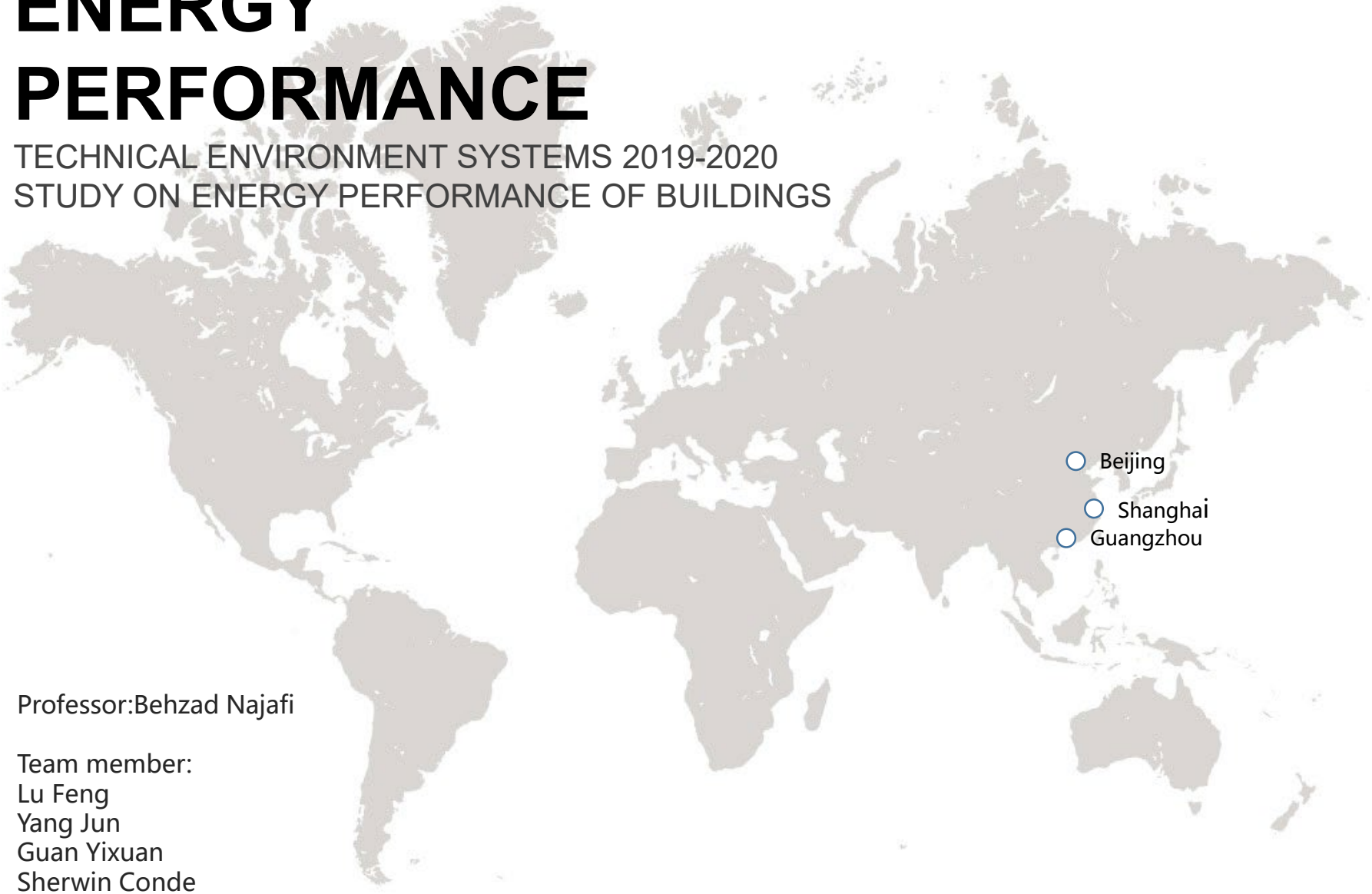
ENERGY PERFORMANCE

TECHNICAL ENVIRONMENT SYSTEMS 2019-2020
STUDY ON ENERGY PERFORMANCE OF BUILDINGS



Professor:Behzad Najafi

Team member:
Lu Feng
Yang Jun
Guan Yixuan
Sherwin Conde

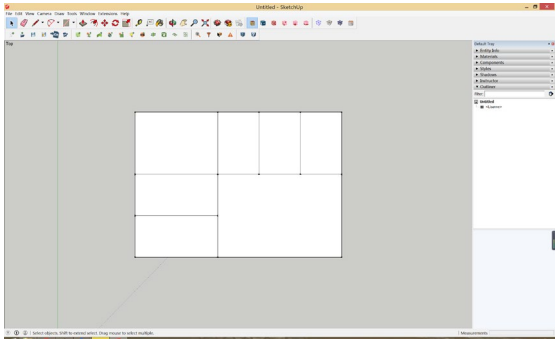
INTRODUCTION

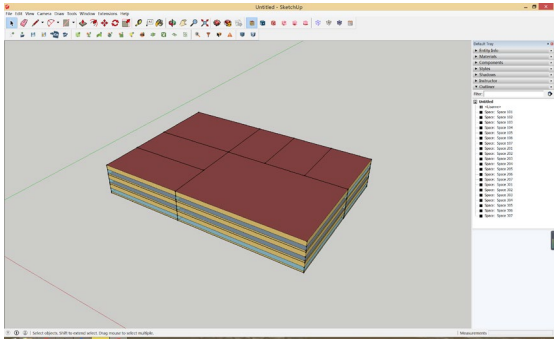
OBJECTIVE

•The objective of the experiment is to analyse the energy performance of a building in different conditions.

•The experiment is performed by calculating the energy consumption in different locations and material and then comparing the result to determine the important factors in energy performance.

