,37 GJ**

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m³]
Heating	0.00	0.00	0.00	0.00	255.75	0.00
Cooling	0.00	0.00	0.00	236.27	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	236.27	255.75	0.00

Note: District heat appears to be the principal heating source based on energy usage.

End Uses (GJ)



DESIGN 3

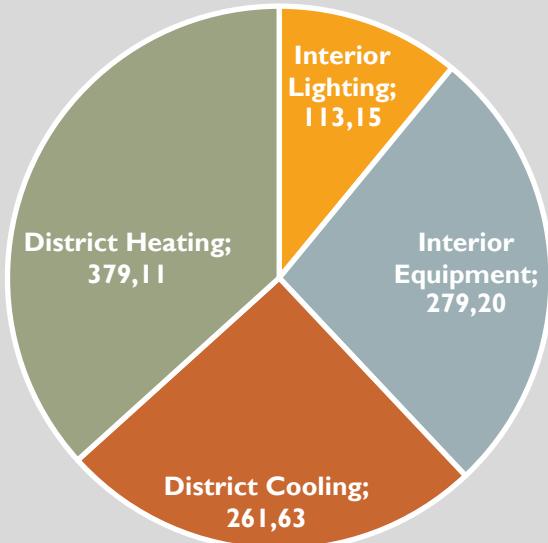
**TOTAL ENERGY
1033,09 GJ**

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m³]
Heating	0.00	0.00	0.00	0.00	379.11	0.00
Cooling	0.00	0.00	0.00	261.63	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	261.63	379.11	0.00

Note: District heat appears to be the principal heating source based on energy usage.

End Uses (GJ)



2nd LOCATION : MANILA - PH



DESIGN 1

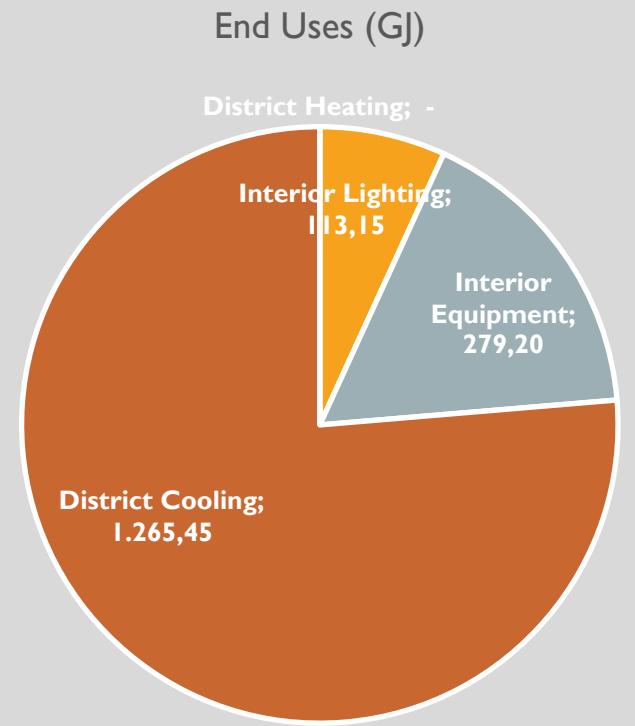
TOTAL ENERGY
1657,80 GJ

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	0.00	0.00	0.00	1265.45	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	1265.45	0.00	0.00

SITE CHARACTERISTICS

- Summer Design Day: 21 | May
- Winter Design Day: 21 | Jan
- Max. Temperature: 34.9° C
- Min. Temperature: 26.1 °C
- Latitude: 14.52°
- Longitude: 121°
- Elevation: 21 meters above sea



DESIGN 2

**TOTAL ENERGY
1581,75 GJ**

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	0.00	0.00	0.00	1189.40	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	1189.40	0.00	0.00

Note: District heat appears to be the principal heating source based on energy usage.

