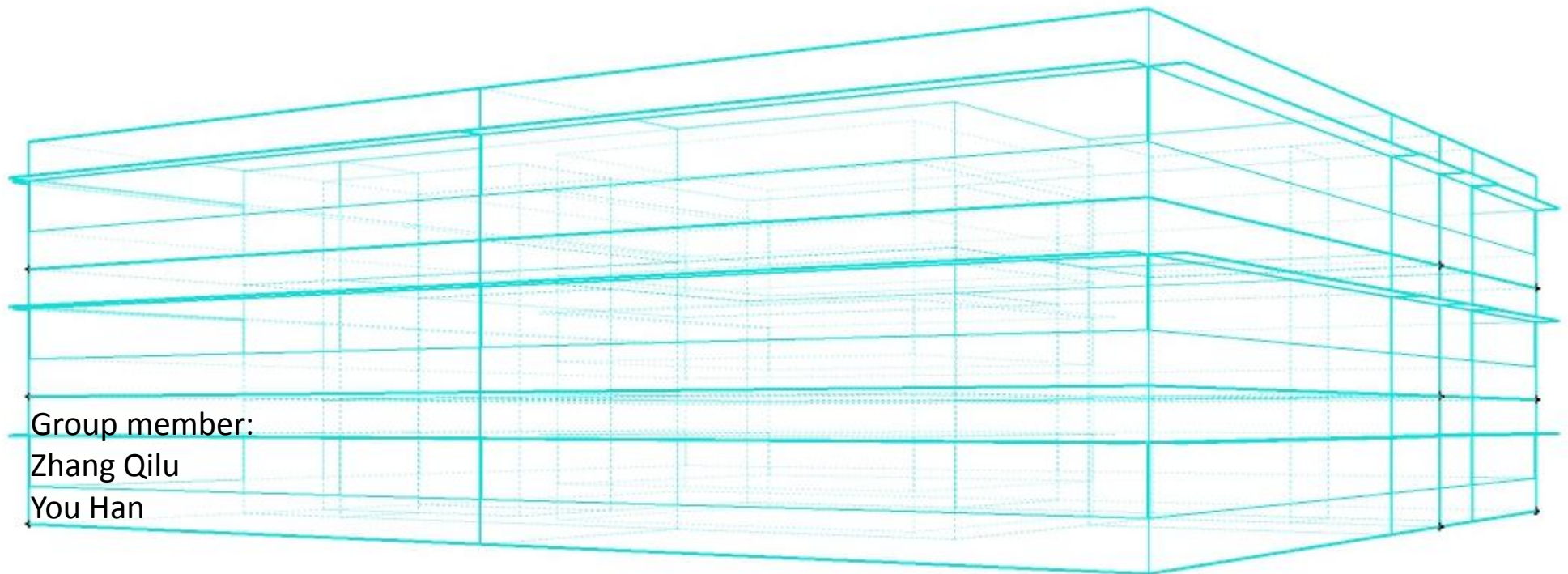


# PROJECT RELATION

TECHNICAL ENVIRONMENTAL SYSTEMS

Prof. Renzo Marchesi



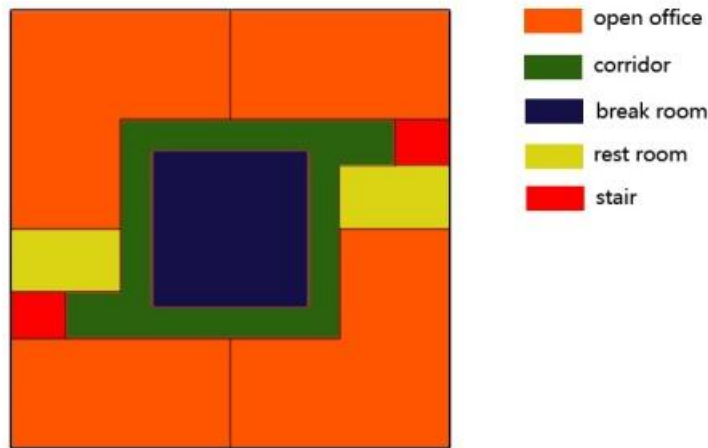
Group member:

Zhang Qilu

You Han

# INTRODUCTION

Our project is a small office building which consists in the analysis of the energetic requirement of a building. The building we took into consideration is located in Piacenza and it has three layers with 28m \* 28m of each. The total building area is 2652 m<sup>2</sup>.

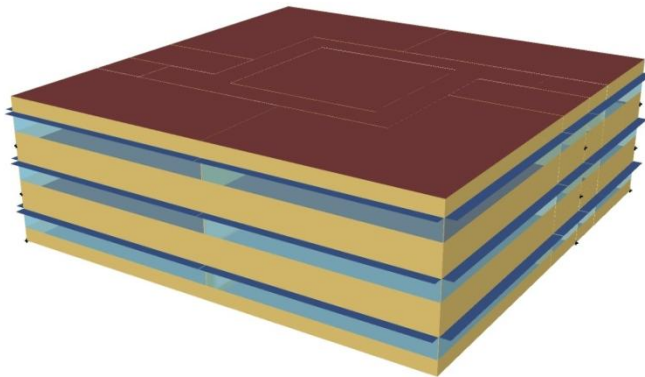
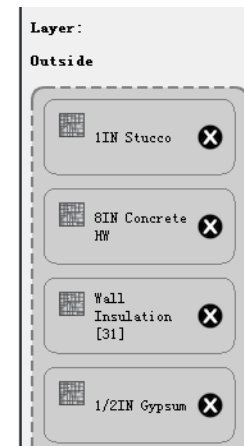


The construction is made of concrete; the exterior wall is composed by:

- 25.3mm Stucco
- 203.3mm Concrete HW
- 33.7mm wall Insulation
- 12.7mm Gypsum

Building Area

	Area [m2]
Total Building Area	2652.00
Net Conditioned Building Area	2652.00
Unconditioned Building Area	0.00



The goal of the exercise is to evaluate the energy performance of the building.

