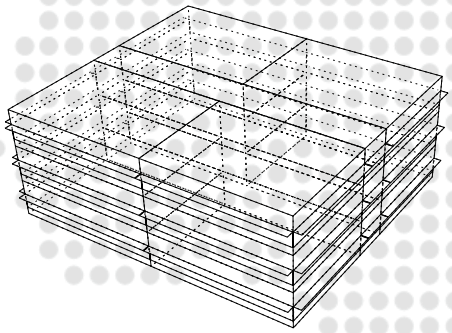
Reykjavik

Piacenza

Athens



Assignment Report

[TECHNICAL ENVIRONMENTAL SYSTEM]

2017-2018

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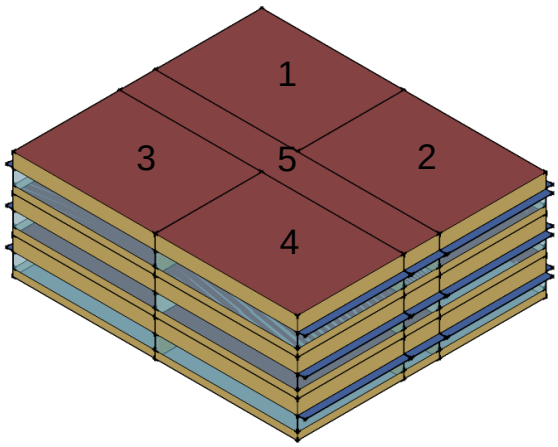
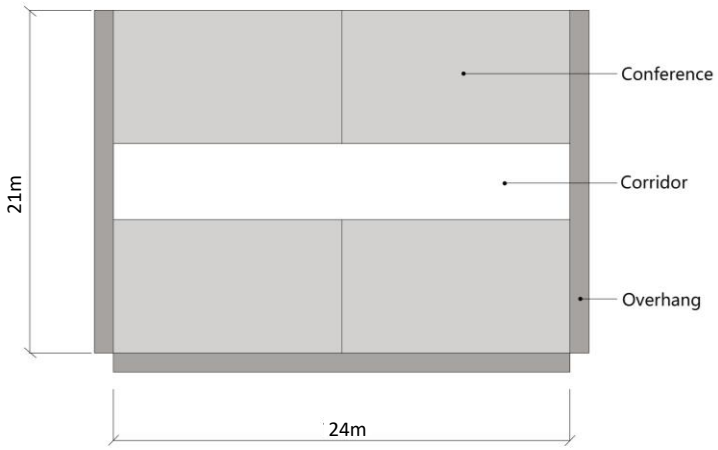
Wu Xiaoyuan

Zhang Guoyi

1. OVERALL BUILDING INTRODUCTION

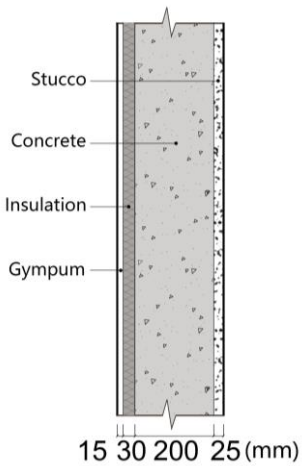
- In this project, based on the usage of 2 software tools(OpenStudio, EnergyPlus) to build modeling and simulate real energy consumption, we chose the layout of a conference building, whose total building area is 1512m^2. There are 3 floors inside and each floor has 4 conference rooms and 1 corridor.



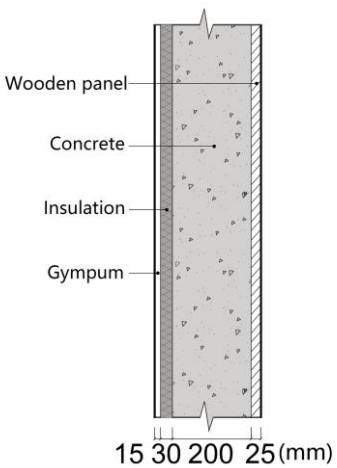


- 1.2.3.4. Conferences 5. Corridor

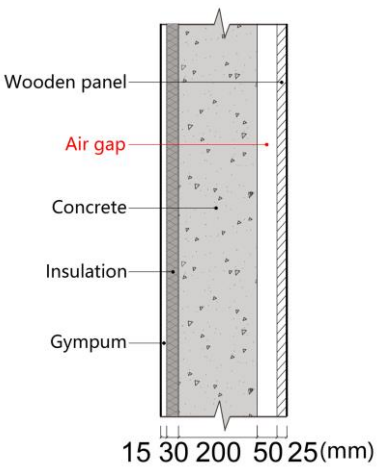
- To test the impact of different factors on the energy consumption of the building, we changed two groups of input which are the material of the external wall and the site. We chose Athens, Piacenza, Reykjavik 3 cities from average temperature high to low, which are located on extreme south of Europe, on the southern Europe, and on the Northern Europe respectively.
- We chose 3 external walls made up of different materials to observe the differences of energy consumption and sustainability: one is the ordinary wall, and one is the wall which surface's material is replaced from stucco to wooden panel. And one is the wall including the air gap.



WALL 1



WALL 2



WALL 3

- So in the following report, we will analysis 9 situations that 3 different walls built in 3 different sites.

2. UNIT MEASUREMENT CONVERSION

2.1 British units convert to International units

1. Fahrenheit (°F) to Celsius (°C)

   T(°C) = (T(°F) - 32) × 5/9

2. British Thermal Unit (Btu) to kilowatt-hour (kWh)

   1 MBtu = 1,000,000 Btu

   1 Btu = 0.00029307107017 kWh

   1 MBtu = 293.07107017 kWh

   1 kBtu = 0.293071039 kWh

BTU/hr to kilowatts conversion table

Power (BTU/hr)	Power (kW)
1 BTU/hr	0.000293071 kW
10 BTU/hr	0.002930710 kW
100 BTU/hr	0.029307104 kW
1000 BTU/hr	0.293071039 kW
10000 BTU/hr	2.930710387 kW