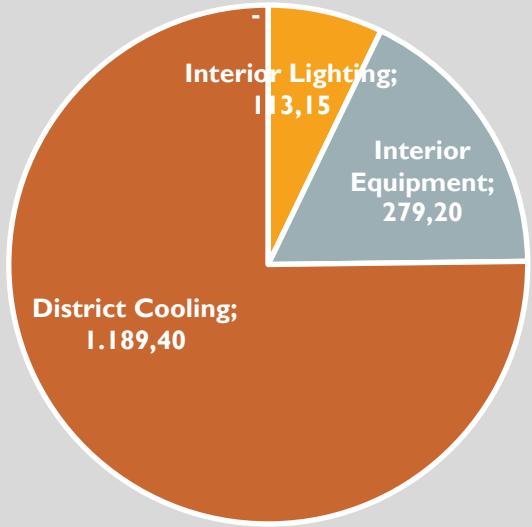
End Uses (GJ)

District Heating; -

Interior Lighting;
113,15

Interior Equipment;
279,20

District Cooling;
1.189,40

**DESIGN 3**

**TOTAL ENERGY
1732,94 GJ**

End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	0.00	0.00	0.00	1340.59	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	1340.59	0.00	0.00

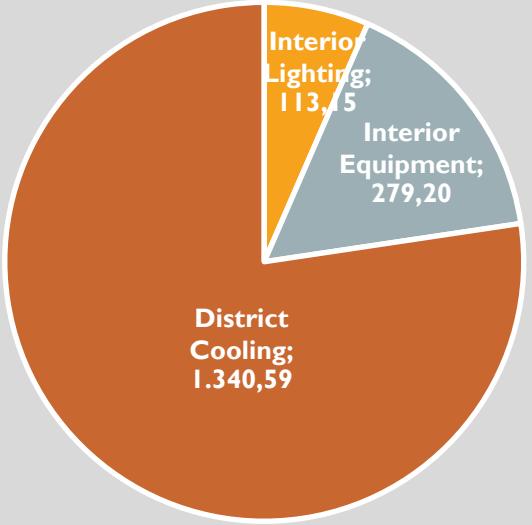
End Uses (GJ)

District Heating; -

Interior Lighting;
113,15

Interior Equipment;
279,20

District Cooling;
1340,59



3rd LOCATION : QUEBEC - CA



DESIGN 1

**TOTAL ENERGY
1321,67 GJ**

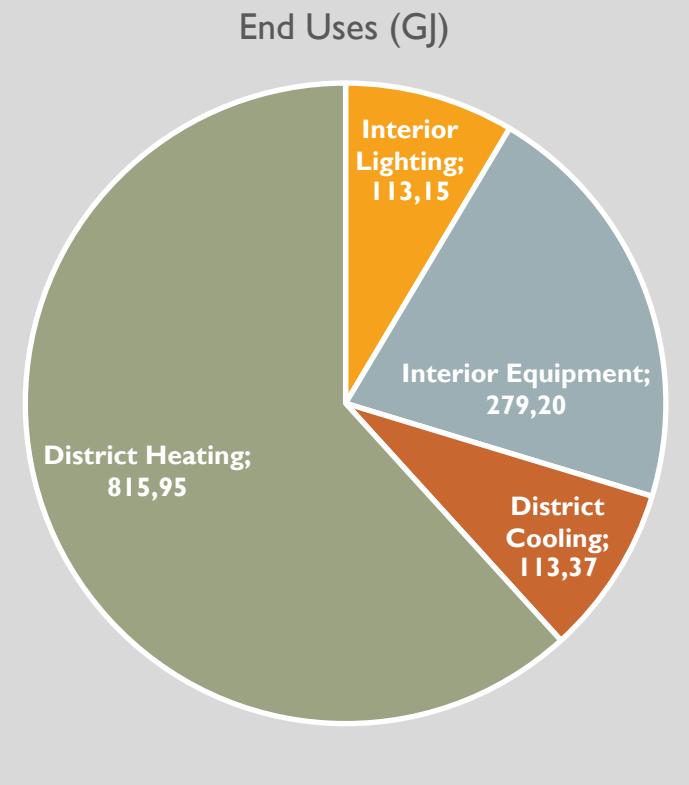
End Uses

	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m³]
Heating	0.00	0.00	0.00	0.00	815.95	0.00
Cooling	0.00	0.00	0.00	113.37	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	113.37	815.95	0.00

Note: District heat appears to be the principal heating source based on energy usage.