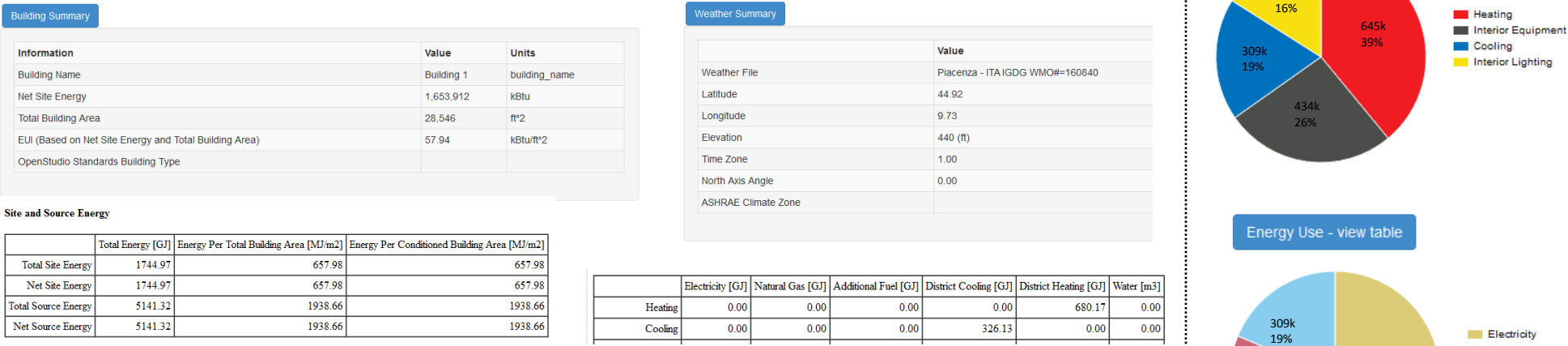
After this the building has been moved in another city with very different thickness of the exterior wall compared to the first one to see how the result would have changed.

# ANALYSIS

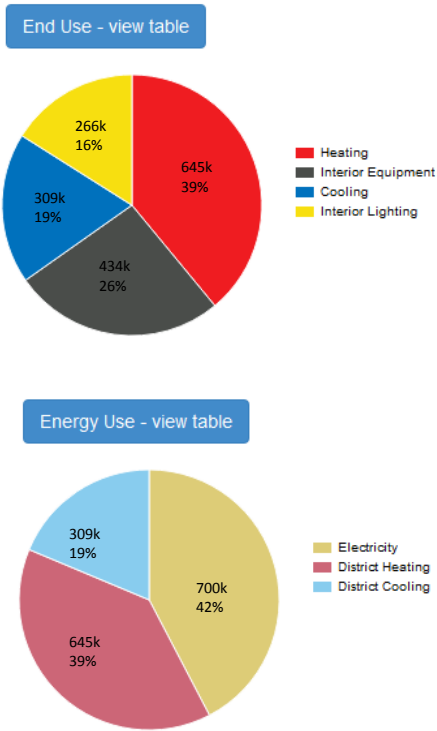
Once inserted the data in the program of calculation “Open Studio”, we went on analyzing.

## Piacenza-Italy

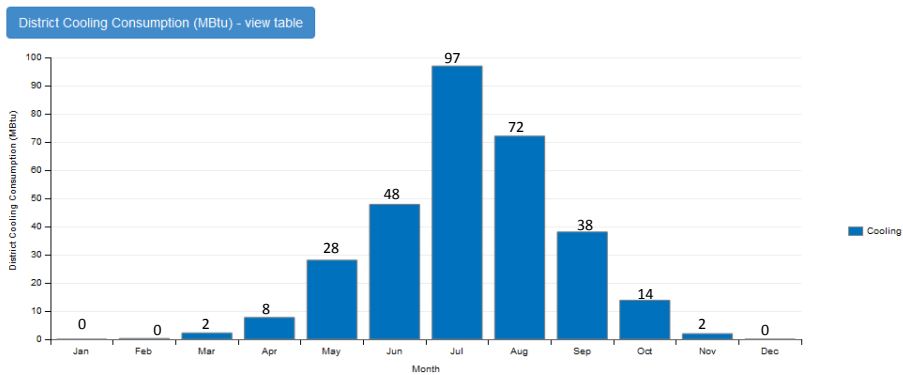
### Model Summary



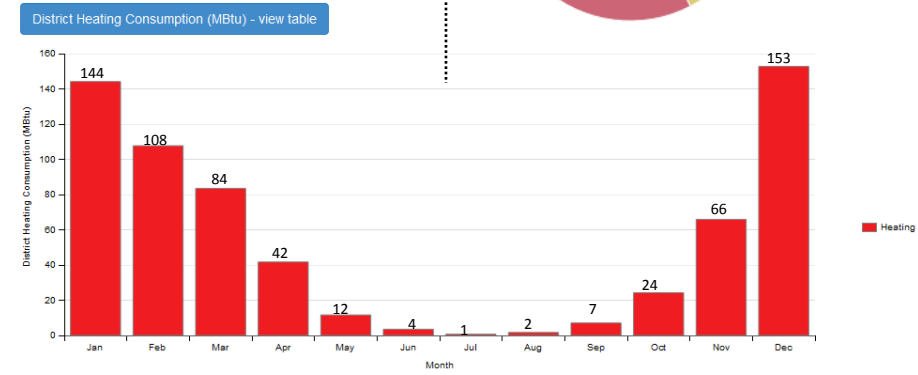
### Annual Overview



The total energy of the building with wall insulation [31] in Piacenza is 1744.97GJ. The energy use for heating is 680.17GJ, which takes the percentage of 39% in total energy, and 19% energy is used for cooling, 42% energy is used for electricity.



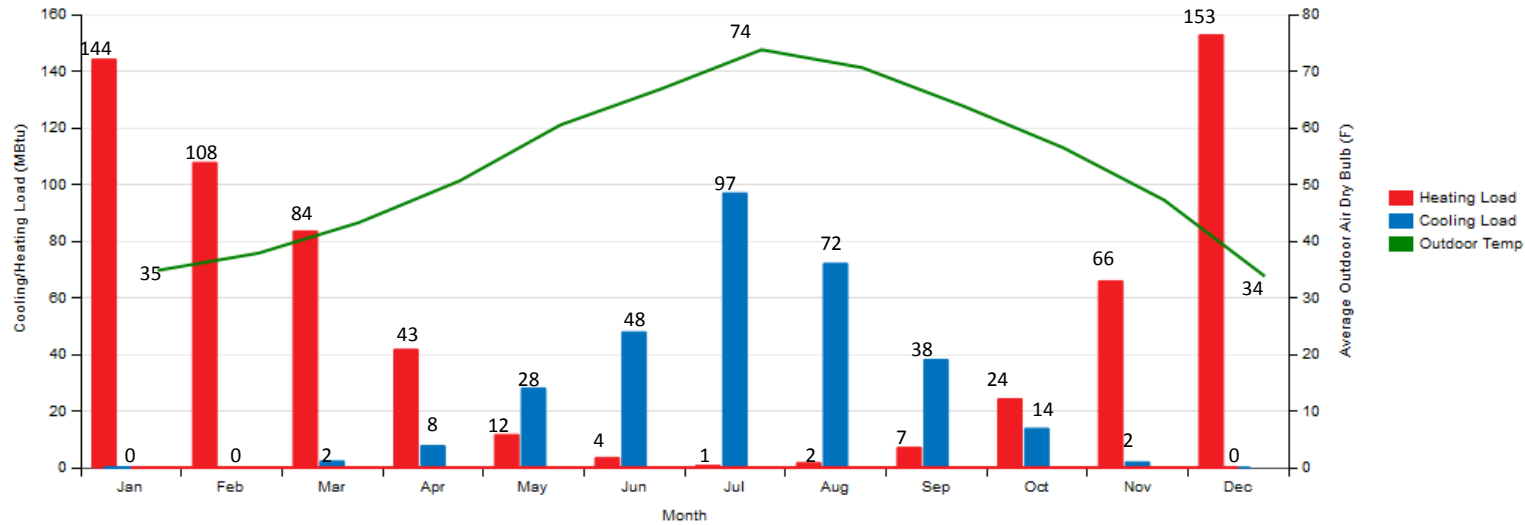
In this bar-table, we can see that the value of the energy use for cooling increases from January to July, then starts to decrease in August, which means there is a peak in July with the value of 97 MBtu.



