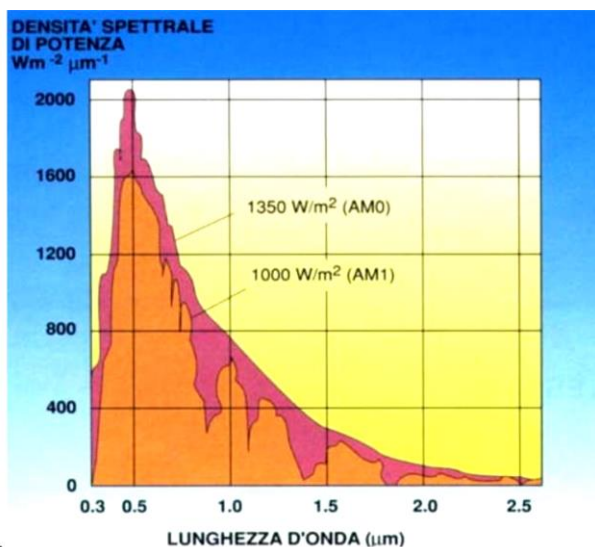


THE SOLAR RADIATION

The solar radiation is the electromagnetic energy emitted by the sun. Its wavelength field goes from 0.3 to 2.5 micrometers.

The maximum yearly average solar radiation density out of the Earth's atmosphere is the solar constant G_{sc} ($G_{sc} = 1367 \text{ W/m}^2$), which is the extraterrestrial solar irradiance (the solar radiation by the unit of receiving surface placed out of the atmosphere and perpendicular to the Sun-Earth ray).

The maximum yearly average solar radiation density on the Earth's surface is 1000 W/m^2



The characteristics of the Solar Radiation are that:

- The Solar radiation, which crosses the atmosphere to reach the Earth's surface, is modified (attenuation), both in the spectral distribution and in the total irradiance.

That is caused by the dispersion (molecular and particle scattering) and the absorption phenomena: the scattering/microscopic effect is composed of the **back reflection** and the **diffuse solar radiation** (or **diffuse irradiance**), G_d .

- The Solar radiation that isn't intercepted by molecules and maintains the incidence direction is the **direct solar radiation** or **beam radiation** or **direct irradiance**, G_b .

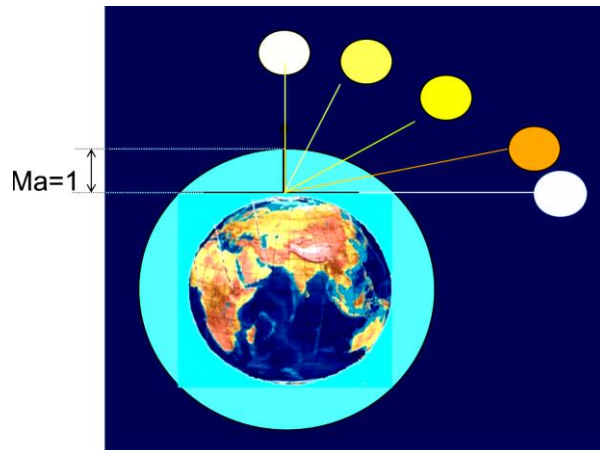
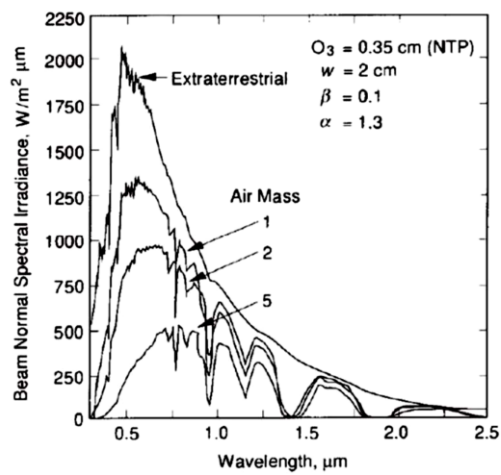
The **diffuse radiation** is when a body has the same radiation in every direction.

The **incident radiation** is everything that is receiving radiation.

The **irradiation** is the received radiation.

The Total Solar Radiation = Direct-Beam + Diffuse Radiation

Regarding the atmospheric absorption, the elements in the atmosphere that absorb the incident radiation (modifying the energetic spectrum) are especially ozone, water and carbon dioxide (absorption bands). The absorbed solar energy is finally converted into internal energy, which is then reemitted in the far-infrared in all the directions.