BUILDING





Building Area

	Area [m2]
Total Building Area	21000.00
Net Conditioned Building Area	21000.00
Unconditioned Building Area	0.00

•We chose the layout of a conference building,whose total building area is 21000m². There are 3 floors inside and each floor has 7 rooms(1open space conference area,6 conference rooms).

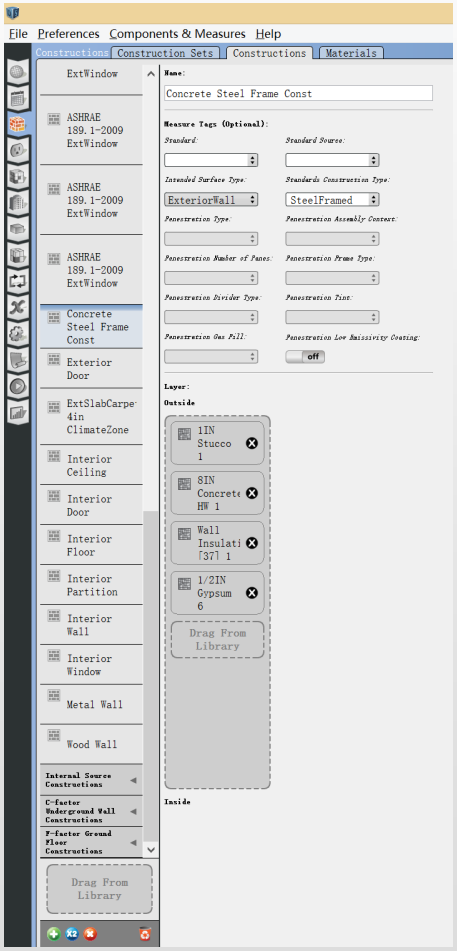
•To test the impact of Building introduction: It has three floors, and each floor is five-meter high.This commercial space is totally open and surrounded by glass and concrete.