In this bar-table, we can see that the value of the energy use for heating decreases from January to July, then starts to increase from August, which means the energy which is used for heating has a highest value (153MBtu) in December and lowest in July (1MBtu).

# HVAC Load Profiles

Monthly Load Profiles - view table



## 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	122.98	256.48	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	122.98	256.48	0.00

## Utility Use Per Total 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	122.98	256.48	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	122.98	256.48	0.00

# Reykjavik-Iceland

## Model Summary

### Building Summary

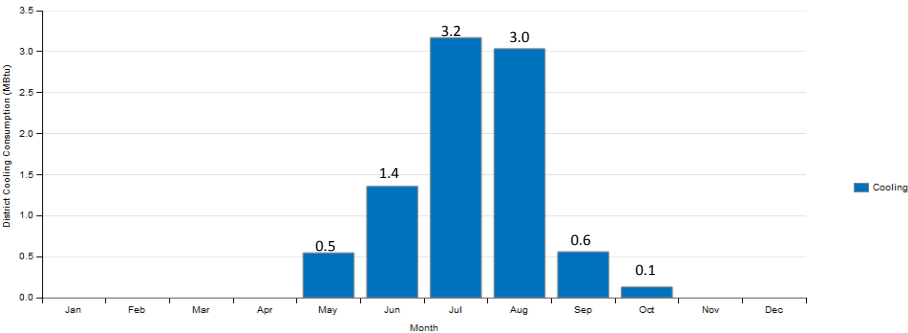
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	2,145,441	kBtu
Total Building Area	28,546	ft²
EUI (Based on Net Site Energy and Total Building Area)	75.16	kBtu/ft²
OpenStudio Standards Building Type		

### Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m²]	Energy Per Conditioned Building Area [MJ/m²]
Total Site Energy	2263.56	853.53	853.53
Net Site Energy	2263.56	853.53	853.53
Total Source Energy	7825.59	2950.83	2950.83
Net Source Energy	7825.59	2950.83	2950.83

	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	1515.62	0.00
Cooling	0.00	0.00	0.00	9.28	0.00	0.00

### District Cooling Consumption (MBtu) - view table



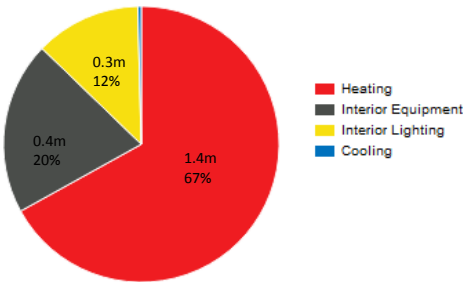
The table shows that the energy is only used from May to October with low value. The peak appears in July with 3.2MBtu value .

### Weather Summary

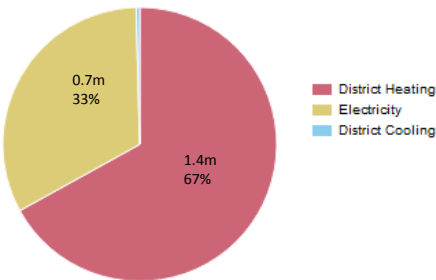
	Value
Weather File	REYKJAVIK - ISL IVEC Data WMO#-040300
Latitude	64.13
Longitude	-21.9
Elevation	200 (ft)
Time Zone	0.00
North Axis Angle	0.00
ASHRAE Climate Zone	

The total energy of the building with wall insulation [31] in Reykjavik, Iceland is 2263.56GJ. The energy use for heating is 1515.62GJ, which takes the percentage of 67% in total energy, and only less than 1% energy is used for cooling(9.28GJ), 33% energy is used for electricity.