3. Power Conversion of kW to BTU/hr

   P(kW) = P(Btu/hr) / 3412.142

   1 BTU/hr = 0.000293071 kW

   1 kBTU/hr = 0.293071039 kW

4. Feet to Meters Conversion

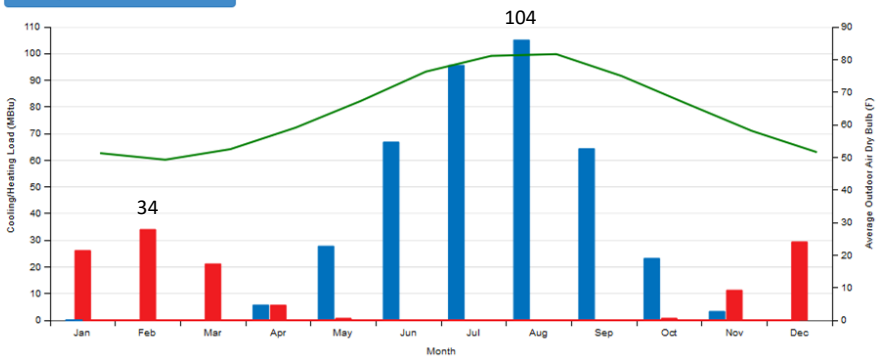
   1 Ft = 0.3048 m

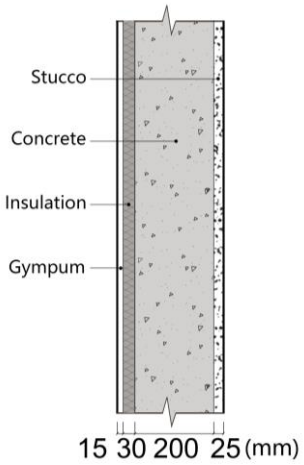
   1 Ft^2 = 0.092903 m^2

3. ATHENS

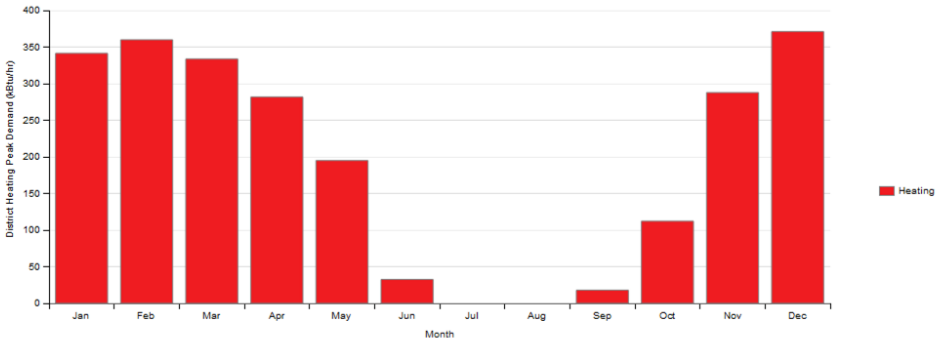
3.1 WALL 1

Monthly Load Profiles - view table

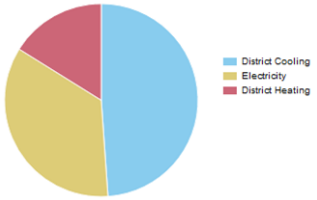




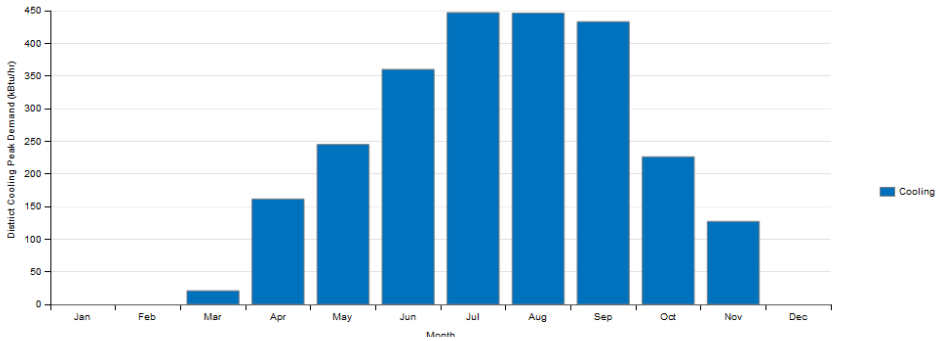
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that about half energy is used in the district cooling. And at the same time, the energy used in electricity is about twice as used in district heating

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	801,787	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	49.26	kBtu/ft^2
OpenStudio Standards Building Type		

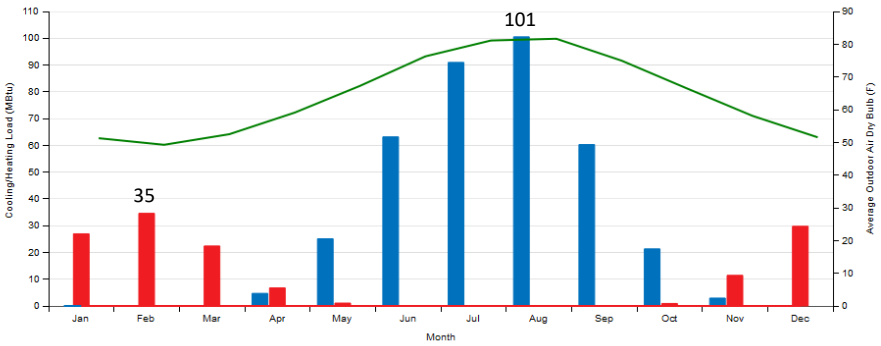
- In this condition, the annual energy consumption is about 801787 kBtu, which equals to 234980.6 kWh.

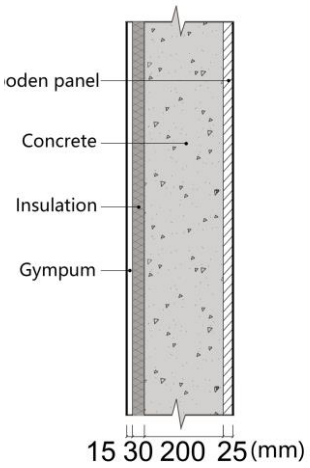
- From the first bar chart we can find that at Aug the cooling load is the highest and at Feb the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Dec the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

3. ATHENS

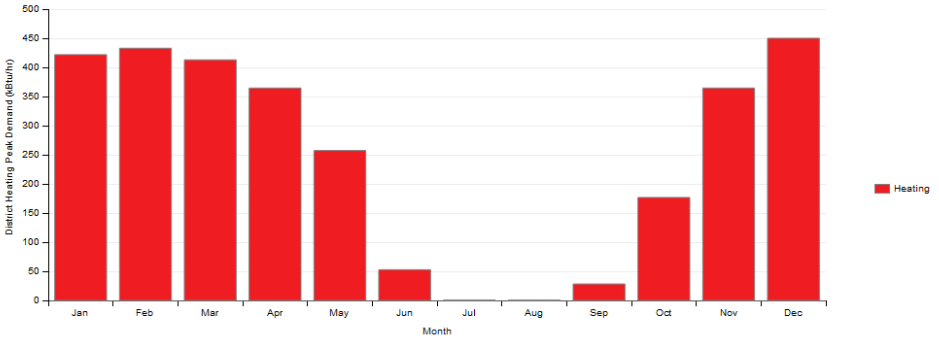
3.2 WALL 2

Monthly Load Profiles - view table

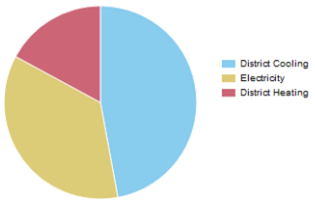




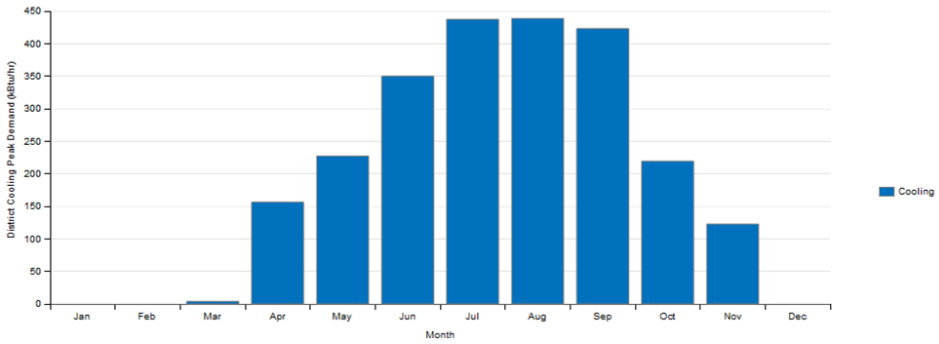
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that about half energy is used in the district cooling. And at the same time, the energy used in electricity is about twice as used in district heating.