INTRODUCTION

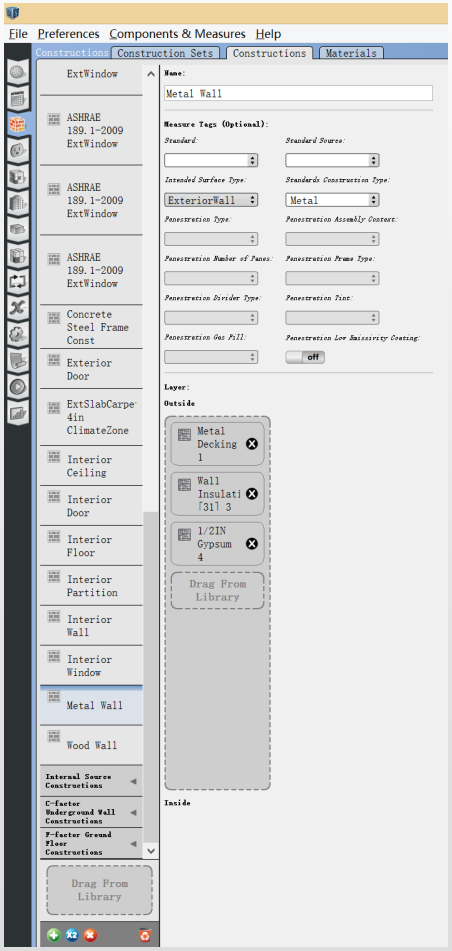
MATERIAL

- The experiment will be performed on the following materials :1. Solid Concrete with Steel Frame; 2. Metal; 3. Wood

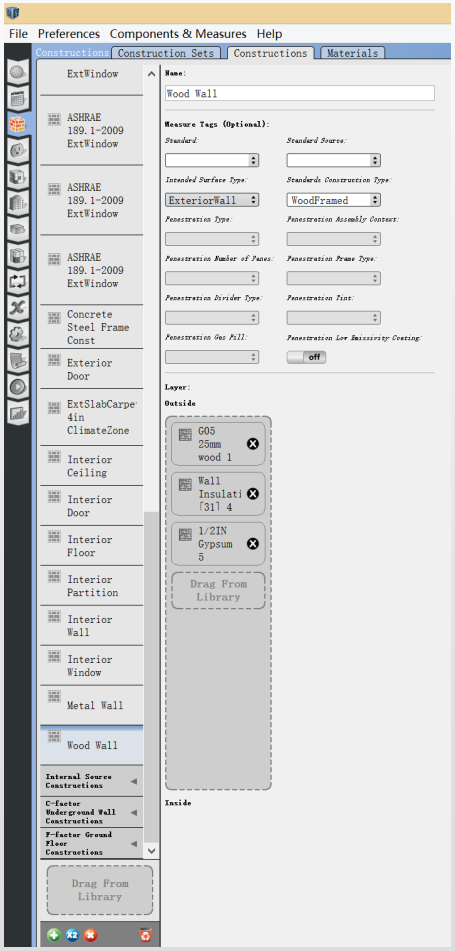
Solid Concrete with Steel Frame



Metal



Wood



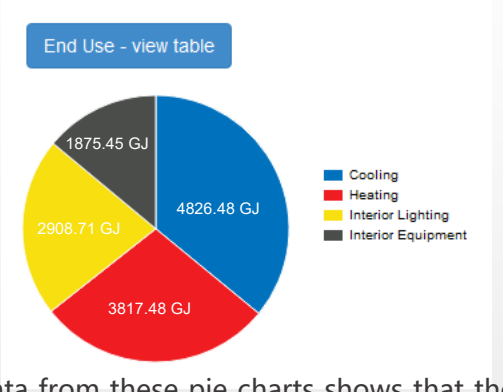
- To test the different factors on the energy consumption of the building, we changed two groups of input which are the material of the external wall (wood, metal and concrete) and the site.

- So in the following report, we will analyze 5 situations that 1 type of wall build in 3 different cities, and 3 different walls in one city.