SITE CHARACTERISTICS

- Summer Design Day: 21 | July
- Winter Design Day: 21 | Jan
- Max. Temperature: 28.9° C
- Min. Temperature: -25.7 °C
- Latitude: 46.8°
- Longitude: -71.38°
- Elevation: 73 meters above sea level

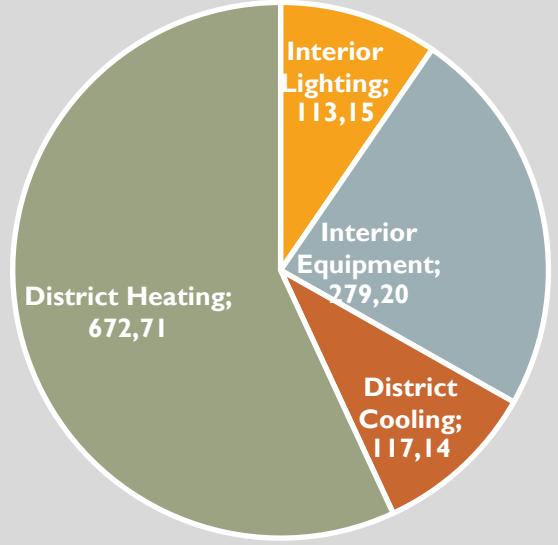


DESIGN 2

**TOTAL ENERGY
1182,20 GJ**

End Uses						
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	672.71	0.00
Cooling	0.00	0.00	0.00	117.14	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	117.14	672.71	0.00

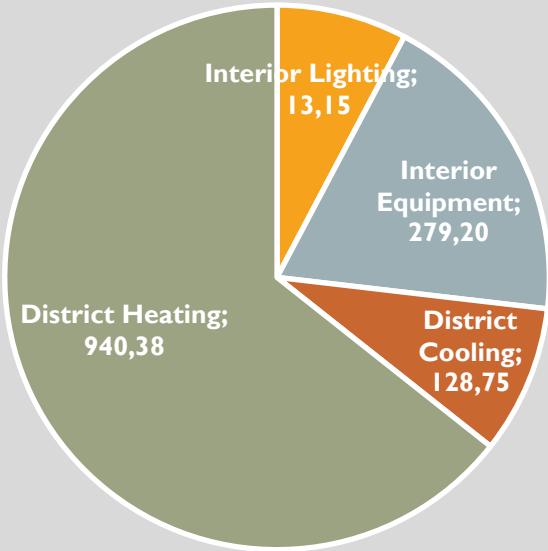
Note: District heat appears to be the principal heating source based on energy usage.

End Uses (GJ)**DESIGN 3**

**TOTAL ENERGY
1461,48 GJ**

End Uses						
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	940.38	0.00
Cooling	0.00	0.00	0.00	128.75	0.00	0.00
Interior Lighting	113.15	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	279.20	0.00	0.00	0.00	0.00	0.00
Exterior Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Fans	0.00	0.00	0.00	0.00	0.00	0.00
Pumps	0.00	0.00	0.00	0.00	0.00	0.00
Heat Rejection	0.00	0.00	0.00	0.00	0.00	0.00
Humidification	0.00	0.00	0.00	0.00	0.00	0.00
Heat Recovery	0.00	0.00	0.00	0.00	0.00	0.00
Water Systems	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration	0.00	0.00	0.00	0.00	0.00	0.00
Generators	0.00	0.00	0.00	0.00	0.00	0.00
Total End Uses	392.35	0.00	0.00	128.75	940.38	0.00