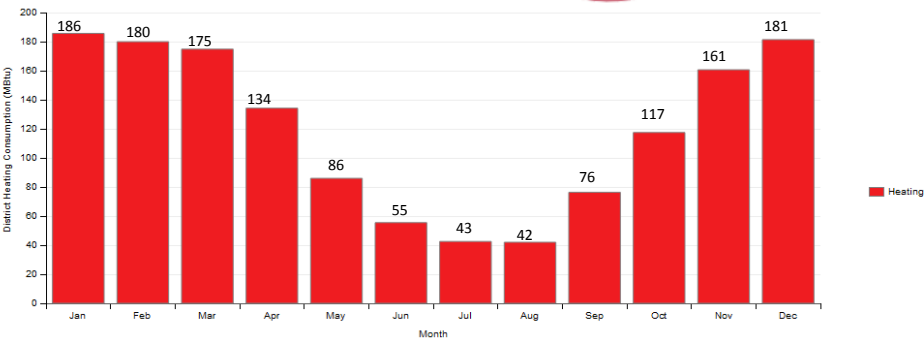
### End Use - view table



### Energy Use - view table



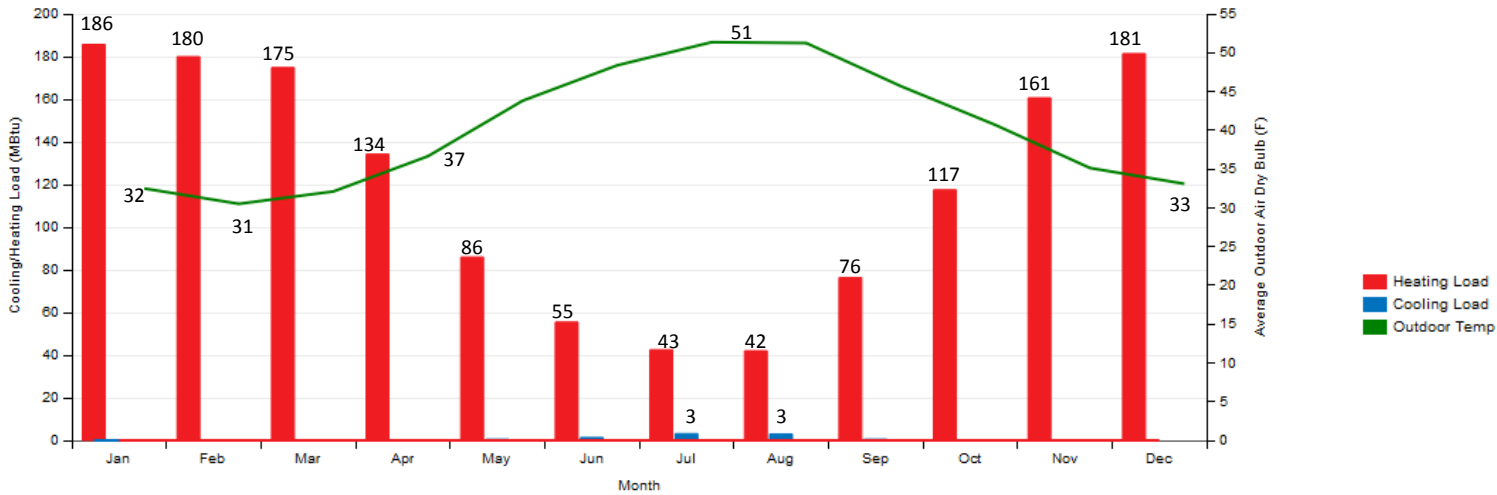
### District Heating Consumption (MBtu) - view table



In this bar-table, we can see that the value of the energy use for heating exists all the year, which decreases from January to July, then starts to increase from August, which means the energy which is used for heating has a highest value(186MBtu) in January and lowest in August(42MBtu).

# HVAC Load Profiles

Monthly Load Profiles - view table



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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	3.50	571.50	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	3.50	571.50	0.00

Utility Use Per Total 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	3.50	571.50	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	3.50	571.50	0.00

# Singapore

## Model Summary

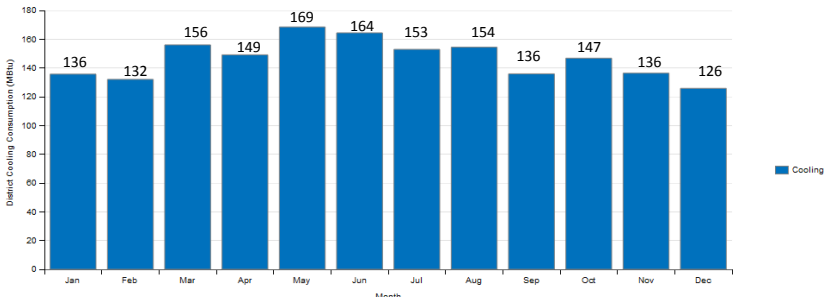
### Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	2,458,287	kBtu
Total Building Area	28,546	ft²
EUI (Based on Net Site Energy and Total Building Area)	86.12	kBtu/ft²
OpenStudio Standards Building Type		

### Site and Source Energy

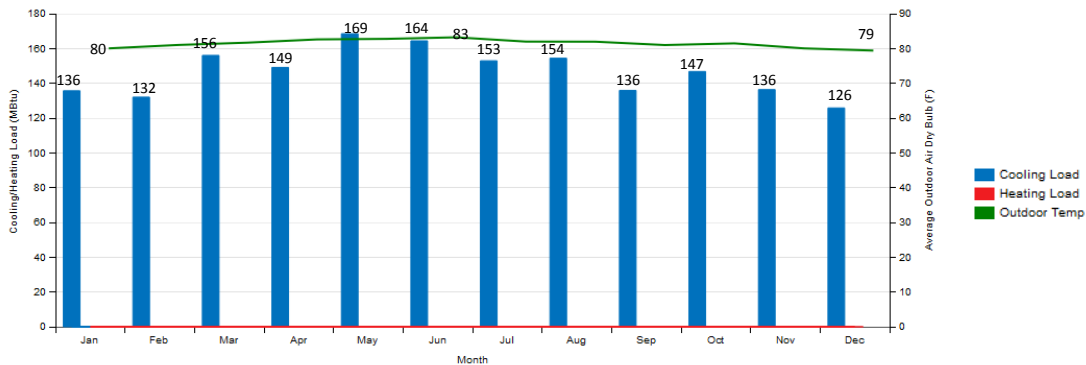
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m²]	Energy Per Conditioned Building Area [MJ/m²]
Total Site Energy	2593.63	977.99	977.99
Net Site Energy	2593.63	977.99	977.99
Total Source Energy	4297.58	1620.51	1620.51
Net Source Energy	4297.58	1620.51	1620.51

### District Cooling Consumption (MBtu) - view table



## HVAC Load Profiles

### Monthly Load Profiles - view table



### Weather Summary

	Value
Weather File	SINGAPORE - SGP IWEBC Data WMO#-486980
Latitude	1.37
Longitude	103.98
Elevation	52 (ft)
Time Zone	8.00
North Axis Angle	0.00
ASHRAE Climate Zone	

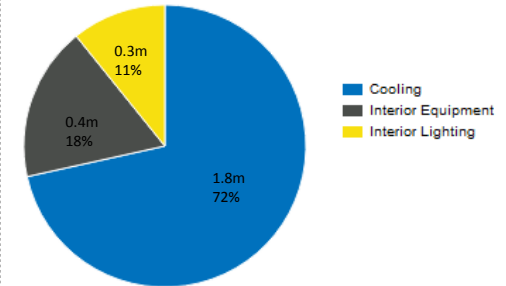
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m³]
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	0.00	0.00	0.00	1854.97	0.00	0.00

The total energy of the building with wall insulation [31] in Singapore is 2593.63GJ. The energy use for heating is 0GJ, and 72% energy is used for cooling(1854.97GJ), 28% energy is used for electricity.

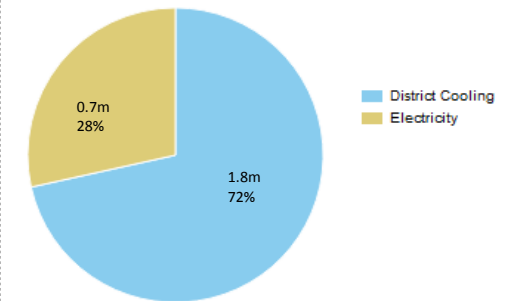
The table shows that a lot of energy is used for cooling through the whole year, with a medial value from 132MBtu to 169MBtu.