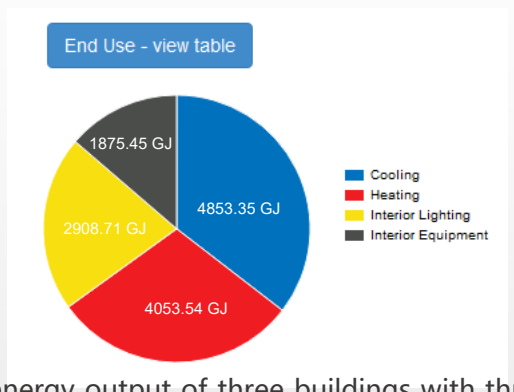
RESULT | THREE MATERIALS IN BEIJING

ENERGY CONSUMPTION

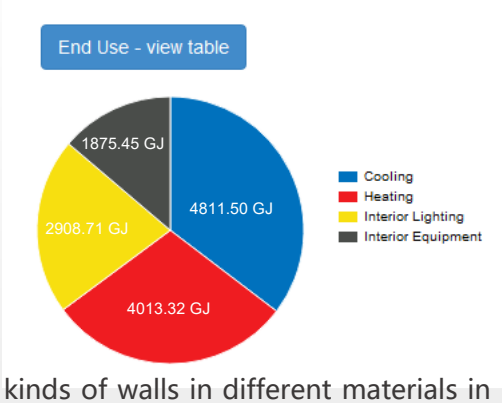
Solid Concrete with Steel Frame (Basic One)



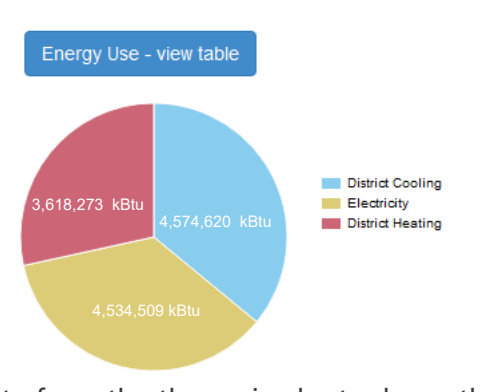
Metal

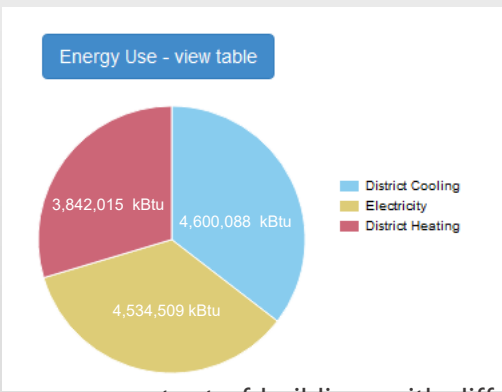


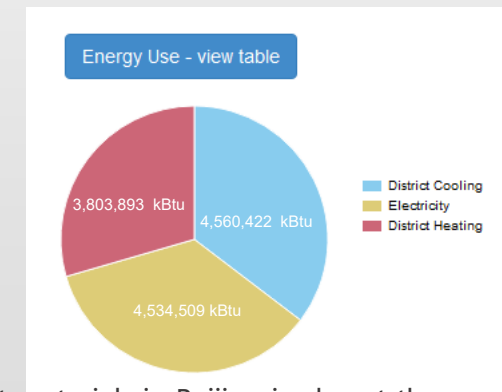
Wood



•The data from these pie charts shows that the energy output of three buildings with three kinds of walls in different materials in the same city, so the weather is the same. And we can see the consumption of energy is almost the same but still has some differences. For heating, metal consumes most and concrete with steel consumes least. As for cooling, the wood has a low consumption and the metal has the highest one.







•The data from the three pie charts shows that the energy output of buildings with different materials in Beijing is almost the same but a little unequal due to the insulation property of the materials. According to the data of district heating energy, concrete with steel buildings is the lowest while metal building is the highest. When it comes to district cooling, the wood building consumes the least and the metal one consumes the most.

