TECHNICAL ENVIRONMENTAL SYSTEM

2017-2018

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CONTENT

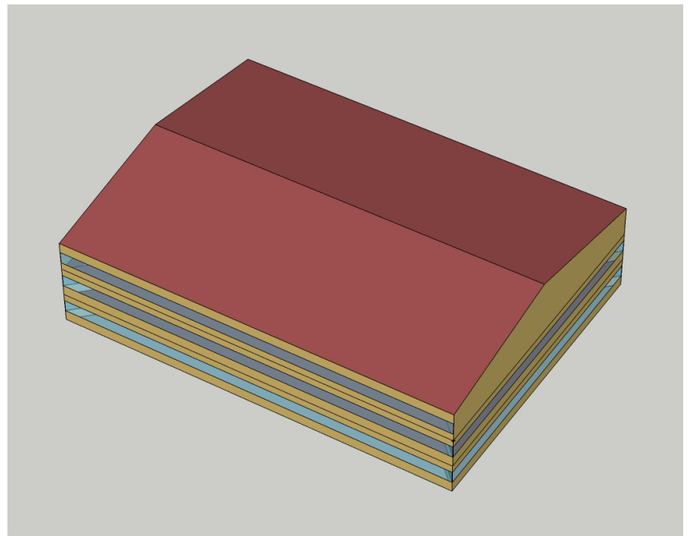
(1)OVERALL

In this study, we chose three different city Piacenza, Tianjin and Yichang as experimental sites. Among them, Piacenza is located in the north of Italy, which belongs to the subtropical humid climate. Tianjin is located in the north of China, which belongs to the temperate monsoon climate. Yichang is located in the south of China, which belongs to the subtropical monsoon humid climate.
In another case, we choose wood, concrete and metal as different building materials for analyzing.

Based on specific buildings with the same materials, we try to compare the situations with different cities .And the other study we try to compare three different materials at the same location.
Construction introduction
Simple two-story residential building. each net height is three meters.

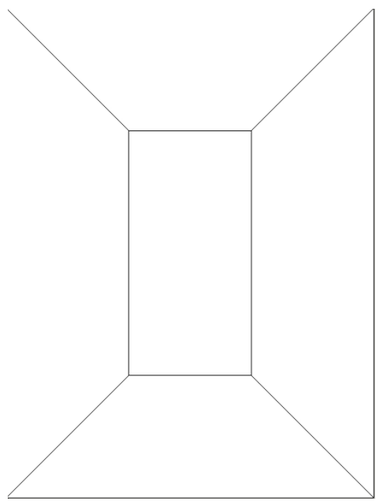
Building Area

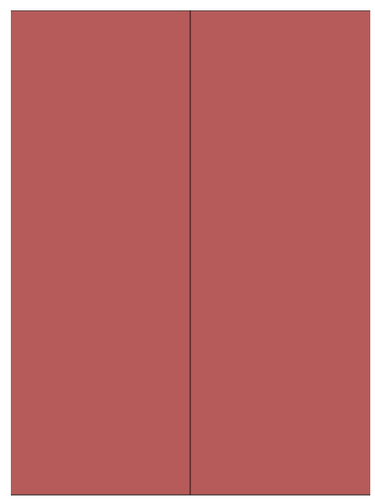
	Area [m2]
Total Building Area	2400.00
Net Conditioned Building Area	2400.00
Unconditioned Building Area	0.00



Building Summary

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	1,208,751	kBtu
Total Building Area	25,833	ft^2
EUI (Based on Net Site Energy and Total Building Area)	46.79	kBtu/ft^2
OpenStudio Standards Building Type		





