



POLITECNICO
MILANO 1863

**THE ENERGETIC IMPACT OF
BUILDINGS ON THE ENVIRONMENT**

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INTRODUCTION:



The building used for the evaluation of the energy performance is located in Borgonovo Val Tidone, Piacenza. It is a three floor residential building. On each floor, there are two apartments of 100sqm, connected with a central common stair.

We have choose this space because is one of the most common typology of building and can be easily adapted to different functions, like offices, houses...

Using OpenStudio program we are able to understand how houses and buildings in general are related with the environment, their influence on the pollution, the energy used for the conditioning, the thermal performances... This kind of program is useful also to know what we can change to obtain a better performance, or what are the best design solution.

THE PROCESS:

Is necessary to have the plan of the building, in order to start using the programs in this sequence:

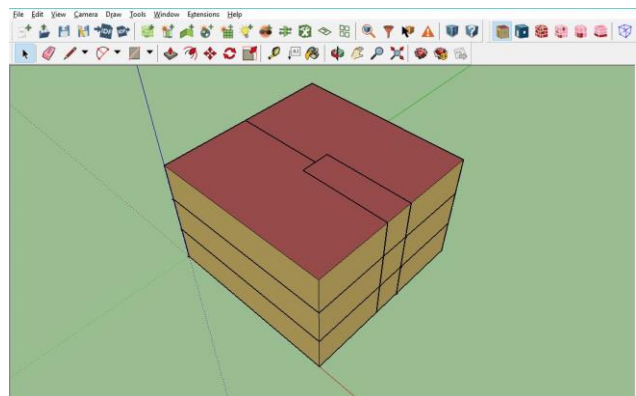
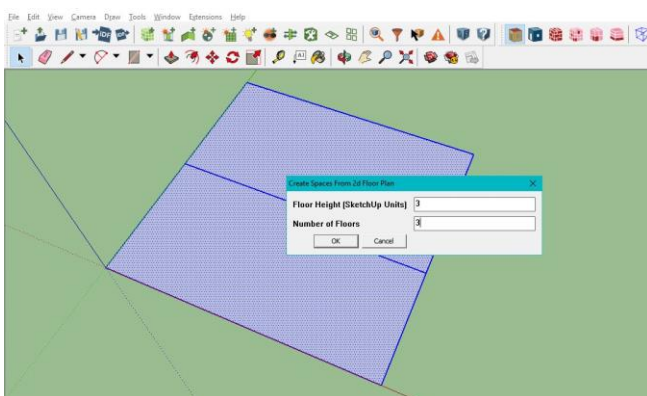
- 1) Sketch-Up (with the OpenStudio plug-in);
- 2) OpenStudio;

We have designed the shape of the building dividing the apartments from the stairwell.

1_ SKETCH-UP

STEP 1 - CREATE THE FLOORS

After the plan of the building is drew, selecting the command *"Create spaces from diagrams"* the program automatically generate the extruded volume of the entire building with the specific height for each floor.

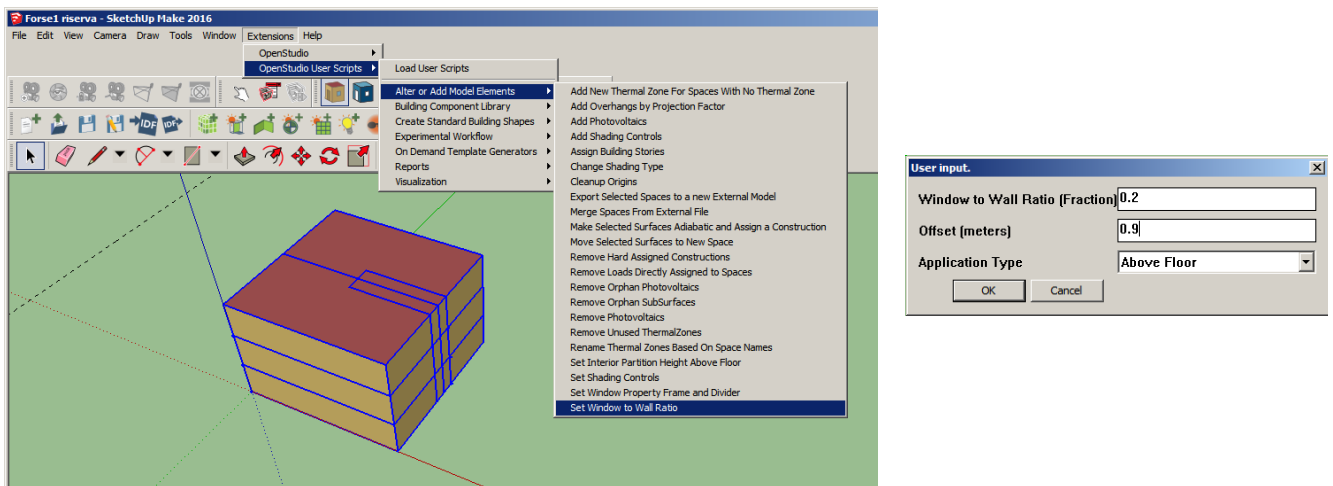


STEP 2 - MATCH MODEL

Then the entire building is made as a one component, letting the program recognize the external and the internal walls separately, using the surface matching tool, matching in entire model.