RESULT | THREE MATERIALS IN BEIJING

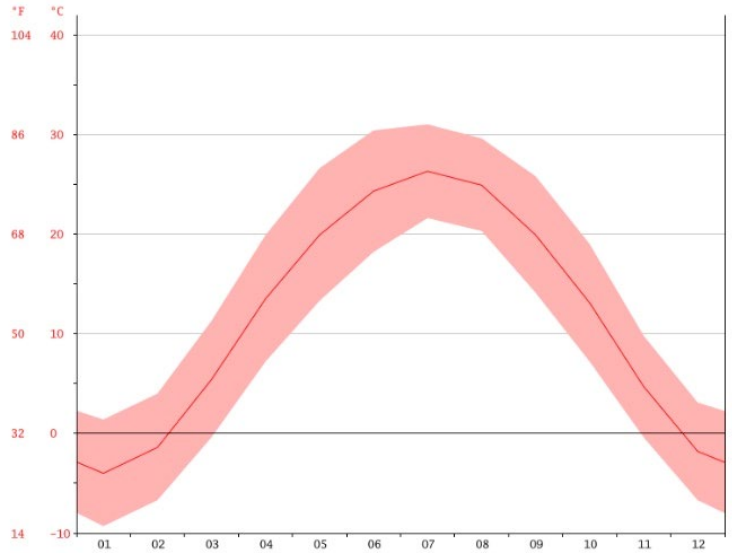
Beijing

CLIMATE BEIJING: WEATHER BY MONTH

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	-4	-1.4	5.4	13.5	19.9	24.3	26.3	24.9	19.9	13.1	4.7	-1.8
Min. Temperature (°C)	-9.3	-6.7	-0.4	7.2	13.3	18.2	21.6	20.3	14.1	7.2	-0.4	-6.7
Max. Temperature (°C)	1.4	4	11.3	19.9	26.6	30.4	31	29.6	25.8	19	9.8	3.1
Avg. Temperature (°F)	24.8	29.5	41.7	56.3	67.8	75.7	79.3	76.8	67.8	55.6	40.5	28.8
Min. Temperature (°F)	15.3	19.9	31.3	45.0	55.9	64.8	70.9	68.5	57.4	45.0	31.3	19.9
Max. Temperature (°F)	34.5	39.2	52.3	67.8	79.9	86.7	87.8	85.3	78.4	66.2	49.6	37.6
Precipitation / Rainfall (mm)	4	5	9	21	32	75	195	192	51	16	7	3

•There is a difference of 192MM of precipitation between the driest and wettest months. The variation in Temperatures throughout the year is 30.3 ℃.