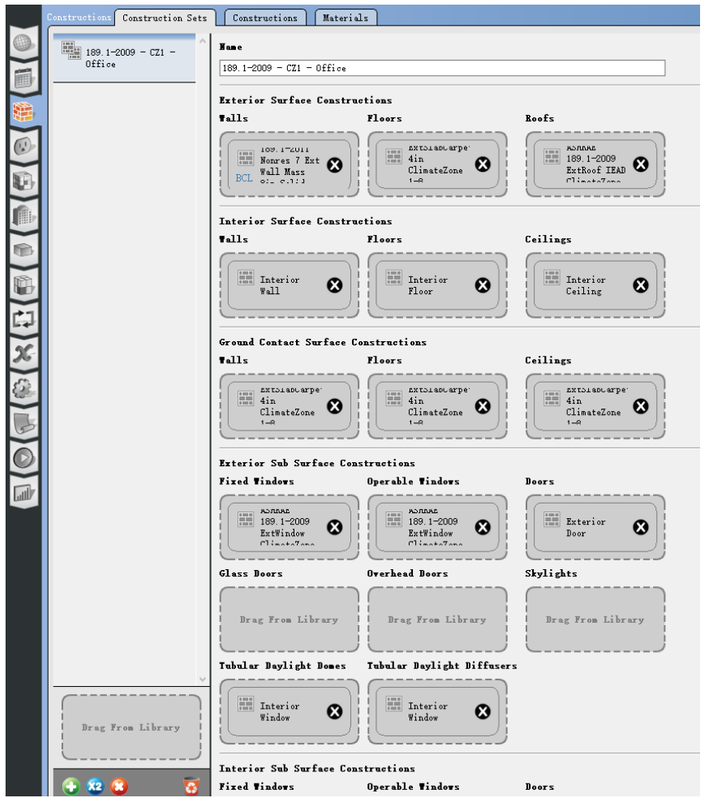
ENVELOPE

Window-Wall Ratio

	Total	North (315 to 45 deg)	East (45 to 135 deg)	South (135 to 225 deg)	West (225 to 315 deg)
Gross Wall Area [m2]	1363.56	316.02	365.76	316.02	365.76
Above Ground Wall Area [m2]	1363.56	316.02	365.76	316.02	365.76
Window Opening Area [m2]	438.91	73.15	146.30	73.15	146.30
Gross Window-Wall Ratio [%]	32.19	23.15	40.00	23.15	40.00
Above Ground Window-Wall Ratio [%]	32.19	23.15	40.00	23.15	40.00

(2)PIACENZA-CONCRETE

IN CASE THE BUILDIING IS LOCATED IN PIACENZA , WE USE CONCRETE AS THE MATERIAL OF THE EXTERIOR OF THE WALL



Program Version:**EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2018.01.17 14:38**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

Environment: **RUN PERIOD 1 ** Piacenza - ITA IGDG WMO#=160840**

Simulation Timestamp: **2018-01-17 14:38:23**

Report: **Annual Building Utility Performance Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 14:38:23**

Values gathered over 8760.00 hours

THE TABLES BELOW SHOW THE SITUATION OF ENERGY CONSUMPTION

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1150.76	479.48	479.48
Net Site Energy	1150.76	479.48	479.48
Total Source Energy	3563.13	1484.64	1484.64
Net Source Energy	3563.13	1484.64	1484.64

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	District Heating [W]	Water [m3/s]
Time of Peak	02-JAN-08:15	-	-	11-JUL-15:00	04-DEC-06:15	-
Heating	0.00	0.00	0.00	0.00	231308.96	0.00
Cooling	0.00	0.00	0.00	93927.61	0.00	0.00
Interior Lighting	23017.55	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	16507.53	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	39525.08	0.00	0.00	93927.61	231308.96	0.00

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	414.84	0.00
Cooling	0.00	0.00	0.00	126.22	0.00	0.00
Interior Lighting	296.94	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	312.76	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	609.70	0.00	0.00	126.22	414.84	0.00

Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050
Other Fuel 1	1.000
Other Fuel 2	1.000

(3)TIANJIN-CONCRETE

IN CASE THE BUILDIING IS LOCATED IN TIANJIN, WE USE CONCRETE AS THE MATERIAL OF THE EXTERIOR OF THE WALL

Program Version:**EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2018.01.17 15:18**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