STEP 3 - PLACE THE WINDOWS

Then in the set of command "Extension", is possible to add elements to the model, in this case is used the command "Set Window to Wall Ratio". Is calculated the total area of the external walls ($A = 504 \text{ sqm}$) and the area of the openings to obtain the percentile ratio ($A = 138 \text{ sqm}$). Considering the presence of 36 openings in the all building, the ratio which we have to use is 0,2 (20%).

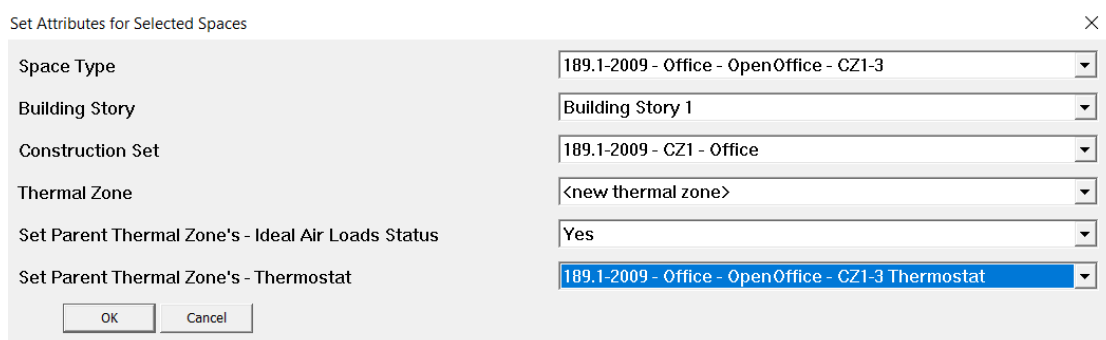


STEP 4 - SPACE TYPE

After, the building is divided in different type of space to define the function for each space. To do that is selected "Set attributes for selected spaces", but only for the first three parameters (space type, building story, construction set). In this case the building is divided by apartments and stairwell.

STEP 5 - THERMAL ZONE

This time, selecting again each apartment one by one, are changed, in the list of the same command "Set attributes for selected spaces", the last three parameters about the thermal zone (Thermal zone, Set parent thermal zone's - Ideal air loads status, Set parent thermal zone - Thermostat).