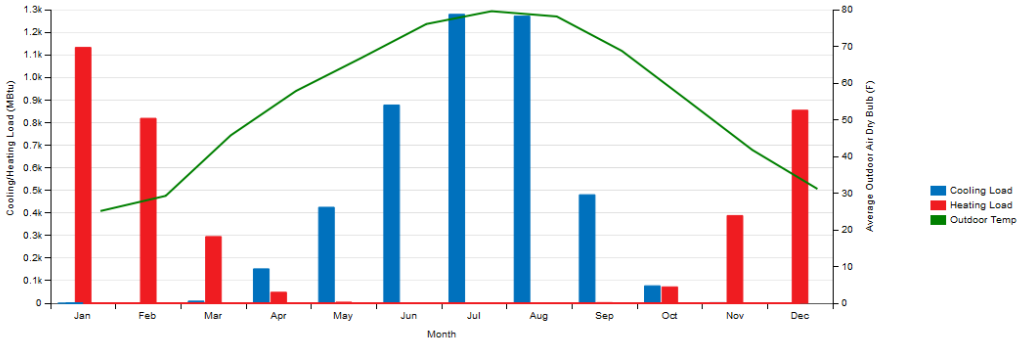
BEIJING AVERAGE TEMPERATURE



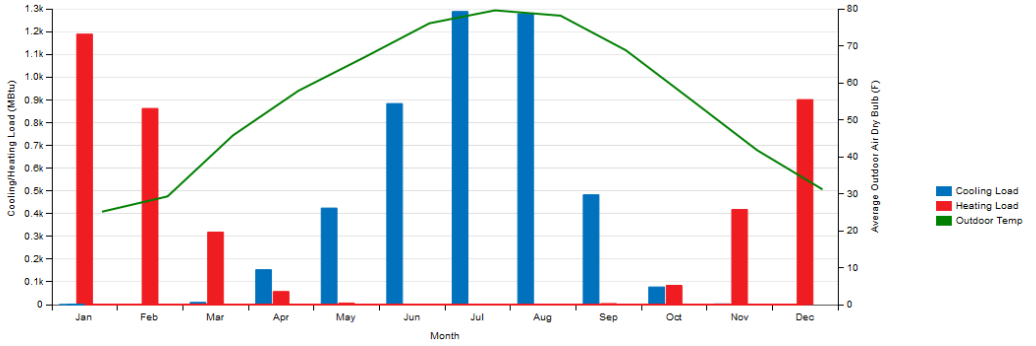
•July is the warmest month of the year. The temperature in July averages 26.3 ℃. The lowest average temperatures in the year occur in January, when it is around -4 ℃.

HVAC Load Profiles

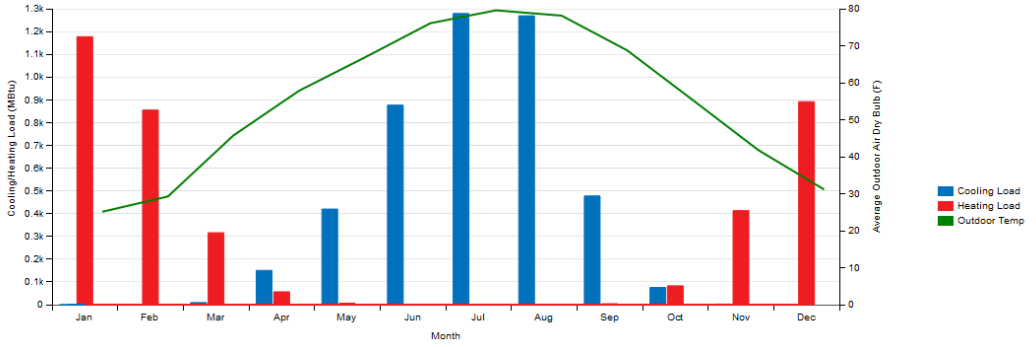
Solid Concrete with Steel Frame (Basic One)



Metal



Wood



RESULT | THREE MATERIALS IN BEIJING
THERMAL RESISTANCE

Solid Concrete with Steel Frame (Basic One)

Base Surface Constructions

Construction	Net Area (ft^2)	Surface Count	R Value (ft^2*h*R/Btu)
ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	75,347	7	19.96
Concrete Steel Frame Const	32,938	33	10.28

Metal

Base Surface Constructions

Construction	Net Area (ft^2)	Surface Count	R Value (ft^2*h*R/Btu)
ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	75,347	7	19.96
Metal Wall	32,938	33	4.88

Wood

Base Surface Constructions

Construction	Net Area (ft^2)	Surface Count	R Value (ft^2*h*R/Btu)
ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1	75,347	7	19.96
Wood Wall	32,938	33	5.84

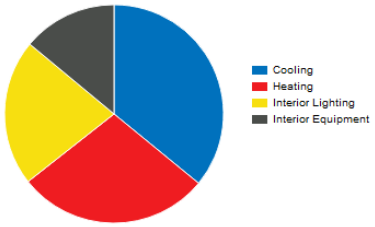
•From the above data, we can see that, in Beijing, due to the different construction of the buildings, the thermal resistances are different. The concrete exterior wall has 10.28 ft^2*h*R/Btu thermal resistance, while the value of metal external wall is 4.88 ft^2*h*R/Btu, and the wood one is 5.84 ft^2*h*R/Btu.