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	783,722	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	48.15	kBtu/ft^2
OpenStudio Standards Building Type		

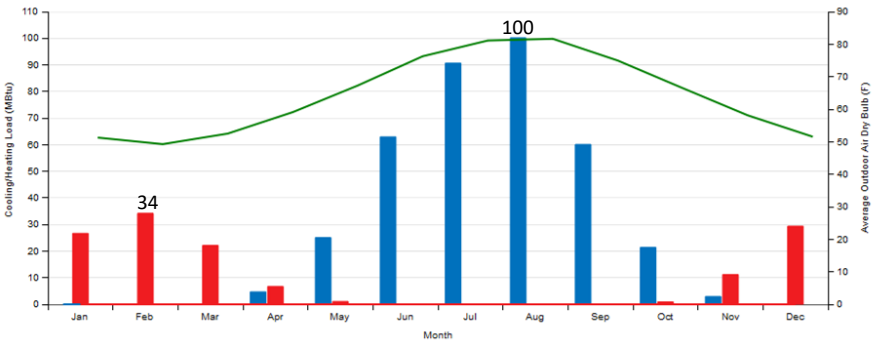
- In this condition, the annual energy consumption is about 783722 kBtu, which equals to 229686.2 kWh.

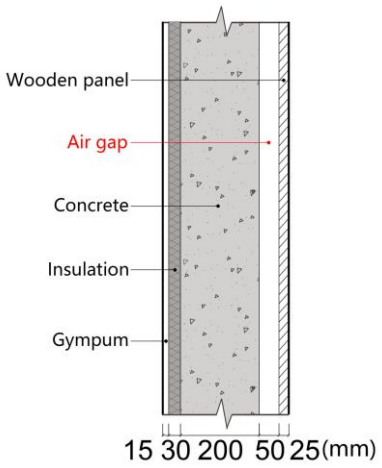
- From the first bar chart we can find that at Aug the cooling load is the highest and at Feb the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Dec the heating peak demand is the highest. At Aug the cooling peak demand is the highest.

3. ATHENS

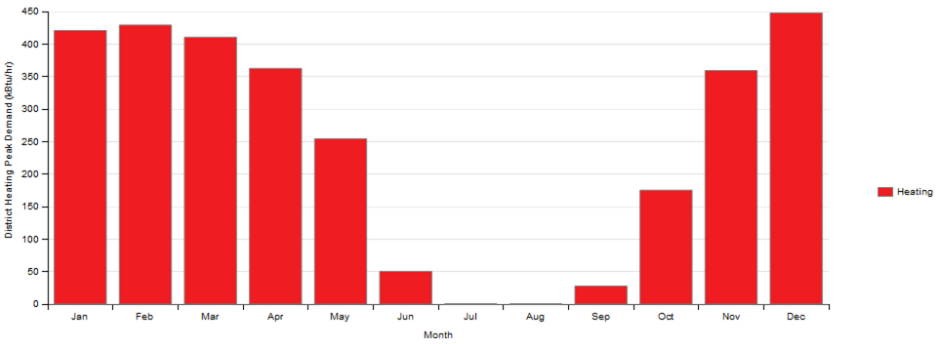
3.3 WALL 3

Monthly Load Profiles - view table

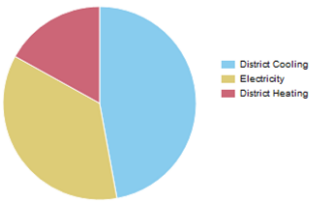




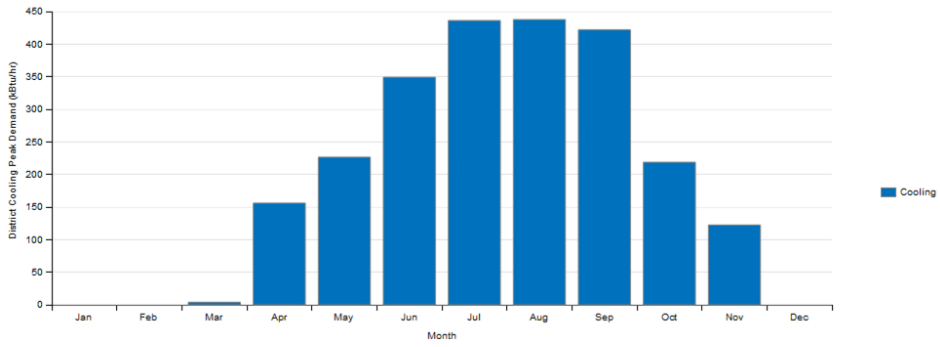
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that about half energy is used in the form of district cooling. And at the same time, the energy used in electricity is about twice as used in district heating .

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	780,925	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	47.98	kBtu/ft^2
OpenStudio Standards Building Type		

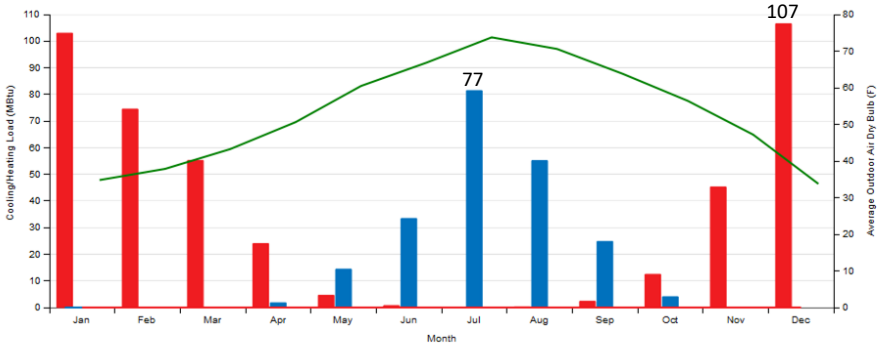
- In this condition, the annual energy consumption is about 780925 kBtu, which equals to 228866.5 kWh.

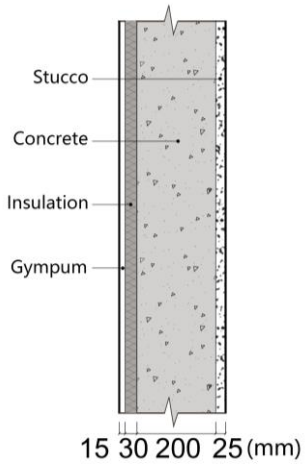
- From the first bar chart we can find that at Aug the cooling load is the highest and at Feb the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Dec the heating peak demand is the highest. At Aug the cooling peak demand is the highest.