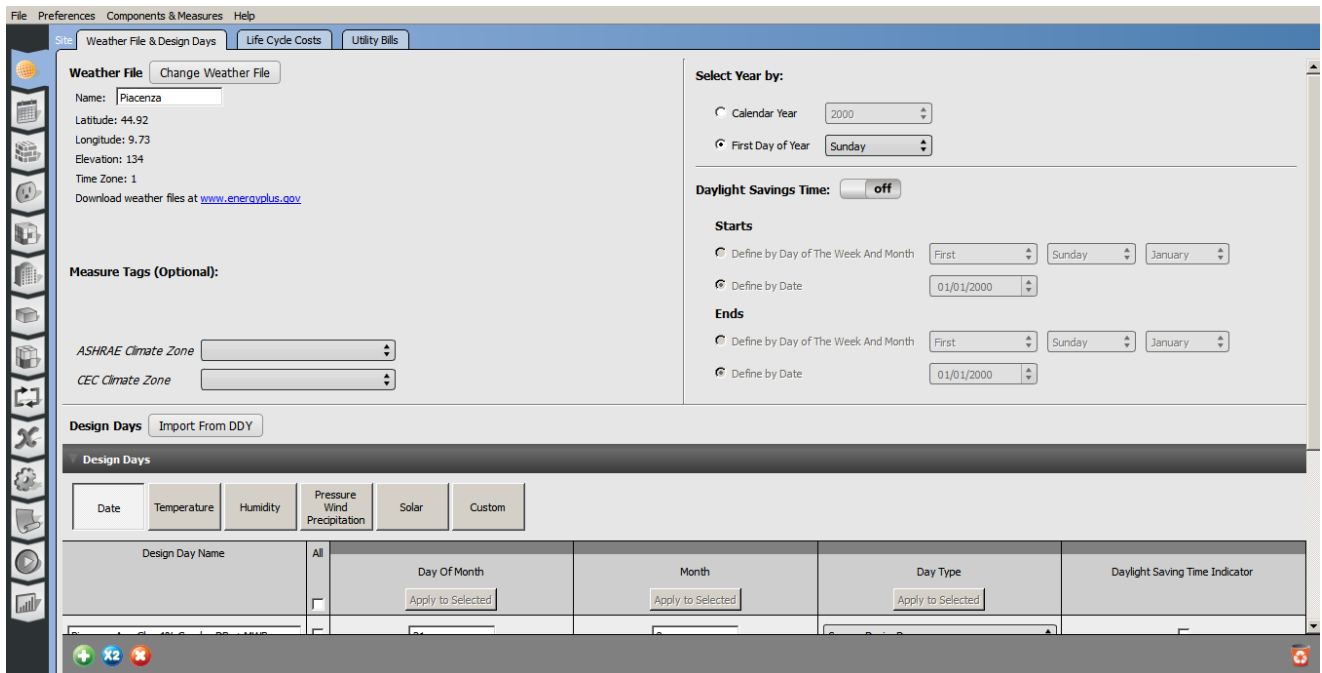


2_ OPEN STUDIO

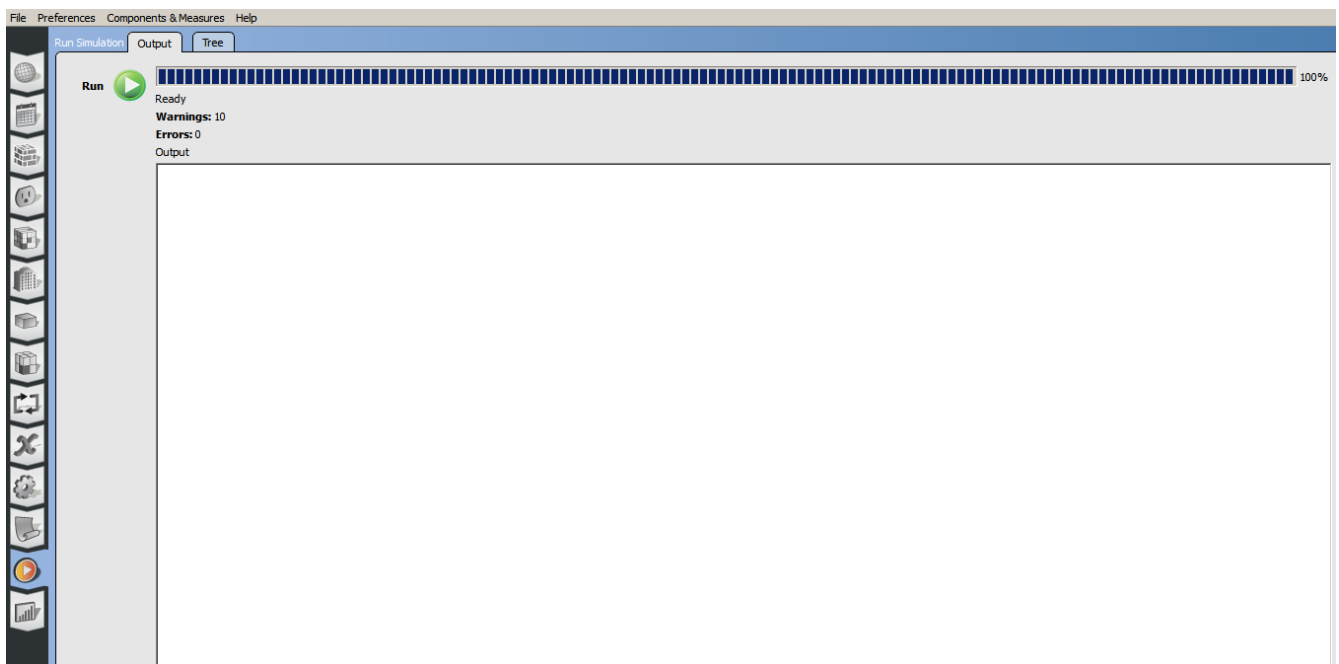
STEP 1 – WEATHER DATA

The first thing to do is launching the program OpenStudio from Sketch-Up. Then, in the page “Site”, is necessary to locate the building, in this case Piacenza, inserting the Weather file (.epw) and the Design Days (.ddy). In this way is possible to know the hottest and the coolest day of the year and have a range of weather data.

N.B. The Weather files can be easily found on the EnergyPlus web site (<https://energyplus.net/weather>).