RESULT | SOLID CONCRETE WITH STEEL FRAME EXT WALLS

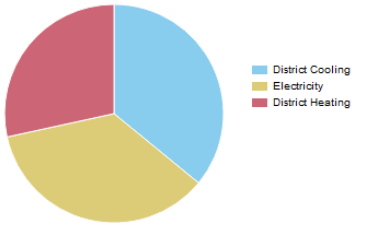
ENERGY CONSUMPTION

Beijing

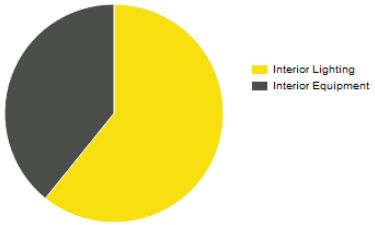
End Use - view table



Energy Use - view table

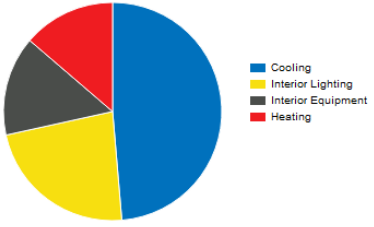


EUI - Electricity - view table

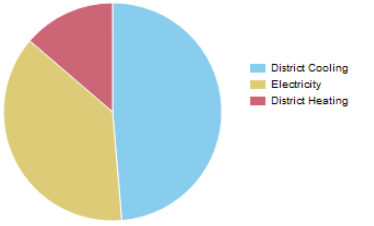


Shanghai

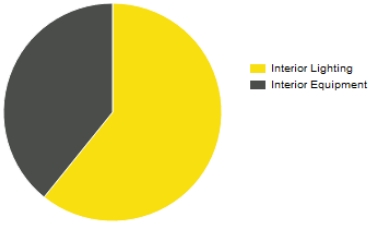
End Use - view table



Energy Use - view table

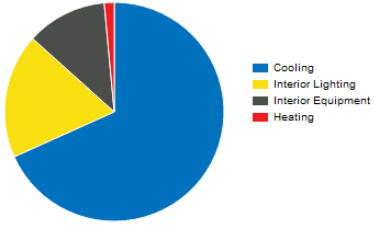


EUI - Electricity - view table

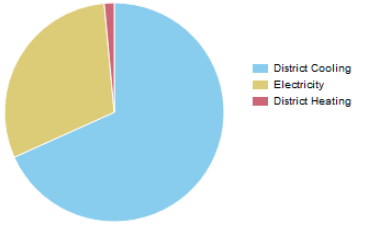


Guangzhou

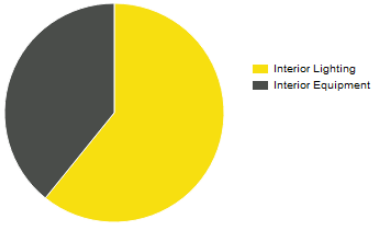
End Use - view table



Energy Use - view table



EUI - Electricity - view table



The data shows that the energy output is different in three cities due to the weather and temperature.

Average temperature of Beijing is lower than Shanghai and Guangzhou, so the heating energy is higher in Beijing. Meanwhile, temperature of Guangzhou is higher than Shanghai and Beijing, so the cooling energy is higher in Guangzhou.

Heating is inversely proportional to temperature, and cooling is directly proportional to temperature.

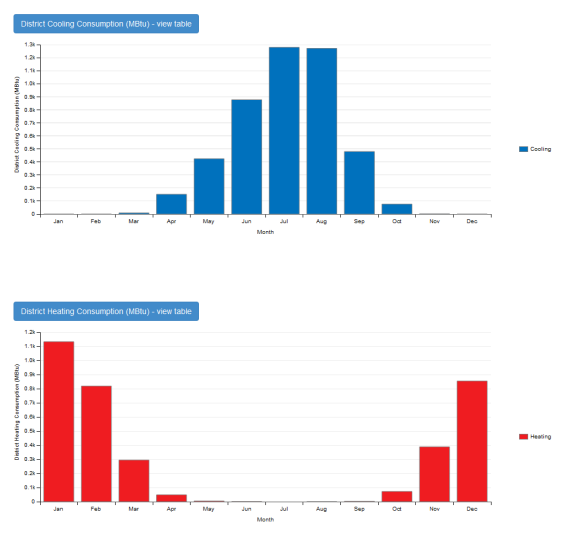
It can be seen from the charts that at the EUI of three sites are almost the same, with similar proportion of electricity.

Proportion of heating and cooling in the end use and energy use charts are the same. But because the use of interior equipment needs electricity, the proportion in energy use is a little bit more than proportion in other charts.