## Annual Overview

### End Use - view table



### Energy Use - view table



### 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	699.46	0.00	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	699.46	0.00	0.00

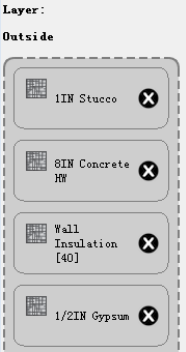
### Utility Use Per Total Floor Area

	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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	699.46	0.00	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	699.46	0.00	0.00

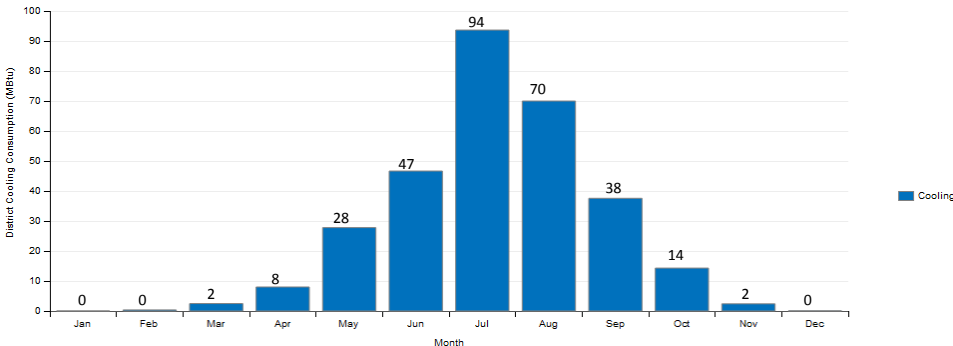
# Piacenza-Italy

We changed the thickness of the wall insulation into 79.4mm. The construction is made of concrete; the exterior wall is composed by:

- 25.3mm Stucco
- 203.3mm Concrete HW
- 79.4mm wall Insulation
- 12.7mm Gypsum



District Cooling Consumption (MBtu) - view table



In this bar-table, we can see that the value of the energy use for cooling increases from January to July, then starts to decrease in August, which means there is a peak in July with the value of 94 MBtu.

## Model Summary

### Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	1,616,493	kBtu
Total Building Area	28,546	ft²
EUI (Based on Net Site Energy and Total Building Area)	56.63	kBtu/ft²
OpenStudio Standards Building Type		

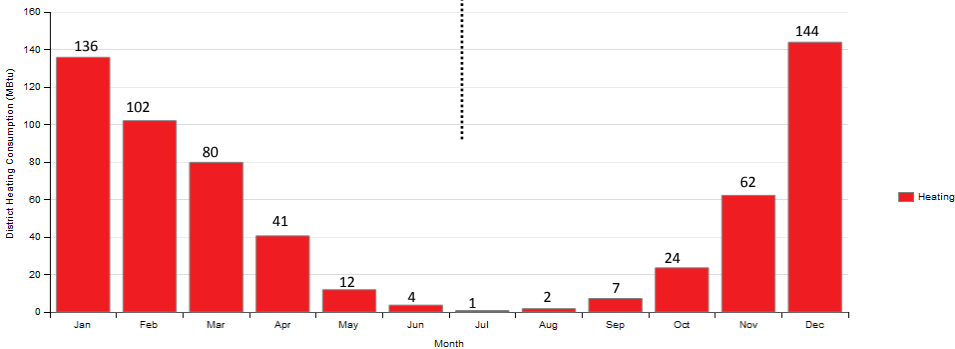
### Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1705.49	643.09	643.09
Net Site Energy	1705.49	643.09	643.09
Total Source Energy	5014.55	1890.85	1890.85
Net Source Energy	5014.55	1890.85	1890.85

	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	646.90	0.00
Cooling	0.00	0.00	0.00	319.92	0.00	0.00

The total energy of the building with wall insulation [40] in Piacenza is 1705.49GJ. The energy use for heating is 646.90GJ, which takes the percentage of 38% in total energy, and 19% energy is used for cooling (319.92GJ), 43% energy is used for electricity.

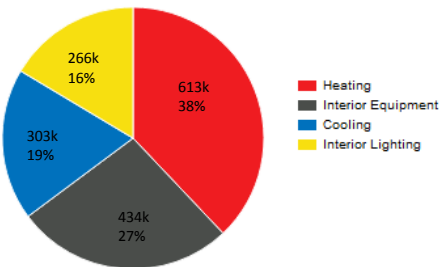
District Heating Consumption (MBtu) - view table



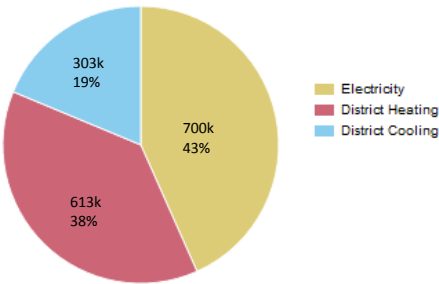
In this bar-table, we can see that the value of the energy use for heating decreases from January to July, then starts to increase from August, which means the energy which is used for heating has a highest value (144MBtu) in December and lowest in July (1MBtu).