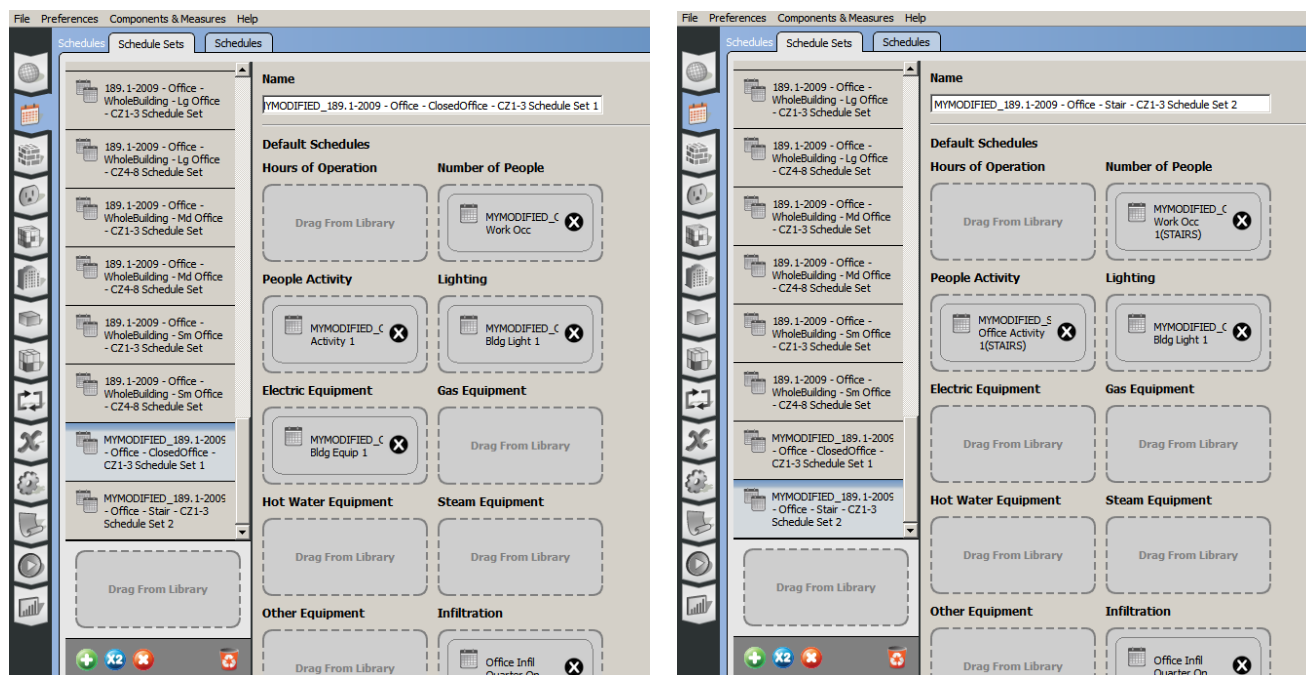


After the run of the simulation and the end of the process, it can be visible an initial result summary that contains the project's data.

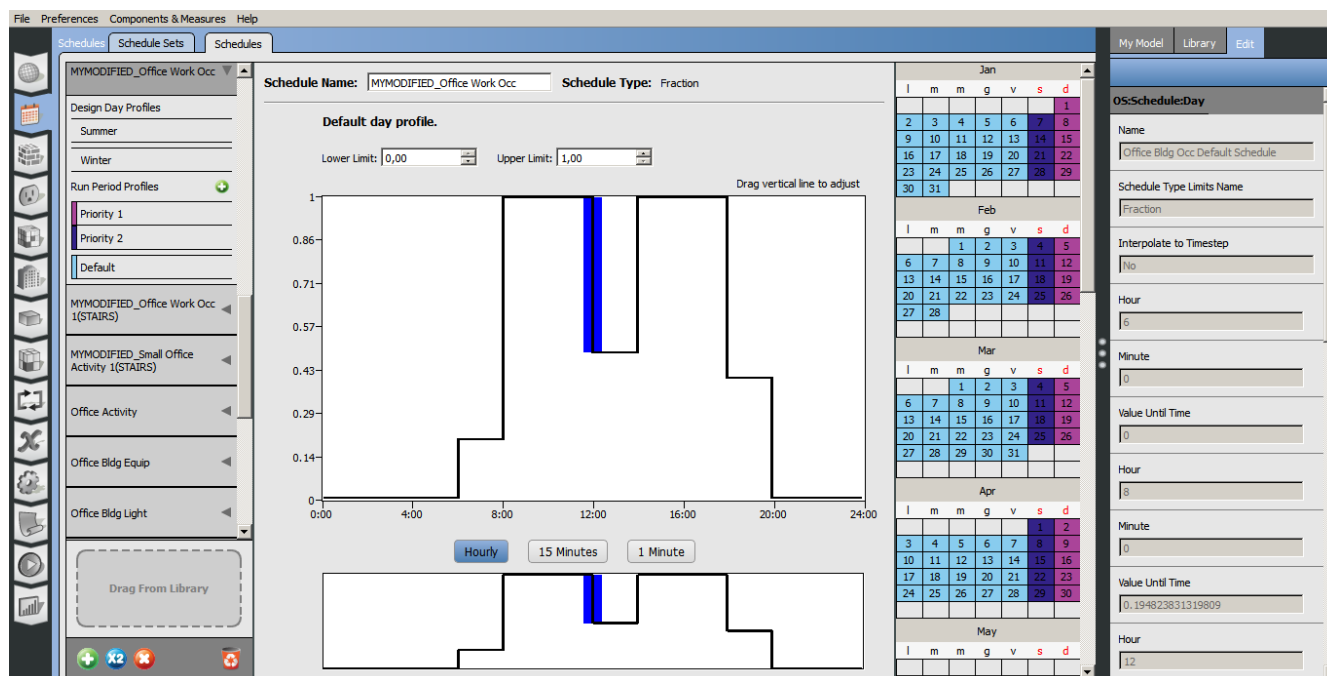


STEP 2 - INSERT ACTIVITY

The second step is to insert, for each thermal zone typology, the personalized “*Schedule Set*” about Number of People, People activity, Lightning equipment, to take also in account the energy produced by people and their activities in the different moments of the day and during the year.