The solar radiation depends on:

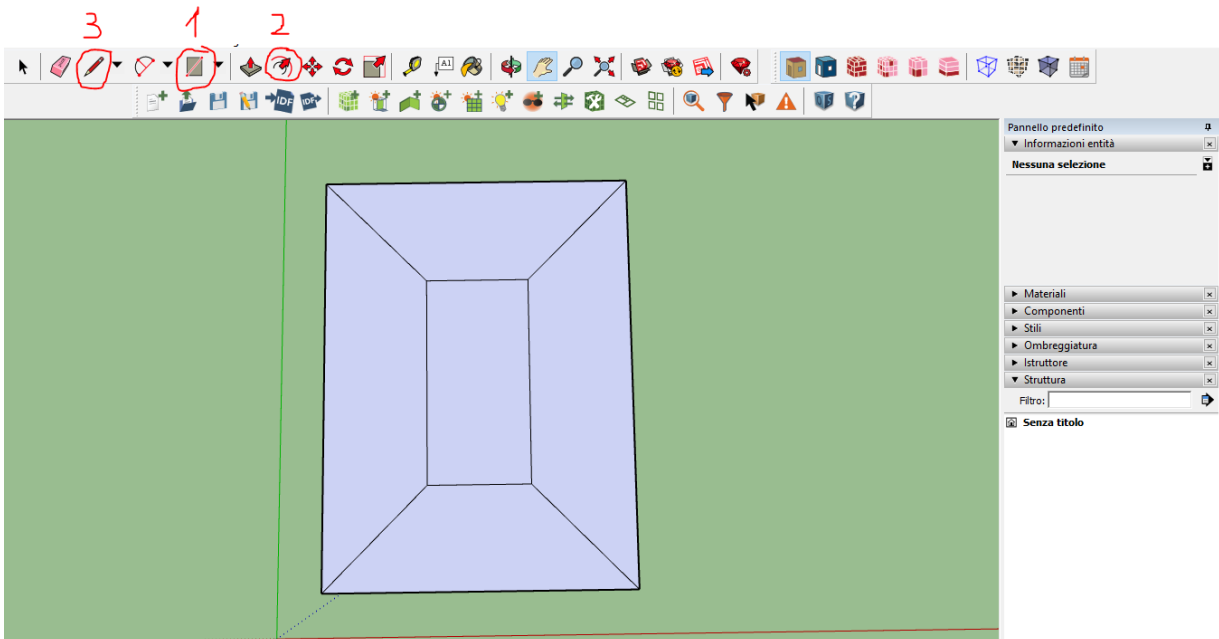
- the position of the Sun (in day and season)
- the weather condition (continental and microclimatic)
- the site altitude over the sea level
- the sunshine hours

The instrument used to measure solar radiation are:

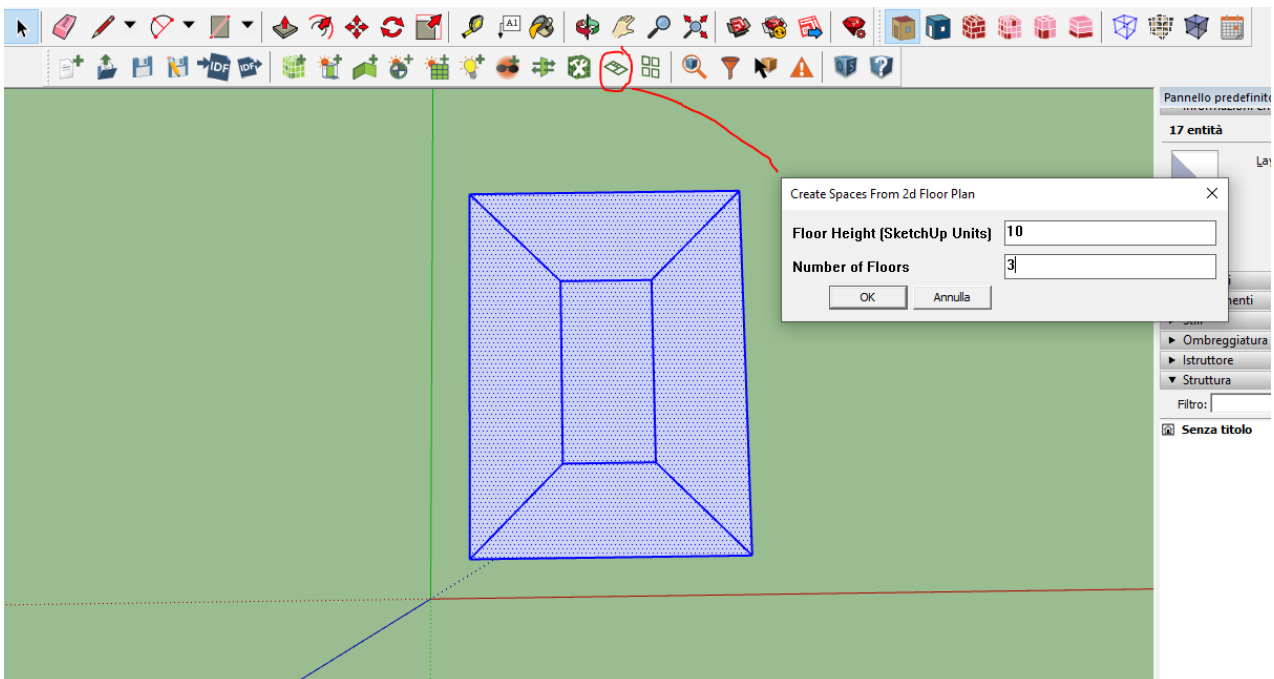
- Pyranometer: to measure the total solar irradiance (diffuse + direct)
- Pyranometer with shadow band: to measure only the diffuse irradiance
- Normal pyranometer: to measure only the normal direct solar radiation

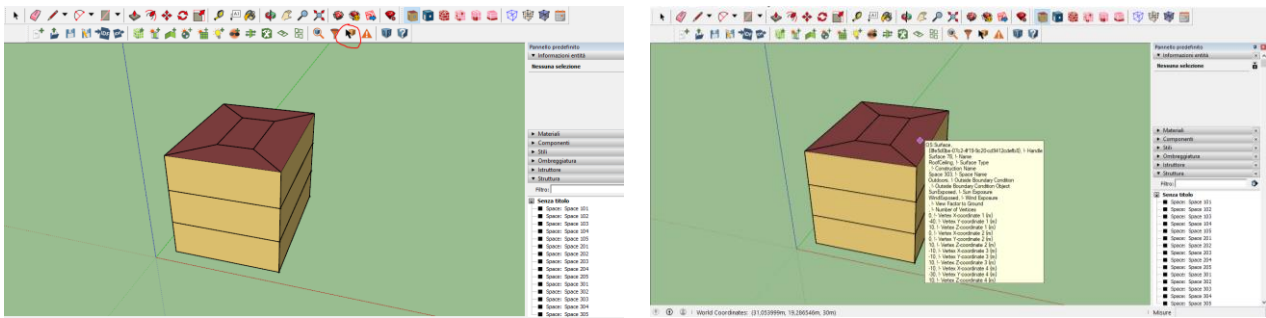
Building in Sketchup and Open Studio

Part 1 (correct)