## Annual Overview

End Use - view table



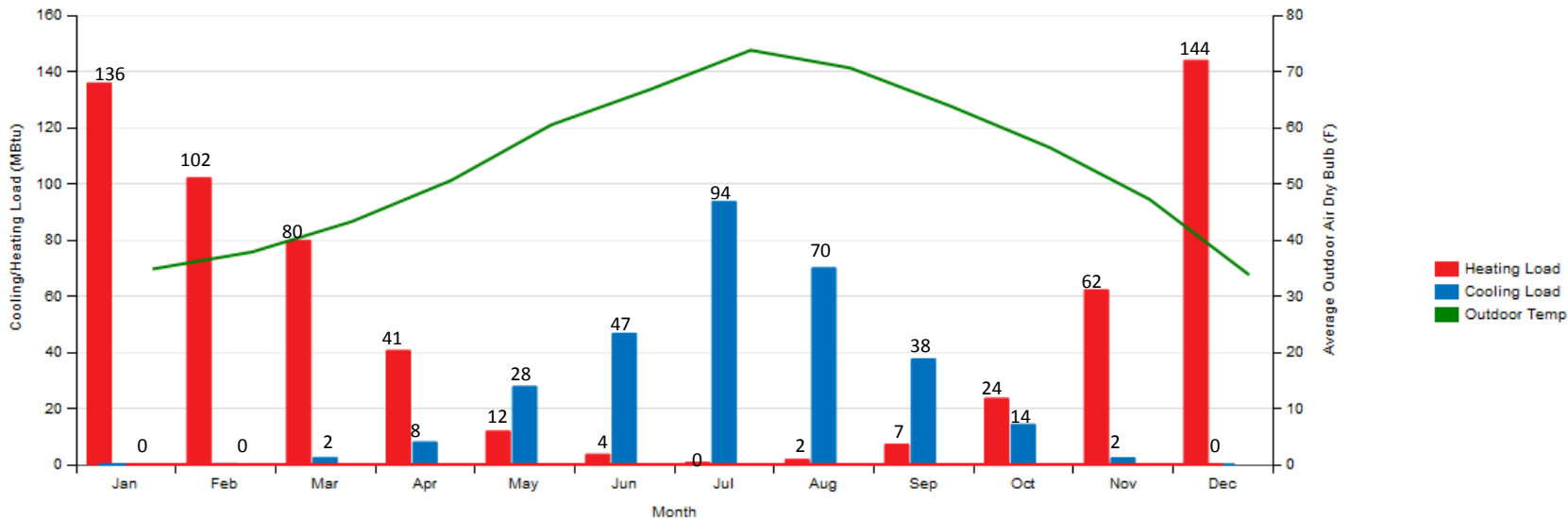
Energy Use - view table





# HVAC Load Profiles

Monthly Load Profiles - view table



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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	120.63	243.93	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	120.63	243.93	0.00

Utility Use Per Total 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	120.63	243.93	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	120.63	243.93	0.00

# Reykjavik-Iceland

## Model Summary

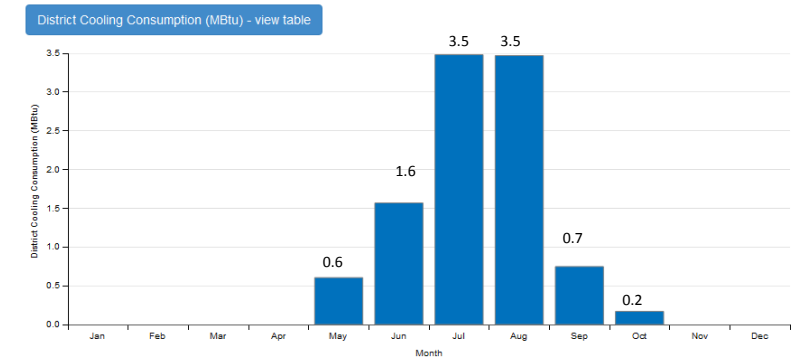
Building Summary		
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	2,072,762	kBtu
Total Building Area	28,546	ft²
EUI (Based on Net Site Energy and Total Building Area)	72.61	kBtu/ft²
OpenStudio Standards Building Type		

Weather Summary	
	Value
Weather File	REYKJAVIK - ISL IWECDATA WMO#040300
Latitude	64.13
Longitude	-21.9
Elevation	200 (ft)
Time Zone	0.00
North Axis Angle	0.00
ASHRAE Climate Zone	

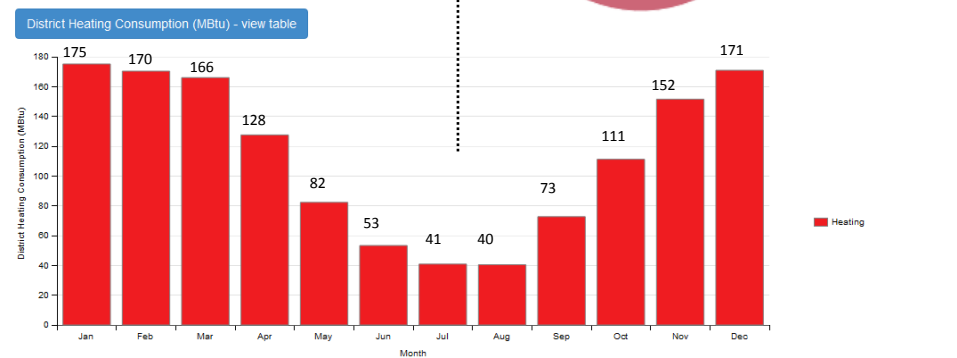
	Total Energy [GJ]	Energy Per Total Building Area [MJ/m²]	Energy Per Conditioned Building Area [MJ/m²]
Total Site Energy	2186.88	824.61	824.61
Net Site Energy	2186.88	824.61	824.61
Total Source Energy	7545.13	2845.07	2845.07
Net Source Energy	7545.13	2845.07	2845.07

	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	1437.62	0.00
Cooling	0.00	0.00	0.00	10.60	0.00	0.00

The total energy of the building with wall insulation [40] in Reykjavik, Iceland is 2186.88GJ. The energy use for heating is 1437.62GJ, which takes the percentage of 66% in total energy, and only less than 1% energy is used for cooling (10.60GJ), 34% energy is used for electricity.



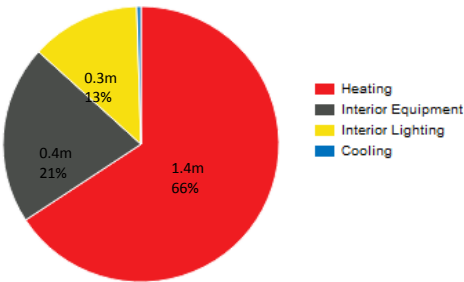
The table shows that the energy is only used from May to October with low value. The peak appears in July and August with 3.5MBtu value.



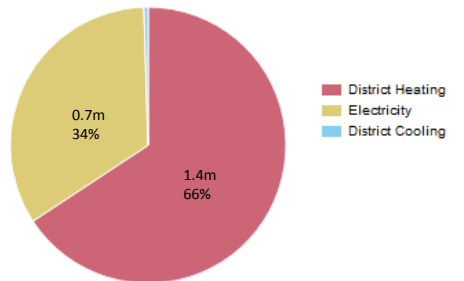
In this bar-table, we can see that the value of the energy use for heating exists all the year, which decreases from January to July, then starts to increase from August, which means the energy which is used for heating has a highest value (175MBtu) in January and lowest in August (40MBtu).