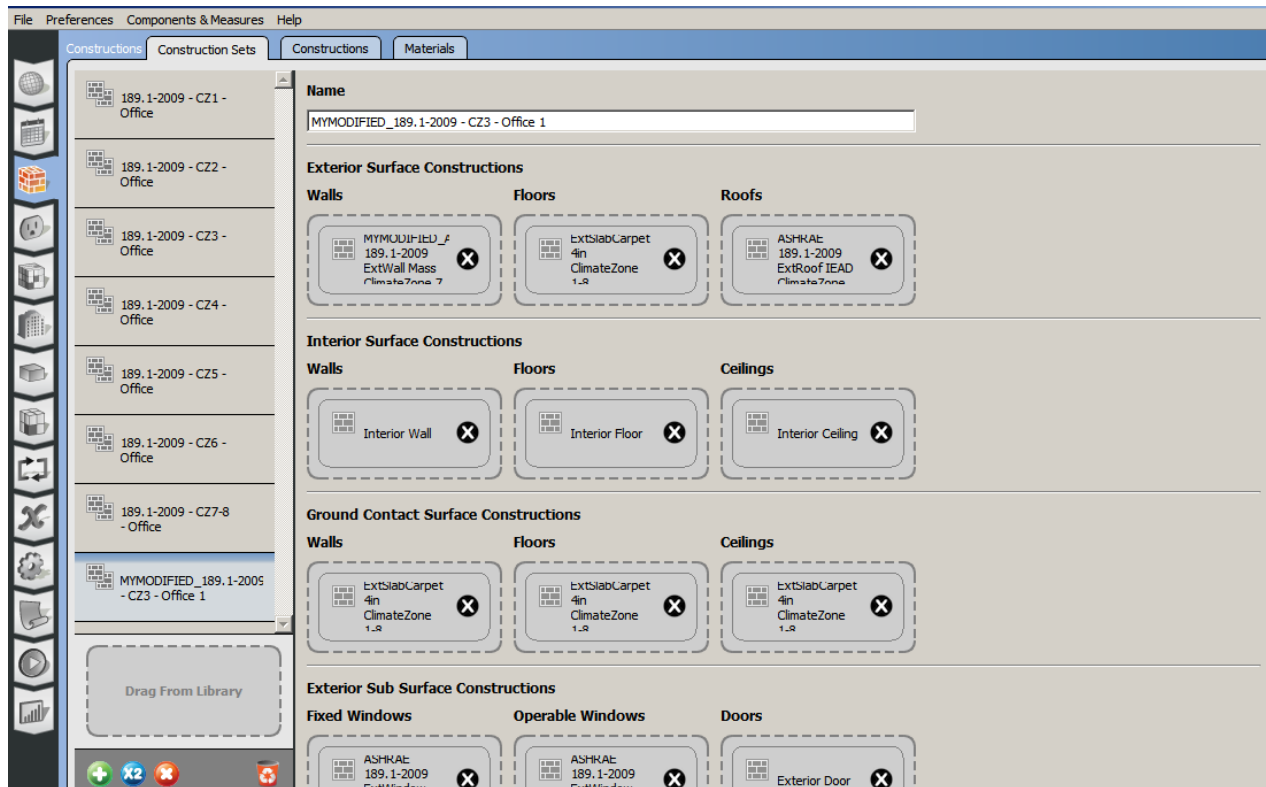
Is possible to change and personalize the hours of activity, the occupation of the different spaces, the use of the lights... according to the calendar.



STEP 3 – INSERT CONSTRUCTION

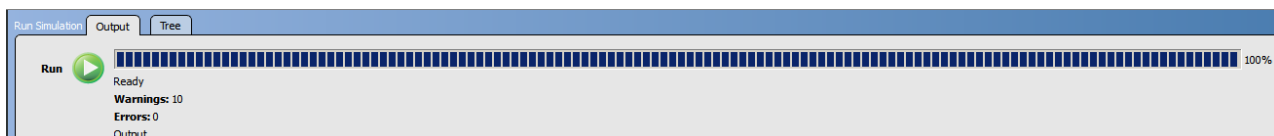
Then is necessary to insert the personalized “Construction Set” about Exterior Surface Construction and Exterior Sub Surface Construction, to take in account the stratigraphy of the walls, the openings and the use of the insulating materials.

N.B. in the program is possible to use only windows with one glass of 3mm.



STEP 4 – RUN SIMULATION

Running the simulation are obtained the final results.



N.B. The program gives the results in Btu (British Thermal Unit).