4. PIACENZA

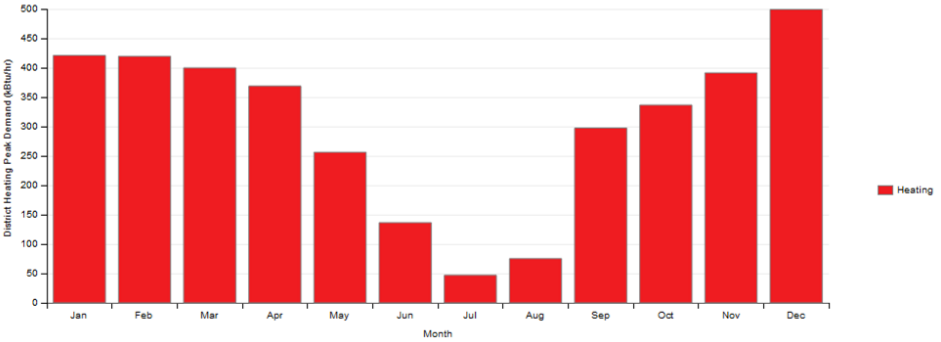
4.1 WALL 1

Monthly Load Profiles - view table

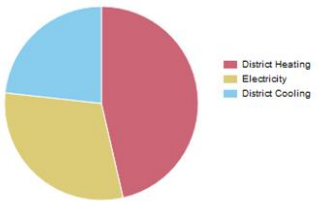




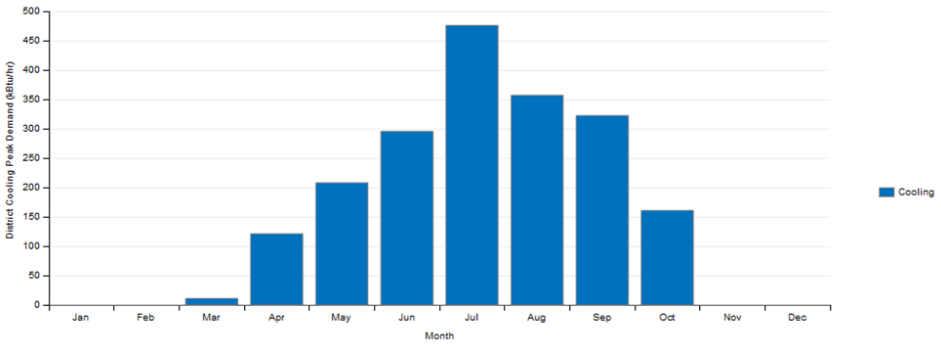
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that about 1/4 energy is used in the form of district cooling. And at the same time, it used in electricity is as same as it used in district heating.

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	924,406	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	56.80	kBtu/ft^2
OpenStudio Standards Building Type		

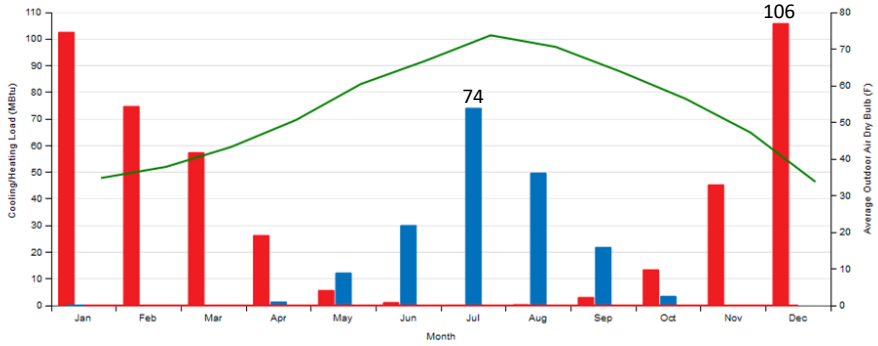
- In this condition, the annual energy consumption is about 924406 kBtu, which equals to 270916.7 kWh.

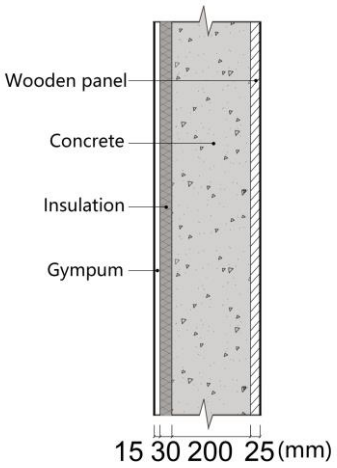
- From the first bar chart we can find that at Jul the cooling load is the highest and at Dec the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Dec the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

4. PIACENZA

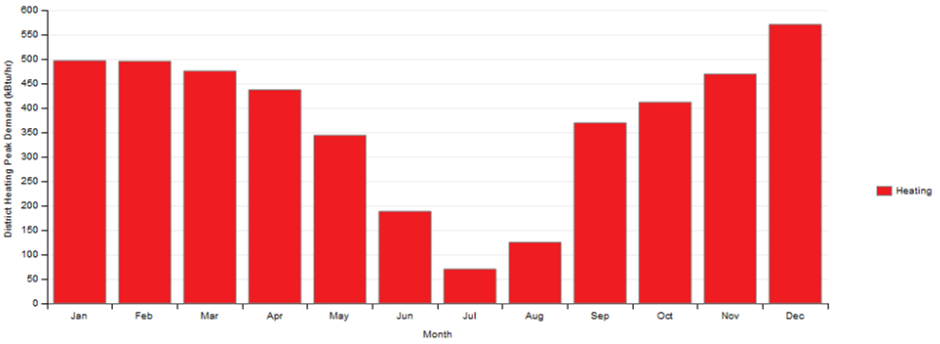
4.2 WALL 2

Monthly Load Profiles - view table

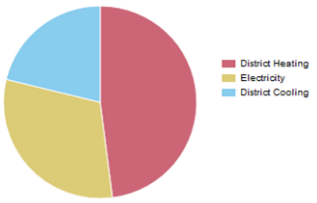




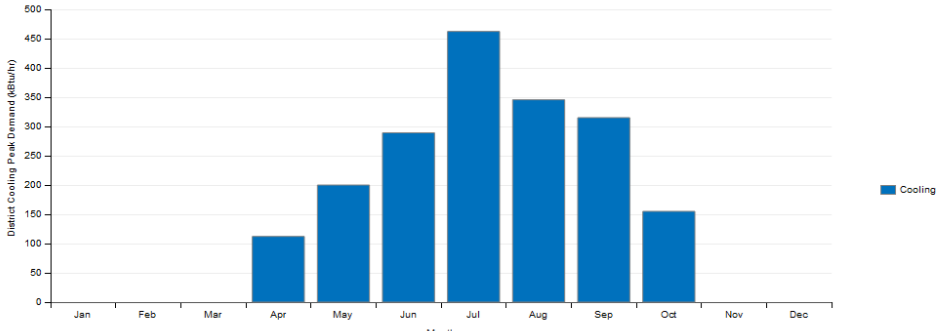
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that about 1/4 energy is used in the form of district cooling. And at the same time, it used in electricity is as same as it used in district heating.

Building Summary

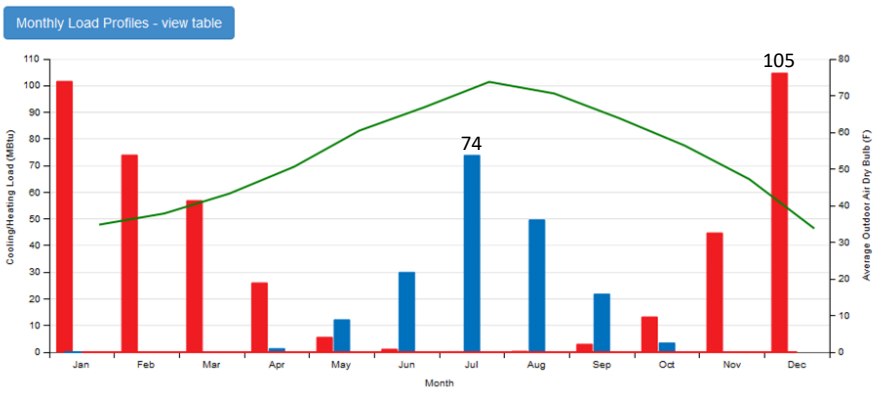
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	909,042	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	55.85	kBtu/ft^2
OpenStudio Standards Building Type		

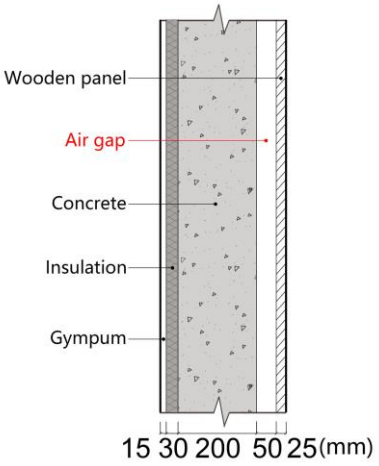
- In this condition, the annual energy consumption is about 909042 kBtu, which equals to 266413.9 kWh.