## Annual Overview

End Use - view table

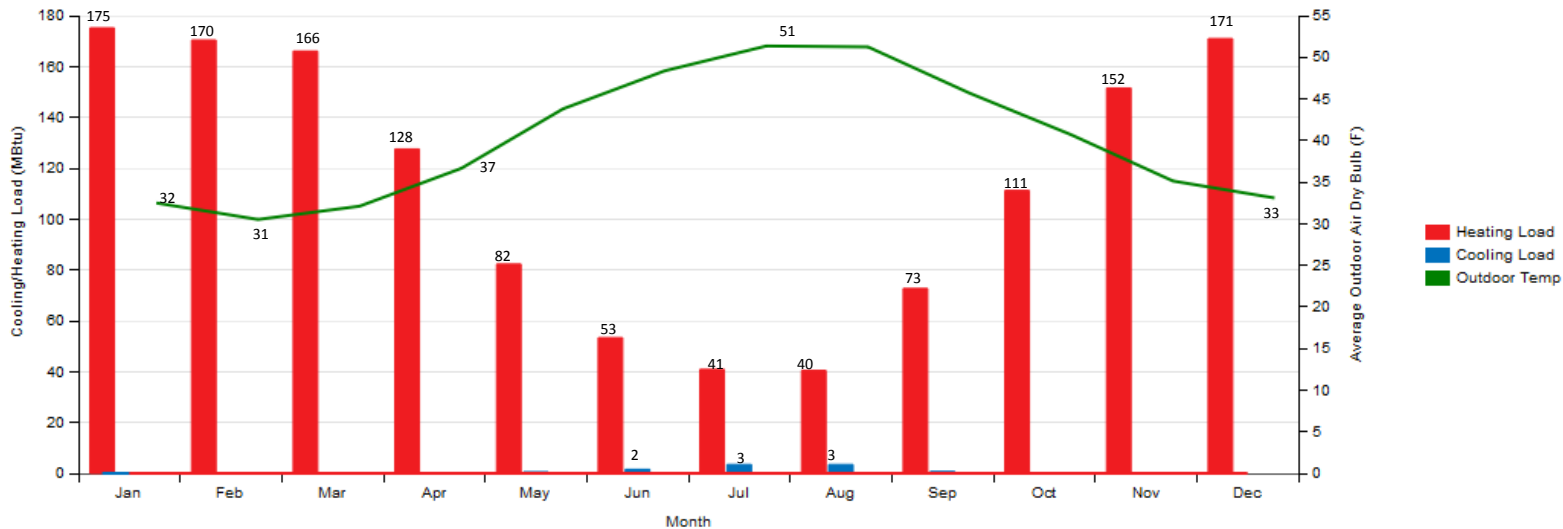


Energy Use - view table



# HVAC Load Profiles

Monthly Load Profiles - view table



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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	4.00	542.09	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	4.00	542.09	0.00

Utility Use Per Total 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	4.00	542.09	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	4.00	542.09	0.00

# Singapore

## Model Summary

Building Summary		
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	2,414,412	kBtu
Total Building Area	28,546	ft²
EUI (Based on Net Site Energy and Total Building Area)	84.58	kBtu/ft²
OpenStudio Standards Building Type		

Weather Summary	
	Value
Weather File	SINGAPORE - SGP IWEC Data WMO#-486980
Latitude	1.37
Longitude	103.98
Elevation	52 (ft)
Time Zone	8.00
North Axis Angle	0.00
ASHRAE Climate Zone	

### Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m²]	Energy Per Conditioned Building Area [MJ/m²]
Total Site Energy	2547.34	960.54	960.54
Net Site Energy	2547.34	960.54	960.54
Total Source Energy	4248.72	1602.08	1602.08
Net Source Energy	4248.72	1602.08	1602.08

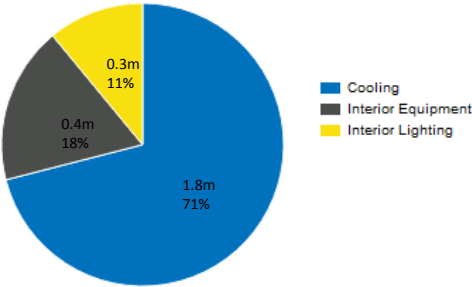
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m³]
Heating	0.00	0.00	0.00	0.00	0.00	0.00
Cooling	0.00	0.00	0.00	1808.67	0.00	0.00

The total energy of the building with wall insulation [40] in Singapore is 2547.34GJ. The energy use for heating is 0GJ, and 71% energy is used for cooling(1808.67GJ), 29% energy is used for electricity.

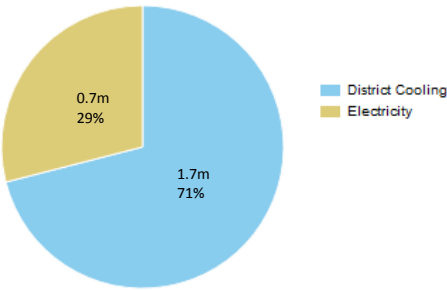
The table shows that a lot of energy is used for cooling through the whole year, with a medial value from 123MBtu to 160MBtu.

## Annual Overview

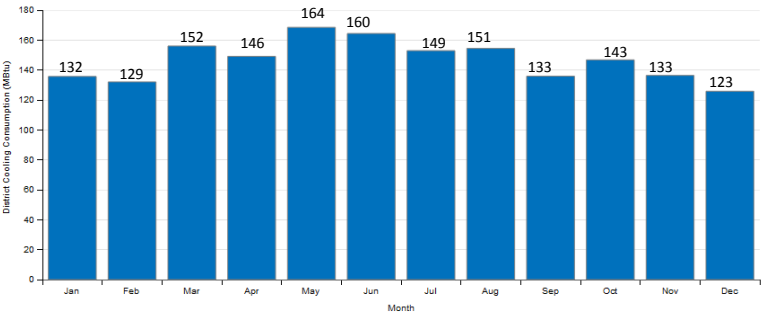
### End Use - view table



### Energy Use - view table

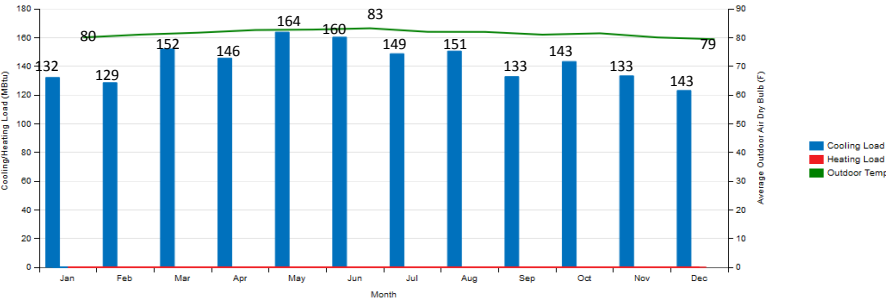


### District Cooling Consumption (MBtu) - view table



## HVAC Load Profiles

### Monthly Load Profiles - view table



### 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	682.00	0.00	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	682.00	0.00	0.00