1 Btu = 252 cal 1 Btu = 1,055056 kJ 1 W = 3,412 Btu/h

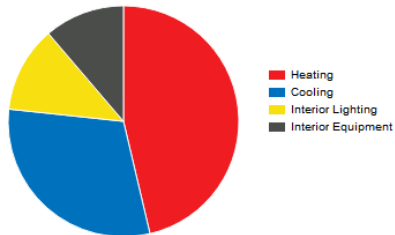
Building Summary		
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	533,678	kBtu
Total Building Area	2,110	ft²
EUI (Based on Net Site Energy and Total Building Area)	252.96	kBtu/ft²
OpenStudio Standards Building Type	Office	

Net site energy =
563060,097Kj
Total Area = 600 sqm

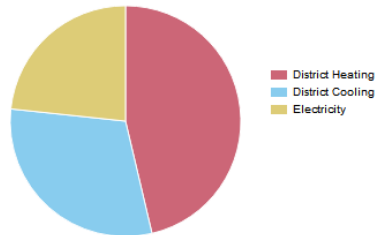
Weather Summary

	Value
Weather File	Piacenza - ITA IGDG WMO#=160840
Latitude	44.92
Longitude	9.73
Elevation	440 (ft)
Time Zone	1.00
North Axis Angle	0.00
ASHRAE Climate Zone	

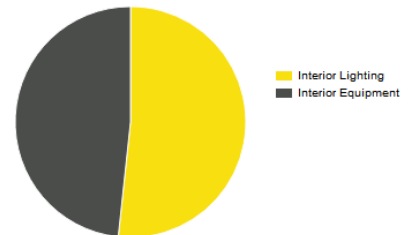
End Use - view table



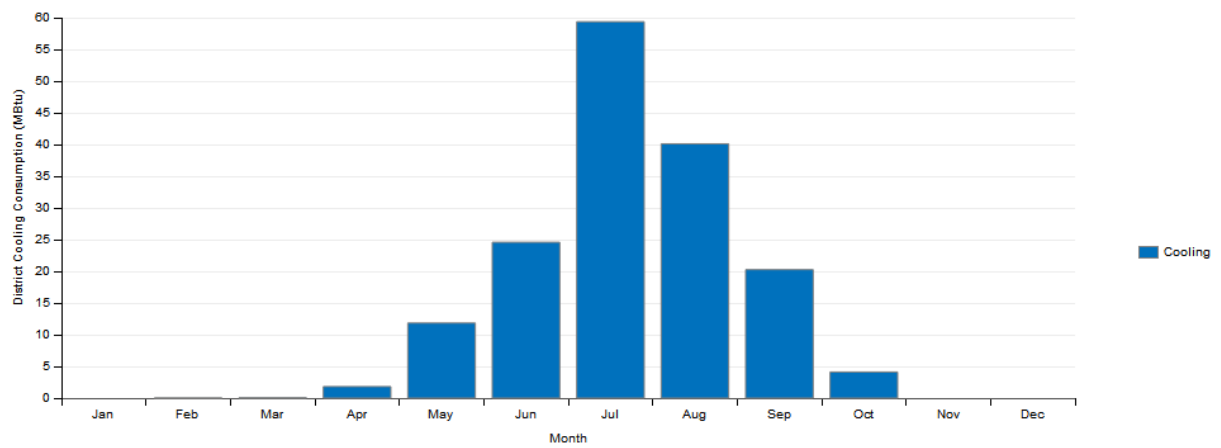
Energy Use - view table



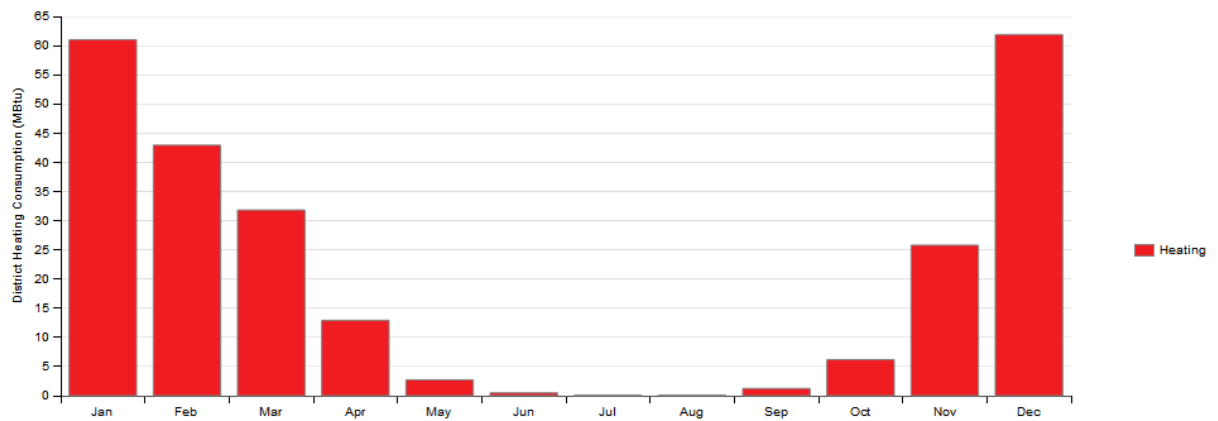
EUI - Electricity - view table



District Cooling Consumption (MBtu) - view table



District Heating Consumption (MBtu) - view table



STEP 5 - CHANGE LOCATION

Changing location from Piacenza to another city is possible to see how this kind of building works in a different location, with different weather data.

The initial step is to change the weather files, so inserting the (.epw) and the (.ddy) files, in this case are used the data of St. Petersburg, Russia.