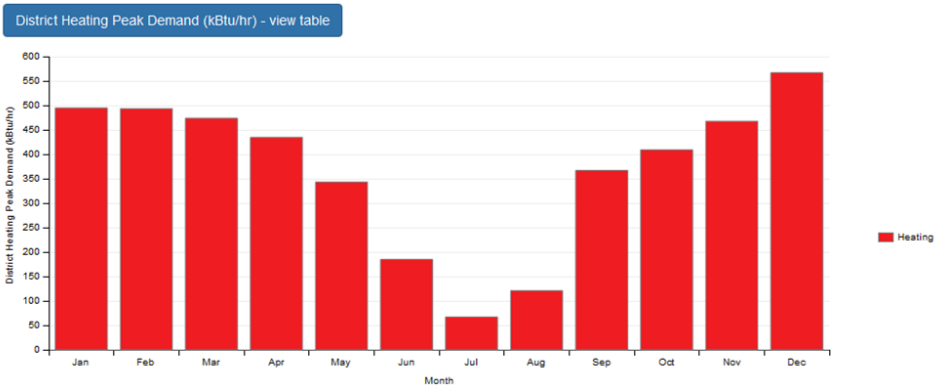
- From the first bar chart we can find that at Jul the cooling load is the highest and at Dec the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Dec the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

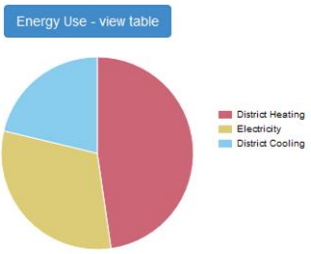
4. PIACENZA

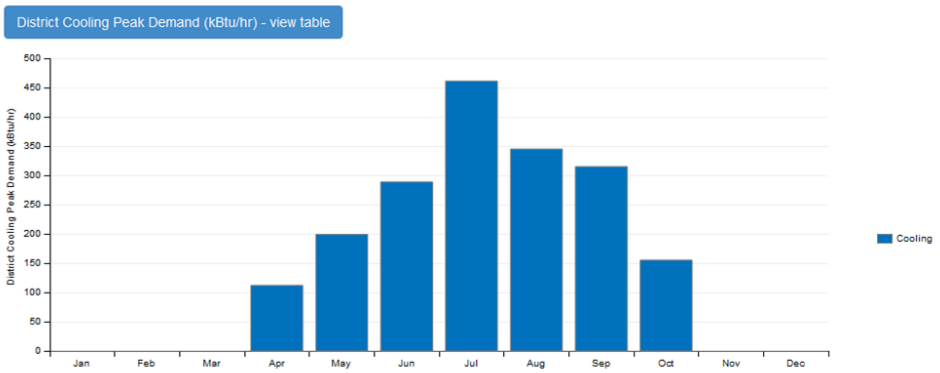
4.3 WALL 3











- In this situation, from the pie chart we can know that about 1/4 energy is used in the form of district cooling. And at the same time, it used in electricity is as same as it used in district heating.

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	904,009	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	55.55	kBtu/ft^2
OpenStudio Standards Building Type		

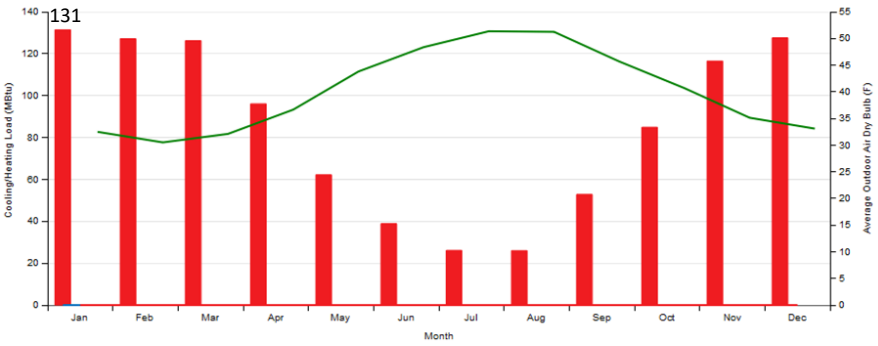
- In this condition, the annual energy consumption is about 904009 kBtu, which equals to 264938.9 kWh.

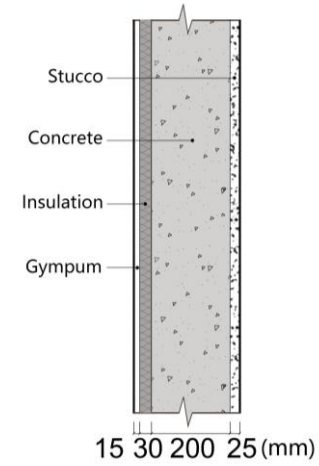
- From the first bar chart we can find that at Jul the cooling load is the highest and at Dec the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Dec the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

5. REYKJAVIK

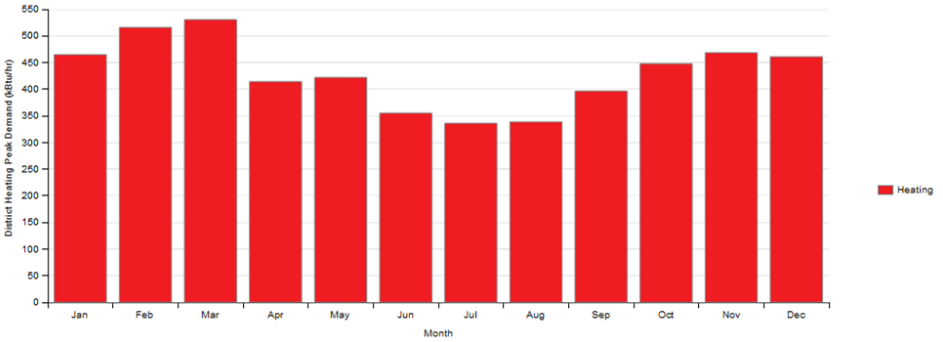
5.1 WALL 1

Monthly Load Profiles - view table

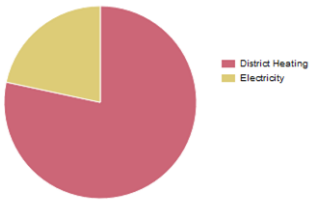




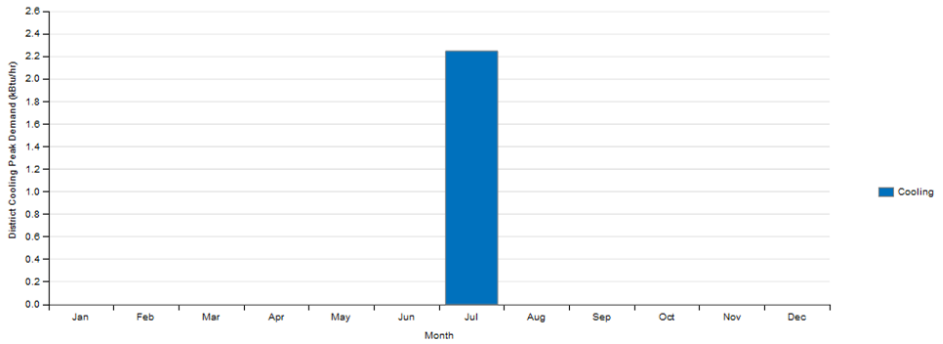
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that there is no energy used in the form of district cooling. And it used in district heating is about 5 time as it used in electricity.

Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	1,296,462	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	79.66	kBtu/ft^2
OpenStudio Standards Building Type		

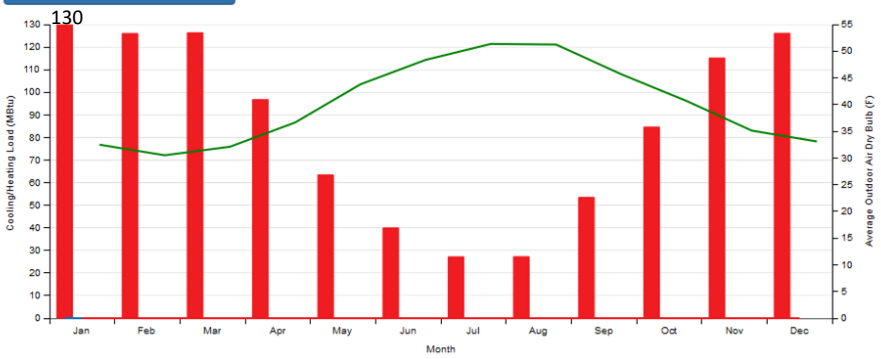
- In this condition, the annual energy consumption is about 1296462 kBtu, which equals to 379955.5 kWh.

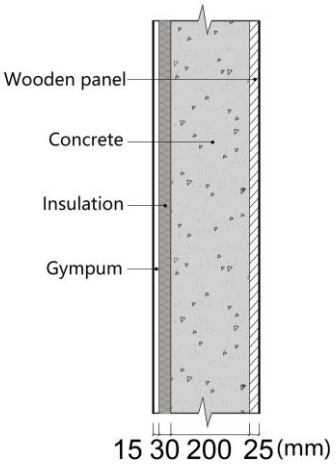
- From the first bar chart we can find that it has few cooling load and at Jan the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Mar the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

5. REYKJAVIK

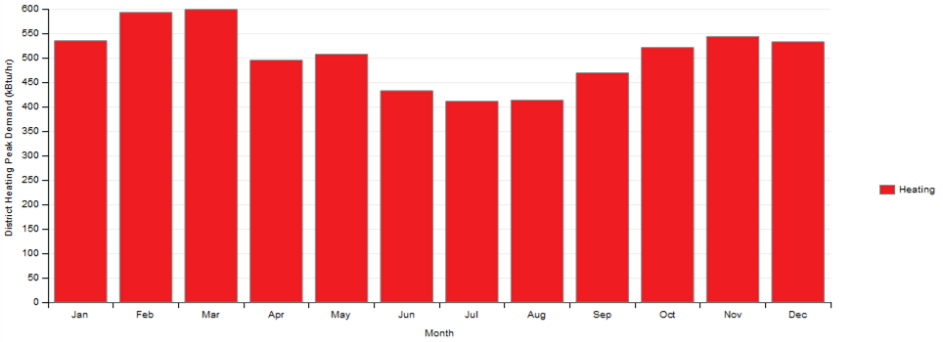
5.2 WALL 2

Monthly Load Profiles - view table

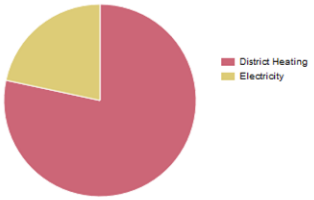




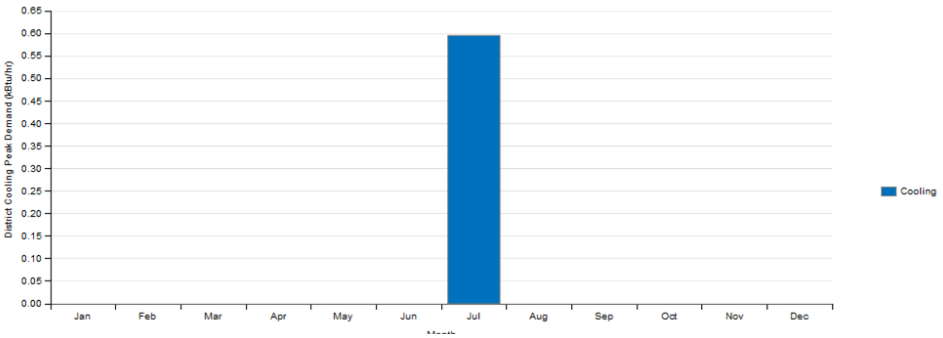
District Heating Peak Demand (kBtu/hr) - view table



Energy Use - view table



District Cooling Peak Demand (kBtu/hr) - view table



- In this situation, from the pie chart we can know that there is no energy used in the form of district cooling. And it used in district heating is about 5 time as it used in electricity.

Building Summary

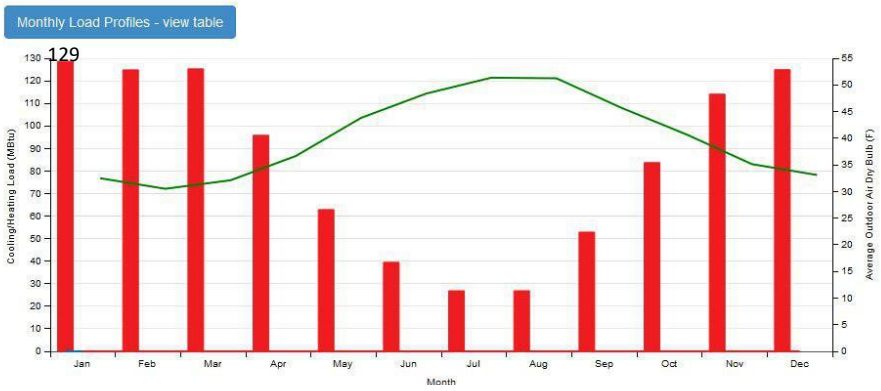
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	1,296,709	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	79.67	kBtu/ft^2
OpenStudio Standards Building Type		

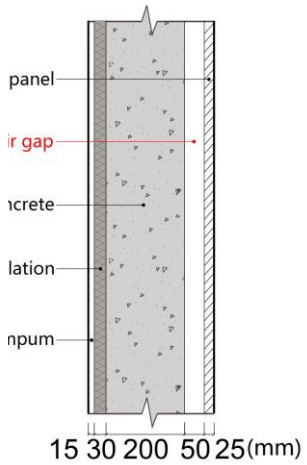
- In this condition, the annual energy consumption is about 1296709 kBtu, which equals to 380027.9 kWh.