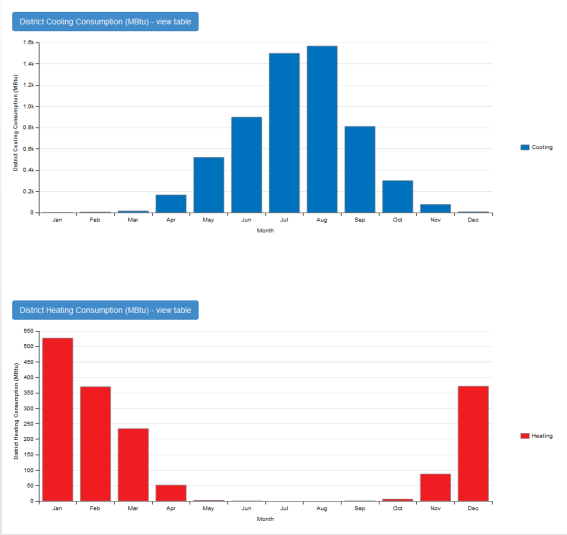
RESULT | SOLID CONCRETE WITH STEEL FRAME EXT WALLS

ENERGY CONSUMPTION

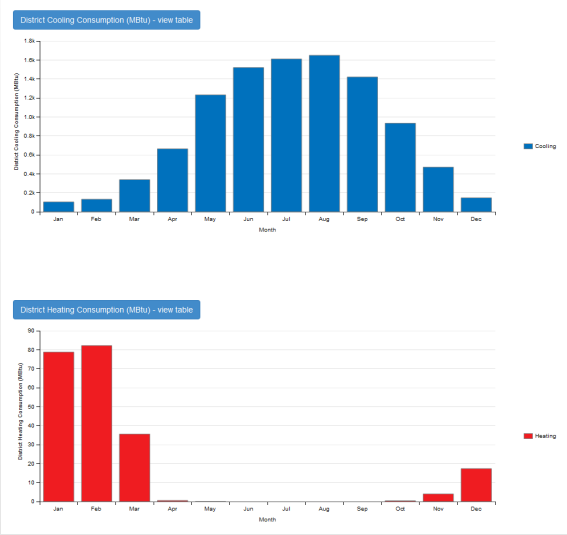
Beijing



Shanghai



Guangzhou



•The cooling consumption in three cities are normal due to seasonal variation. Normally its higher in April till November and will peak in July - August. In other months are more uniform. Beijing and Shanghai have no cooling need in December till February. Guangzhou have cooling needs all the year.

•Consumption of heating load in three cities show similar trend. It mainly become higher in winter season from November to March, during summer the load is extremely low than other months. Three cities had almost no heating demand from May till September.

CONCLUSION

THREE MATERIALS IN BEIJING

Material	[GJ]	Beijing	Total
Concrete	Cooling	4826.48	8643.96
	Heating	3817.48	
Metal	Cooling	4853.35	8906.89
	Heating	4053.54	
Wood	Cooling	4811.50	8824.82
	Heating	4013.32	

•Regarding the energy performance of the building with different construction properties, we can conclude that:

•CONCRETE overall has the lowest energy consumption, while METAL overall has the highest energy consumption. So, the best choice is CONCRETE, the energy saved will result in lower cost in the long run.

•WOOD is the best for cooling and CONCRETE is the best for heating.

•METAL is the highest both in cooling and heating, so it is the least ideal material.

CONCRETE WITH STEEL IN THREE CITIES

	Beijing	Shanghai	Guangzhou
Cooling	4826.48	6184.43	10785.62
Heating	3817.48	1742.46	231.01
Total	8643.96	7926.89	11016.63

•It is clear that there are differences in cooling and heating loads in the three cities with the same elements.

•For the cooling, Beijing has the lowest requirement, while Guangzhou is the highest. For the heating, Beijing is the highest and Guangzhou is the lowest. Shanghai always has the medium load for both heating and cooling.

•For the total , Guangzhou is the highest and followed by Beijing, then Shanghai is the lowest. So, Weather is most important variable that caused this variety. A place that is too cold or too hot will cost more energy.