The screenshot shows the 'Weather File & Design Days' tab in the OpenStudio software. The 'Weather File' section on the left shows the location 'SAINT-PETERSBURG' with coordinates (Latitude: 59.97, Longitude: 30.3) and elevation (4). The 'Design Days' section shows the 'Import From DDY' button. The 'ASHRAE Climate Zone' is set to '1' and the 'CEC Climate Zone' is set to '1'. The 'Daylight Savings Time' is set to 'off'. The 'Design Days' table is visible at the bottom, showing columns for Date, Temperature, Humidity, Pressure, Wind, Precipitation, Solar, and Custom.

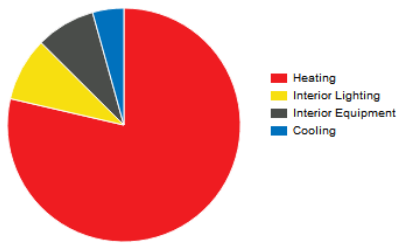
Running again the model, we obtain the result for the new location.

Building Summary		
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	729,772	kBtu
Total Building Area	2,110	ft²
EUI (Based on Net Site Energy and Total Building Area)	345.91	kBtu/ft²
OpenStudio Standards Building Type	Office	

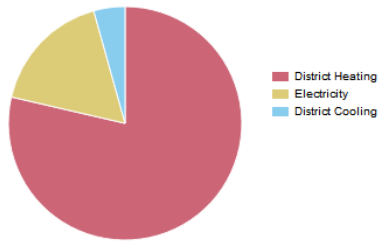
Net site energy =
769897,467Kj
Total Area = 600 sqm

Weather Summary	
	Value
Weather File	SAINT-PETERSBURG - RUS IWECC Data WMO#-260630
Latitude	59.97
Longitude	30.30
Elevation	13 (ft)
Time Zone	3.00
North Axis Angle	0.00
ASHRAE Climate Zone	