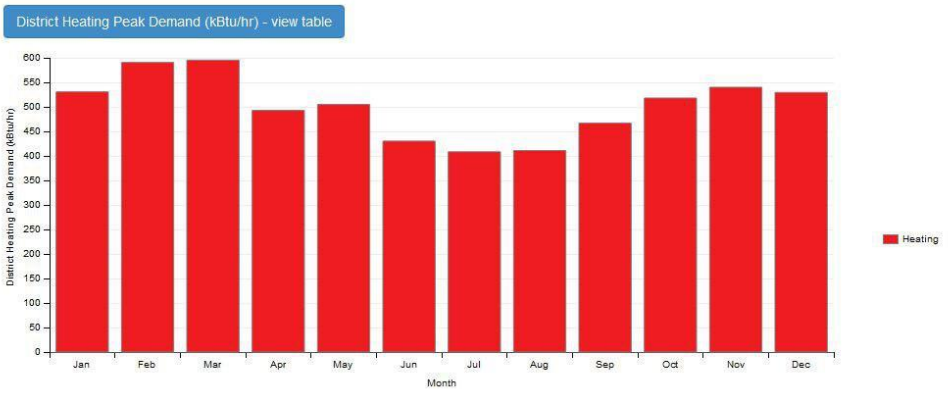
- From the first bar chart we can find that it has few cooling load and at Jan the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Mar the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

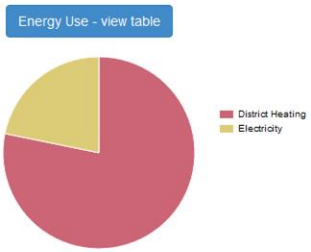
5. REYKJAVIK

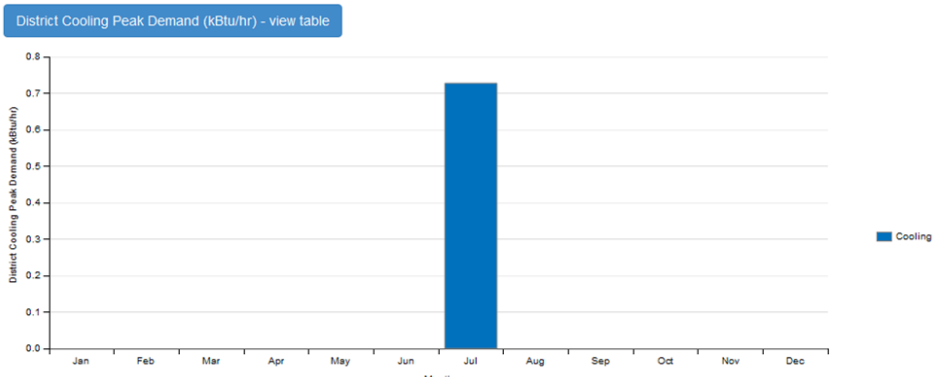
5.3 WALL 3











- In this situation, from the pie chart we can know that there is no energy used in the form of district cooling. And it used in district heating is about 5 time as it used in electricity.

Building Summary

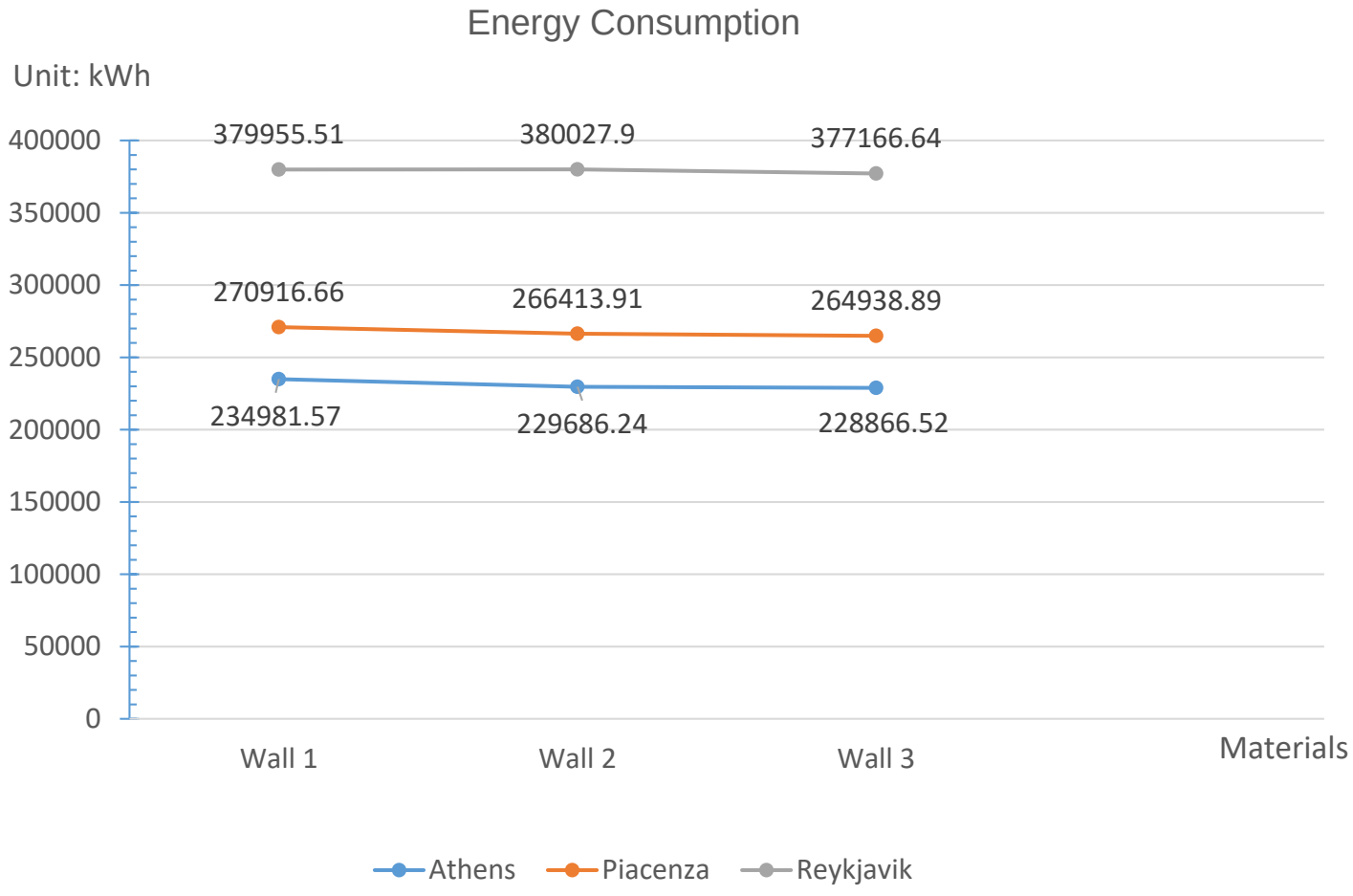
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	1,286,946	kBtu
Total Building Area	16,275	ft^2
EUI (Based on Net Site Energy and Total Building Area)	79.07	kBtu/ft^2
OpenStudio Standards Building Type		

- In this condition, the annual energy consumption is about 1286946 kBtu, which equals to 377166.6 kWh.