Environment: **RUN PERIOD 1 ** Tianjin Tianjin CHN CSWD WMO#=545270**

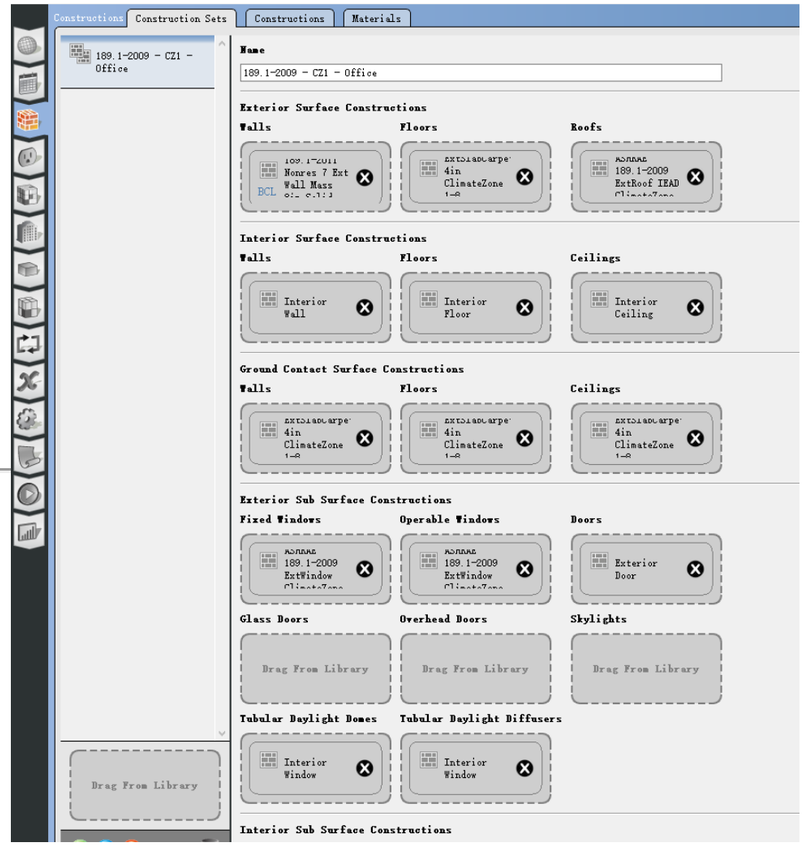
Simulation Timestamp: **2018-01-17 15:18:09**

Report: **Annual Building Utility Performance Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 15:18:09**

Values gathered over 8760.00 hours



Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1275.30	531.38	531.38
Net Site Energy	1275.30	531.38	531.38
Total Source Energy	3833.86	1597.44	1597.44
Net Source Energy	3833.86	1597.44	1597.44

Report: **Demand End Use Components Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 15:18:09**

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	District Heating [W]	Water [m3/s]
Time of Peak	02-JAN-08:15	-	-	28-JUL-16:00	07-FEB-06:15	-
Heating	0.00	0.00	0.00	0.00	244820.03	0.00
Cooling	0.00	0.00	0.00	114863.06	0.00	0.00
Interior Lighting	23017.55	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	16507.53	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	39525.08	0.00	0.00	114863.06	244820.03	0.00

End Uses

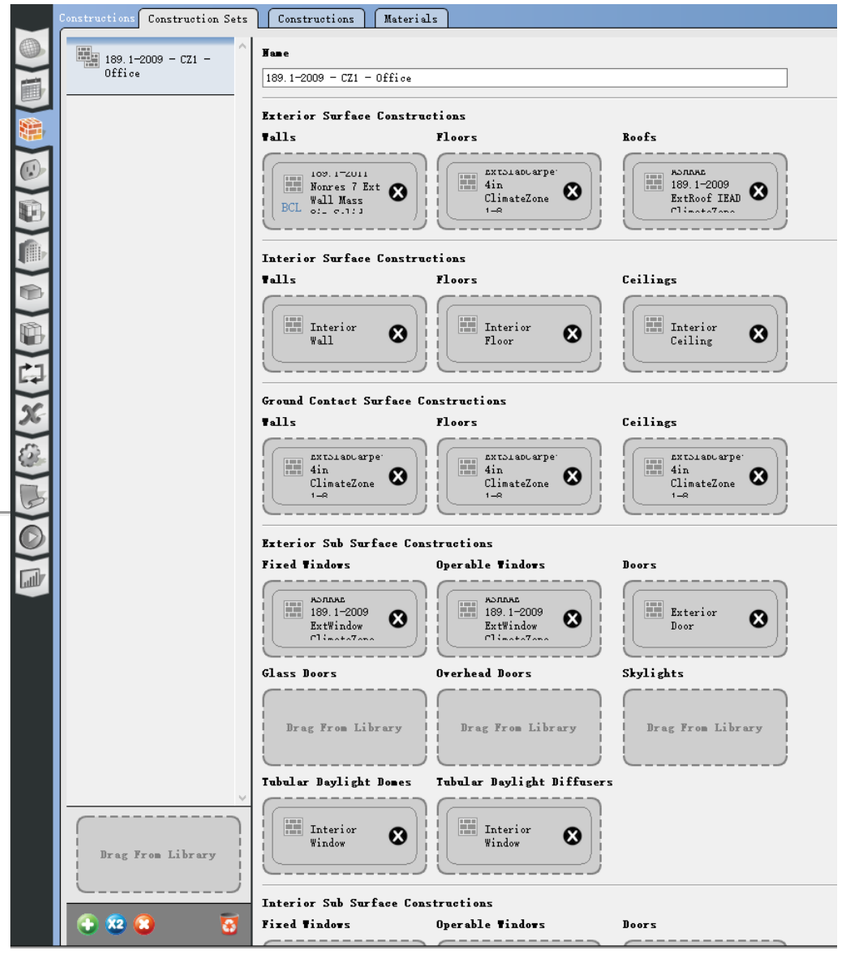
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	469.29	0.00
Cooling	0.00	0.00	0.00	196.31	0.00	0.00
Interior Lighting	296.94	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	312.76	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	609.70	0.00	0.00	196.31	469.29	0.00

Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050
Other Fuel 1	1.000
Other Fuel 2	1.000

(4)YICHANG-CONCRETE

IN CASE THE BUILDIING IS LOCATED IN YICHANG, WE USE CONCRETE AS THE MATERIAL OF THE EXTERIOR OF THE WALL



Program Version:**EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2018.01.17 15:21**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

Environment: **RUN PERIOD 1 ** Yichang Hubei CHN CSWD WMO#=574610**

Simulation Timestamp: **2018-01-17 15:21:19**

Report: **Annual Building Utility Performance Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 15:21:19**

Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1087.30	453.04	453.04
Net Site Energy	1087.30	453.04	453.04
Total Source Energy	3030.23	1262.60	1262.60
Net Source Energy	3030.23	1262.60	1262.60

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	District Heating [W]	Water [m3/s]
Time of Peak	02-JAN-08:15	-	-	29-JUN-16:00	09-JAN-06:15	-
Heating	0.00	0.00	0.00	0.00	217153.50	0.00
Cooling	0.00	0.00	0.00	114205.33	0.00	0.00
Interior Lighting	23017.55	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	16507.53	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	39525.08	0.00	0.00	114205.33	217153.50	0.00

End Uses

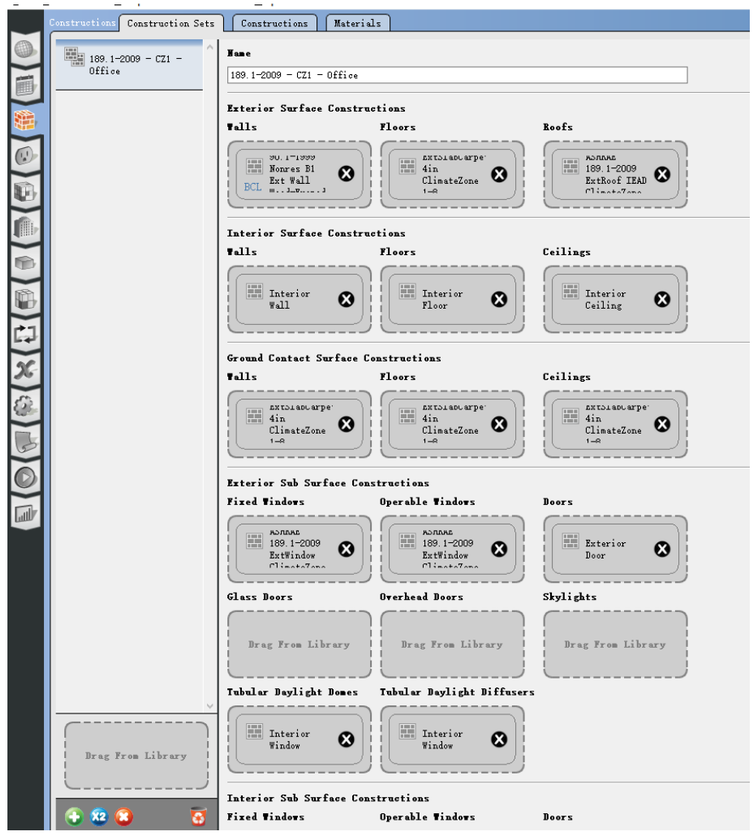
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	232.68	0.00
Cooling	0.00	0.00	0.00	244.92	0.00	0.00
Interior Lighting	296.94	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	312.76	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	609.70	0.00	0.00	244.92	232.68	0.00

Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050
Other Fuel 1	1.000
Other Fuel 2	1.000

(5)PIACENZA-WOOD

IN CASE THE BUILDIING IS LOCATED IN PIACENZA , WE USE WOOD AS THE MATERIAL OF THE EXTERIOR OF THE WALL



Program Version:**EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2018.01.17 15:02**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

Environment: **RUN PERIOD 1 ** Piacenza - ITA IGDG WMO#=160840**

Simulation Timestamp: **2018-01-17 15:02:18**

Report: **Annual Building Utility Performance Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 15:02:18**

Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1184.49	493.54	493.54
Net Site Energy	1184.49	493.54	493.54
Total Source Energy	3650.59	1521.08	1521.08
Net Source Energy	3650.59	1521.08	1521.08

Report: **Demand End Use Components Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 15:02:18**

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	District Heating [W]	Water [m3/s]
Time of Peak	02-JAN-08:15	-	-	11-JUL-15:00	04-DEC-06:15	-
Heating	0.00	0.00	0.00	0.00	234411.49	0.00
Cooling	0.00	0.00	0.00	98882.59	0.00	0.00
Interior Lighting	23017.55	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	16507.53	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	39525.08	0.00	0.00	98882.59	234411.49	0.00

End Uses

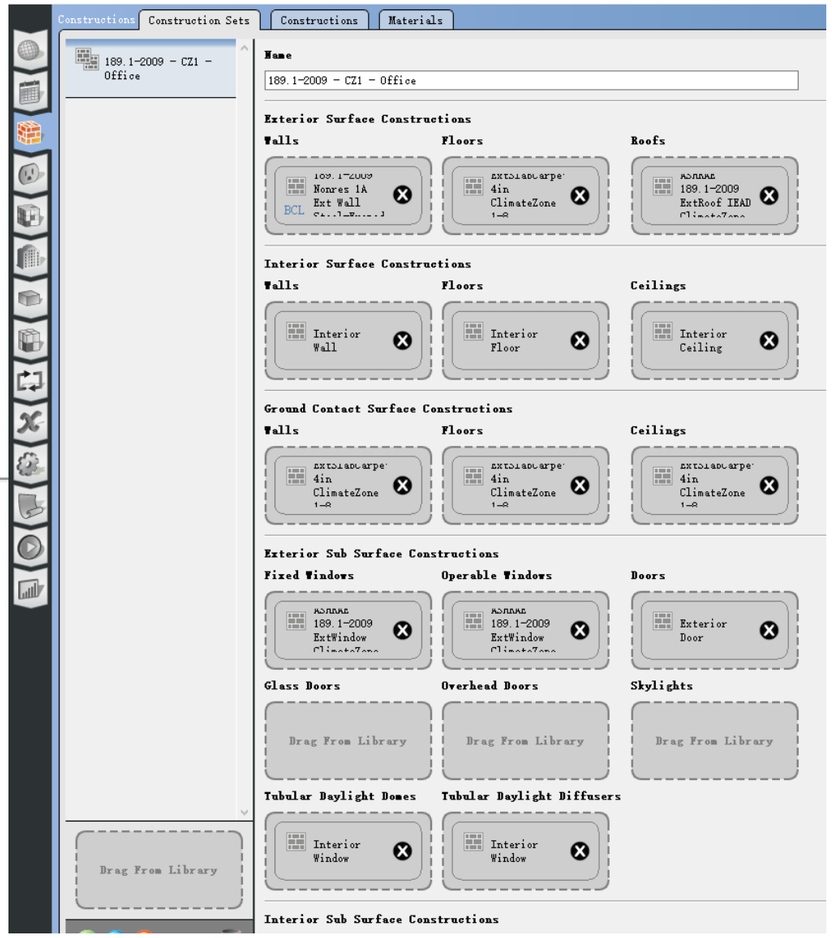
	Electricity [GJ]	Natural Gas [GJ]	Additional Fuel [GJ]	District Cooling [GJ]	District Heating [GJ]	Water [m3]
Heating	0.00	0.00	0.00	0.00	435.11	0.00
Cooling	0.00	0.00	0.00	139.68	0.00	0.00
Interior Lighting	296.94	0.00	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Interior Equipment	312.76	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	609.70	0.00	0.00	139.68	435.11	0.00

Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050
Other Fuel 1	1.000
Other Fuel 2	1.000

(6)PIACENZA-STEEL

IN CASE THE BUILDIING IS LOCATED IN PIACENZA , WE USE STEEL AS THE MATERIAL OF THE EXTERIOR OF THE WALL



Program Version:**EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2018.01.17 14:58**

Tabular Output Report in Format: **HTML**

Building: **Building 1**

Environment: **RUN PERIOD 1 ** Piacenza - ITA IGDG WMO#=160840**

Simulation Timestamp: **2018-01-17 14:58:48**

Report: **Annual Building Utility Performance Summary**

For: **Entire Facility**

Timestamp: **2018-01-17 14:58:48**

Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m2]	Energy Per Conditioned Building Area [MJ/m2]
Total Site Energy	1172.54	488.56	488.56
Net Site Energy	1172.54	488.56	488.56
Total Source Energy	3621.56	1508.98	1508.98
Net Source Energy	3621.56	1508.98	1508.98

End Uses

	Electricity [W]	Natural Gas [W]	Propane [W]	District Cooling [W]	District Heating [W]	Water [m3/s]
Time of Peak	02-JAN-08:15	-	-	11-JUL-16:00	04-DEC-06:15	-
Heating	0.00	0.00	0.00	0.00	233389.65	0.00
Cooling	0.00	0.00	0.00	97174.35	0.00	0.00
Interior Lighting	23017.55	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	16507.53	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	39525.08	0.00	0.00	97174.35	233389.65	0.00

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	428.69	0.00
Cooling	0.00	0.00	0.00	134.15	0.00	0.00
Interior Lighting	296.94	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	312.76	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	609.70	0.00	0.00	134.15	428.69	0.00

Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050
Diesel	1.050
Coal	1.050
Fuel Oil #1	1.050
Fuel Oil #2	1.050
Propane	1.050
Other Fuel 1	1.000
Other Fuel 2	1.000

7. COMPARISON AND SUMMARY

Regarding the consumption(GJ) and power (W) of hesting and cooling, the tables below show the comparison. Among these, yellow stands foe the maximum when red presents the minimum.

Comparison A - three different places

	Piacenza-Concrete	Tianjin-Concrete	Yichang-Concrete
District Heating [GJ]	414.84	469.29	232.68
District Cooling [GJ]	126.22	196.31	244.92
District Heating Load [W]	231308.96	244820.03	217153.51
District Cooling Load [W]	93927.61	114863.06	114205.33

Summary A (for table 1)

From this table we find that the analyzing of the building in three different areas shows different situations. The District Heating [GJ] and District Heating Load [W] in Tianjin are higher than quantity in other two areas, while the District Cooling [GJ] and District Cooling Load [W] in Piacenza shows the lowest.

The conclusion is that the internal energy consumption of the building is closely related to the external environment of the building. Under the same conditions, no matter in summer or winter, the greater the difference in temperature between indoor and outdoor, the more energy needs to be consumed.

Comparison B - three different materials of exterior wall

	Piacenza-Concrete	Piacenza-Wood	Piacenza-Metal
District Heating [GJ]	414.84	435.11	428.69
District Cooling [GJ]	126.22	139.68	134.15
District Heating Load [W]	231308.96	234411.49	233389.56
District Cooling Load [W]	93927.61	98882.59	97174.35

Summary B(for table 2)

From this table, we find that all the number of the Piacenza-Wood are the highest one. But the Piacenza-Concrete shows the opposite situation, the numbers are the lowest.

The conclusion is that among the three materials, more energy is required to heat or cool the wood material, followed by the metal material, and finally the concrete material. In contrast, for this building, concrete is more suitable for constructio