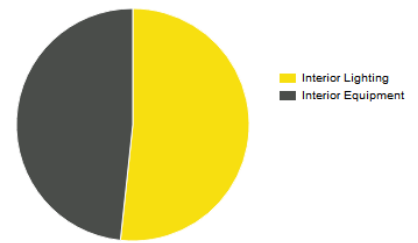
End Use - view table



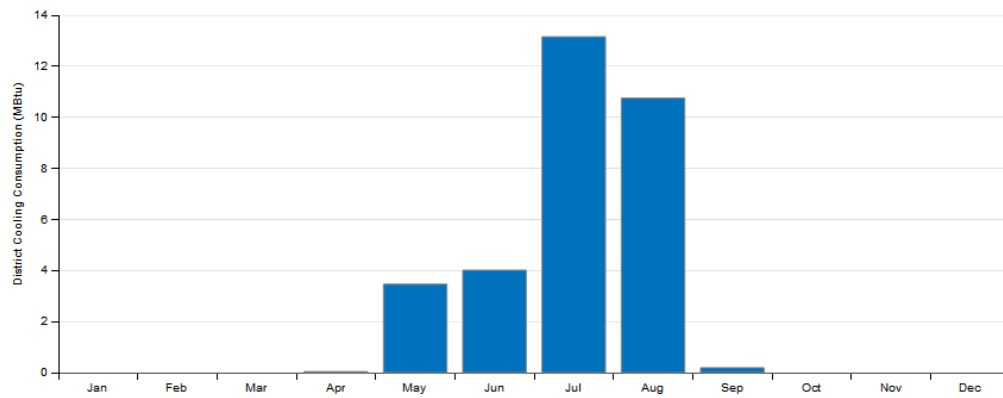
Energy Use - view table



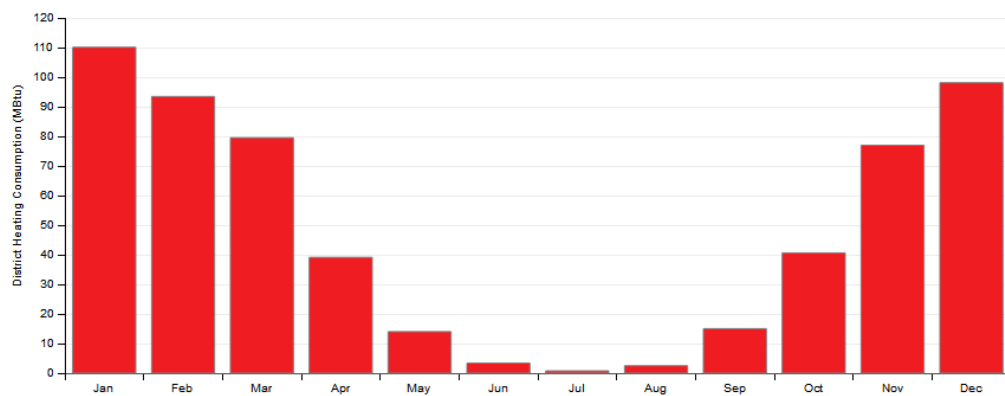
EUI - Electricity - view table



District Cooling Consumption (MBtu) - view table



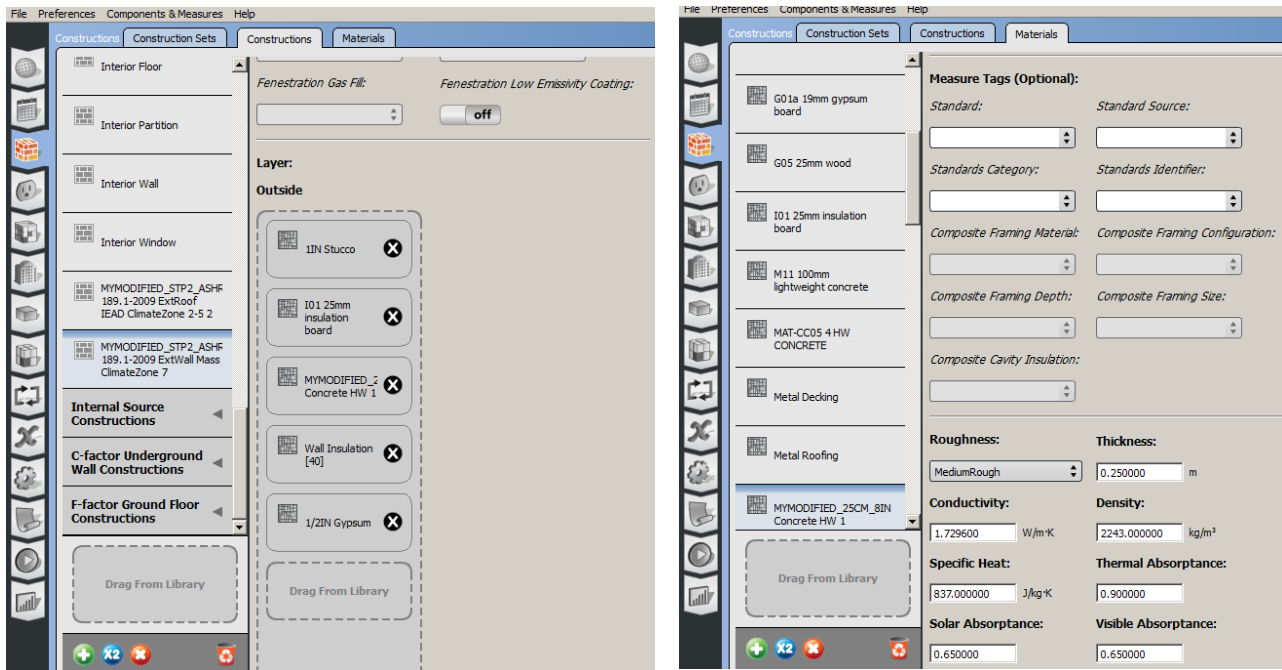
District Heating Consumption (MBtu) - view table



From these graphs is possible to see that in this location the building needs a lot of energy more than in Piacenza to heating during the winter.

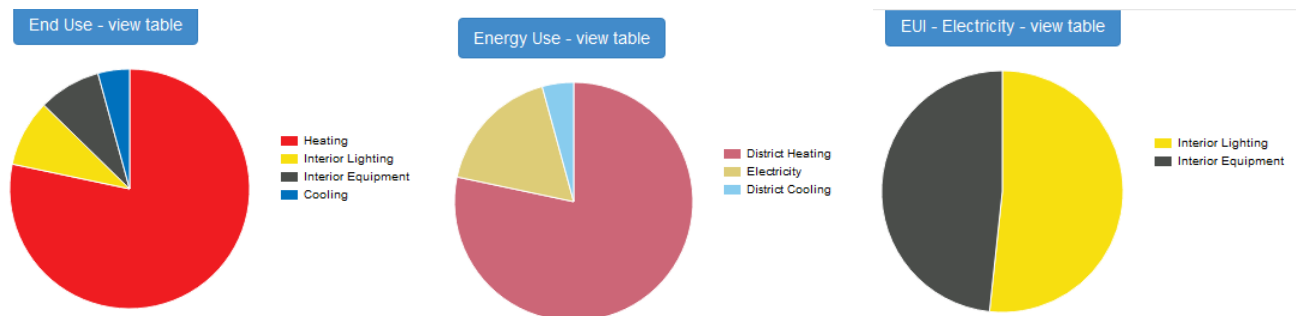
STEP 3 - CHANGE CONSTRUCTION STRUCTURES

From the last consideration, come the final step and so try to change the construction set in order to adapt the building to a different climate zone.



Building Summary		
Information		
Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	714,389	kBtu
Total Building Area	2,110	ft²
EUI (Based on Net Site Energy and Total Building Area)	338.62	kBtu/ft²
OpenStudio Standards Building Type	Office	

Net site energy =
753720,295Kj
Total Area = 600 sqm



As we could see, also changing and improving the construction and the materials of the wall, the result doesn't change so much. The impossibility of changing the windows (problem due to the program) with ones with double glasses and the air gap, causes the invariance of the result.