### Utility Use Per Total 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	105.67	0.00	0.00	0.00	0.00	0.00
HVAC	0.00	0.00	0.00	682.00	0.00	0.00
Other	172.86	0.00	0.00	0.00	0.00	0.00
Total	278.53	0.00	0.00	682.00	0.00	0.00

# COMPARISON-Different City

## VALUE OF DISTRICT COOLING(GJ)

Thickness of the wall insulation (mm)	CITY			off%	
	Piacenza (C <sub>1</sub> )	Iceland (C <sub>2</sub> )	Singapore (C <sub>3</sub> )	$\frac{C_2-C_1}{C_1}$	$\frac{C_3-C_1}{C_1}$
33.7	326.13	9.28	1854.97	-97.0	468.8
79.4	319.92	10.60	1808.67	-96.7	465.4

## VALUE OF DISTRICT HEATING(GJ)

Thickness of the wall insulation (mm)	CITY			off%	
	Piacenza (C <sub>1</sub> )	Iceland (C <sub>2</sub> )	Singapore (C <sub>3</sub> )	$\frac{C_2-C_1}{C_1}$	$\frac{C_3-C_1}{C_1}$
33.7	680.17	1515.62	0.00	122.8	-100.0
79.4	646.90	1437.62	0..00	122.2	-100.0

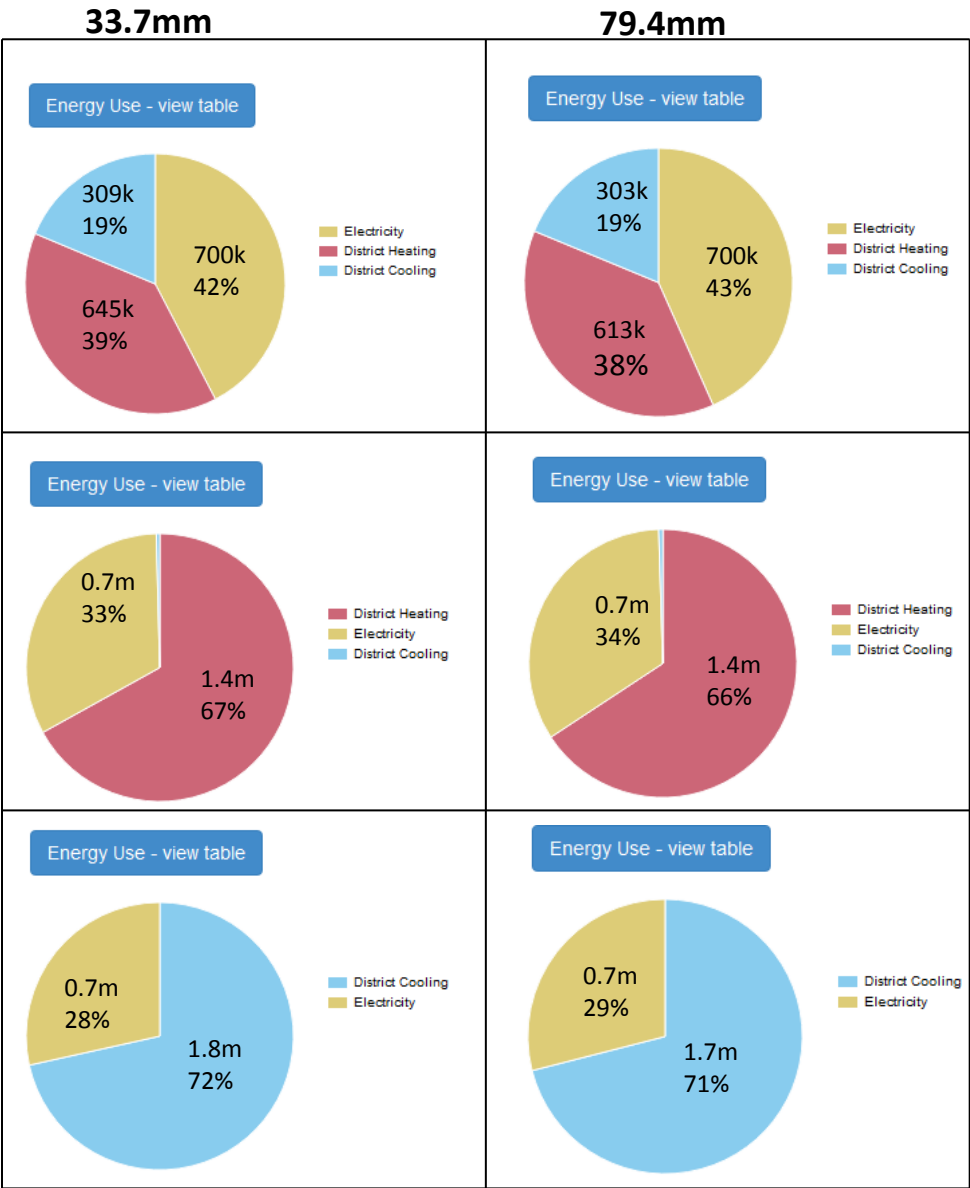
In the case of 33.7mm wall insulation:

Comparing other two cities, the value of energy for cooling in Piacenza (326.13GJ) is higher than that in Reykjavik-Iceland(9.28GJ), but much lower than that in Singapore(1854.97GJ). And for heating, the value in Piacenza is double lower than that in Iceland, but much higher than that in Singapore, since the value in Singapore for heating is 0.

The case of 79.4mm wall insulation is the same situation as the one above.

# COMPARISON-Different Thickness

Piacenza-Italy



When the thickness of wall insulation is double higher than before, the value of energy for cooling and heating decreases a little, only 1%. The energy for electricity nearly dose not change.

All three cities has the same situation.

# CONCLUSION

Climate has an important influence on the use of energy a lot. The energy for heating is used much more than that for cooling in low-temperature area, on the contrary, people in high-temperature area use more energy for cooling than that for heating. What's more, the energy for electricity is not affected by weather.

The thickness of wall insulation affects the use of energy a little. When the wall insulation turns to be thicker, the use of energy decreases a little both for heating and cooling and dose not change for electricity.

In conclusion, when we design a building, we should consider that different climate has a different influence on the energy use. Also the construction of the wall should be taken into consideration, such as the thickness of wall insulation.

This project study help us to think more about the energetic requirement of architecture and create a more sustainable environment when we are working on building-design in the future.