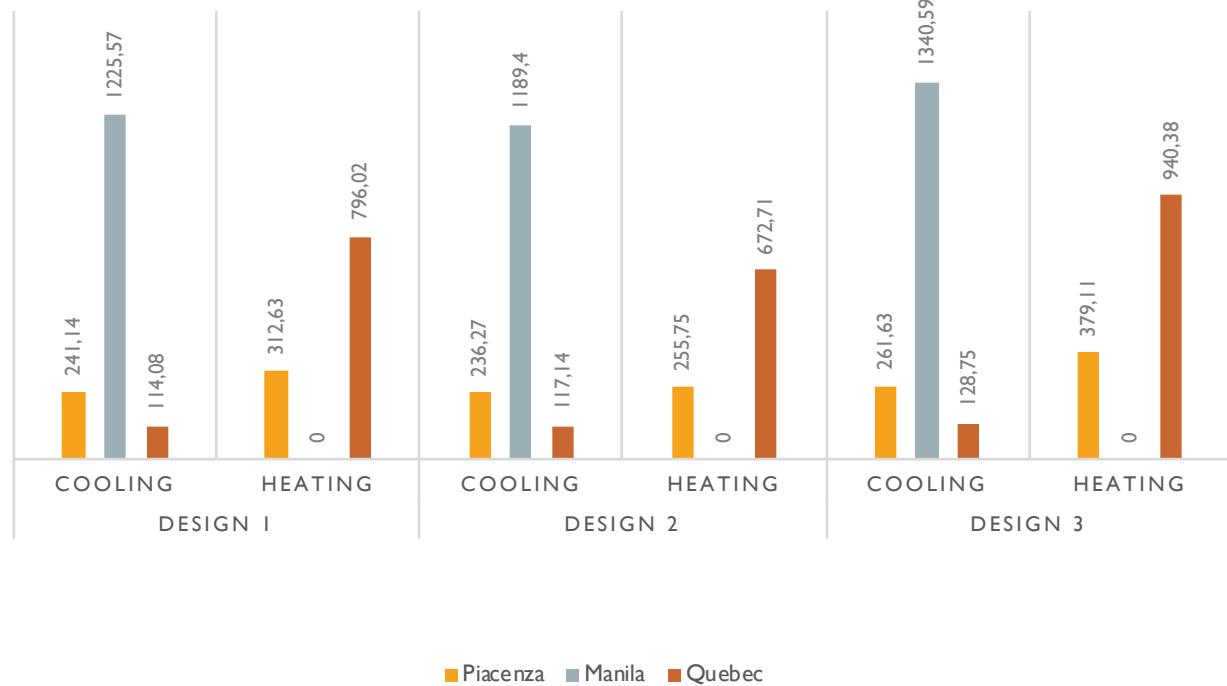
Note: District heat appears to be the principal heating source based on energy usage.

End Uses (GJ)

CONCLUSION

- From the simulation its clear that Design 2 (wall with insulation) shows the lowest energy consumption in the 3 cities, so it is true that using insulation will reduce energy consumption in all climates.
- The city location plays the most important factor in order to determine the energy consumption.
- It is shown that Manila, a tropical city consumes more energy throughout the year due to the cooling, while Quebec shows that most significant energy consumption is for heating.
- It is also shown that Manila consummates big amount of energy even with an insulated wall.

ANNUAL CONSUMPTION BY CATEGORY



	PIACENZA	MANILA	QUEBEC
DESIGN 1	946,12 GJ	1647,92 GJ	1302,45 GJ
DESIGN 2	884,37 GJ	1581,75 GJ	1182,20 GJ
DESIGN 3	1033,09 GJ	1732,94 GJ	1461,48 GJ