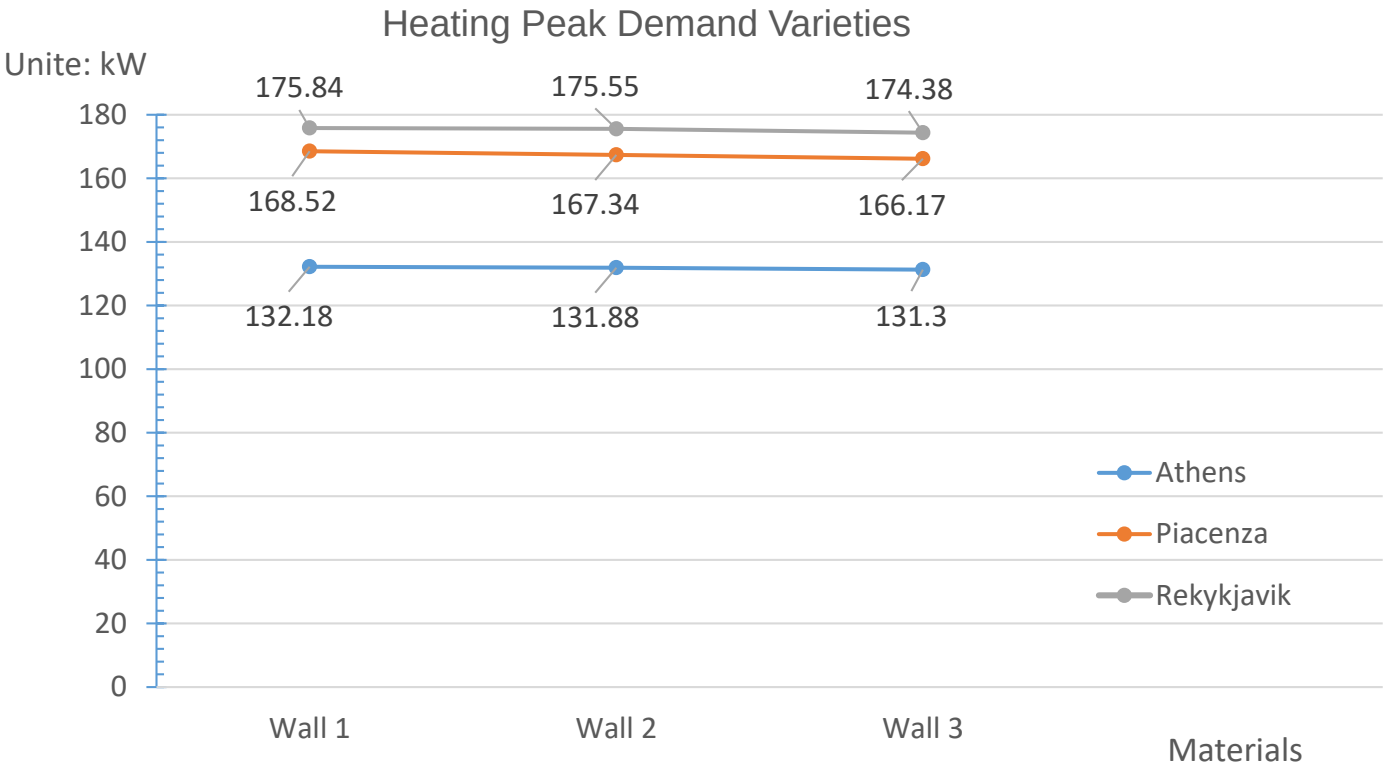
- From the first bar chart we can find that it has few cooling load and at Jan the heating load is the highest. From the last 2 bar charts we can analysis that monthly peak demand of district cooling and heating. At Mar the heating peak demand is the highest. At Jul the cooling peak demand is the highest.

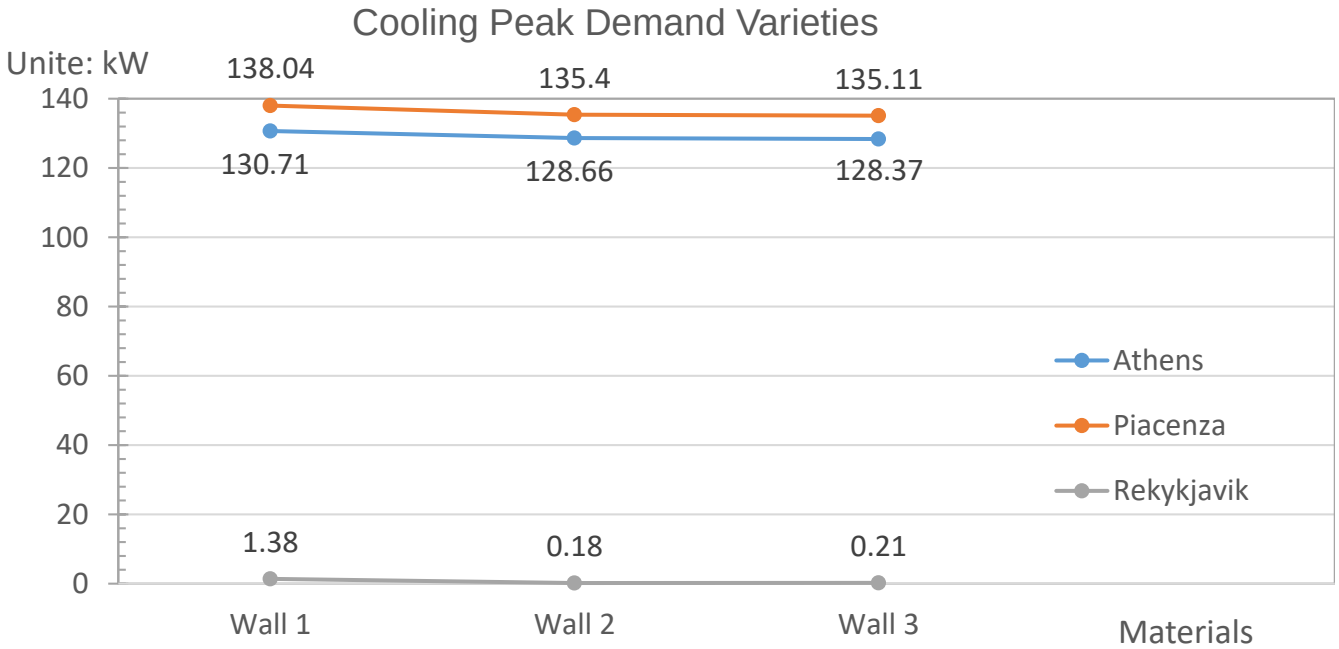
6. SUMMARY

Type of Wall	Classification	Athens	Piacenza	Reykjavik
Wall 1	Total Energy (kWh)	234 981.57	270 916.66	379 955.51
	Heating Peak Demand(kW)	132.18	168.516	175.84
	Cooling Peak Demand(kW)	130.71	138.04	1.38
Wall 2	Total Energy (kWh)	229 686.24	266 413.91	380 027.89
	Heating Peak Demand(kW)	131.88	167.34	175.55
	Cooling Peak Demand(kW)	128.66	135.40	0.18
Wall 3	Total Energy (kWh)	228 866.52	264 938.89	377 166.64
	Heating Peak Demand(kW)	131.30	166.17	174.38
	Cooling Peak Demand(kW)	128.37	135.11	0.21



6. SUMMARY





- After all the analysis, we can have two kinds of comparers.
- The first variate-factor we chose is the site, which means to analysis the same exterior wall positioned in 3 different places. It shows how the weather condition influences the value of energy consumption. In this case, Athens has the least energy consumption.
- The second variate-factor we chose is the material of wall, which means to analysis different wall materials in the same site. The result shows how the building construction affects the energy consumption. In this case, we have the conclusion the air-gap one can be considered as a construction material with better insulation property comparing to other 2 wall materials, which leads to the lowest energy consumption and least heating and cooling peak demand among 3 different walls in all the cities.