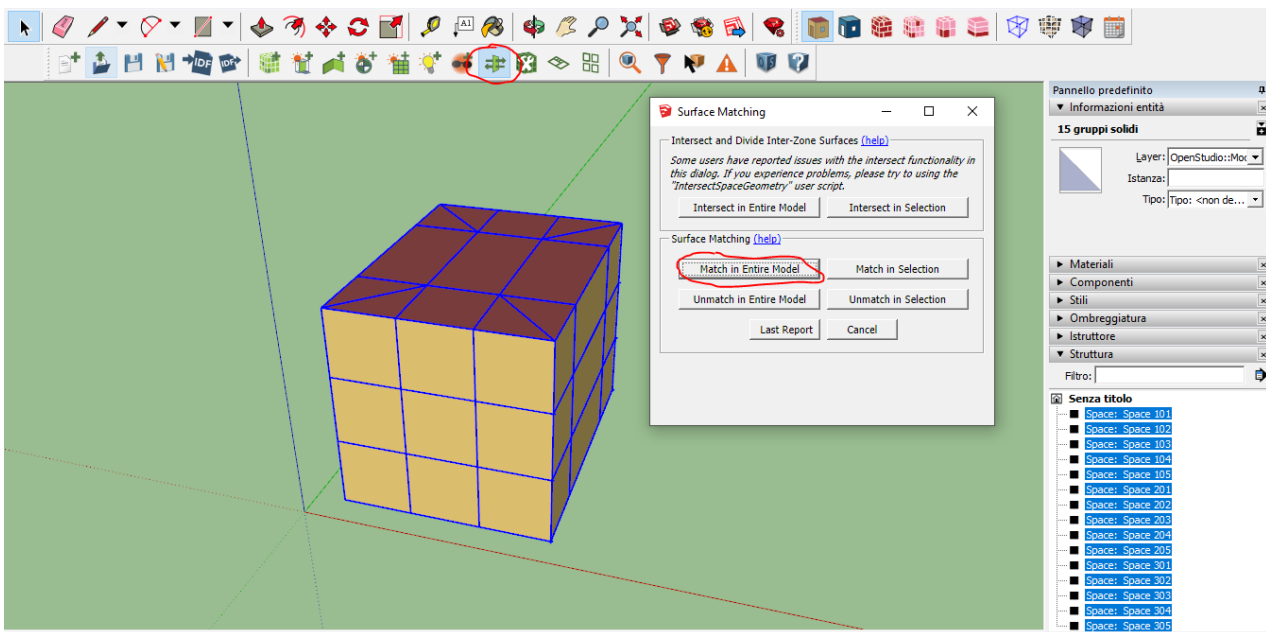


I have created a rectangular with dimension 30x40 cm using as a tool the rectangular size, offset (of 10m through the center) and the pen.

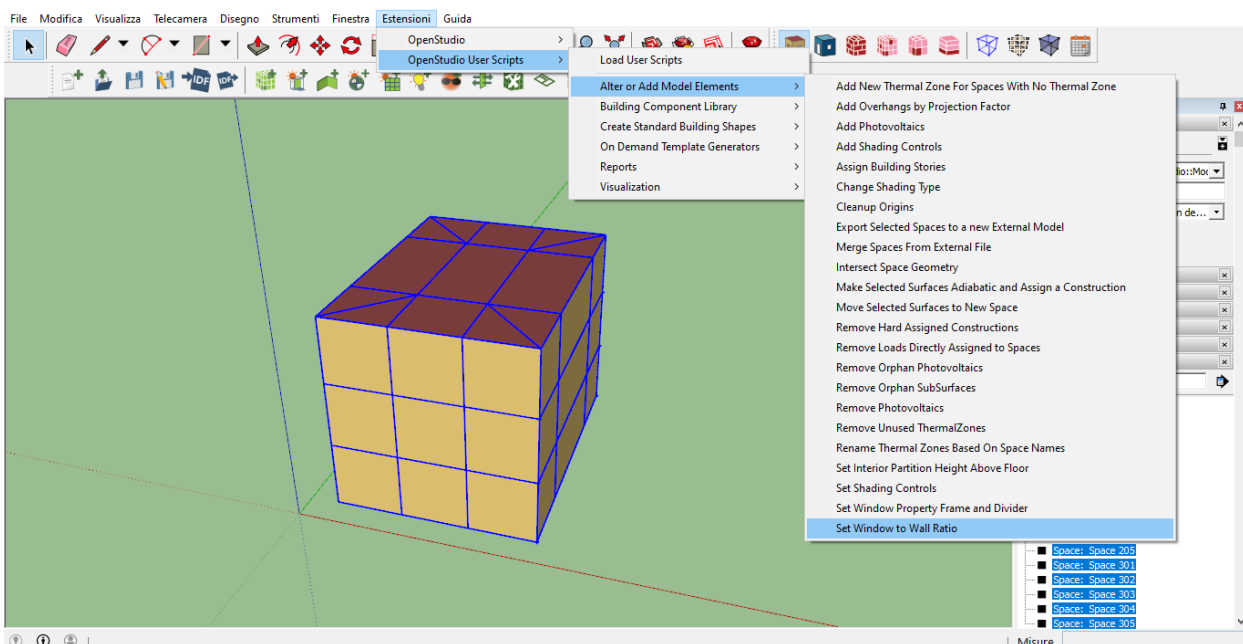


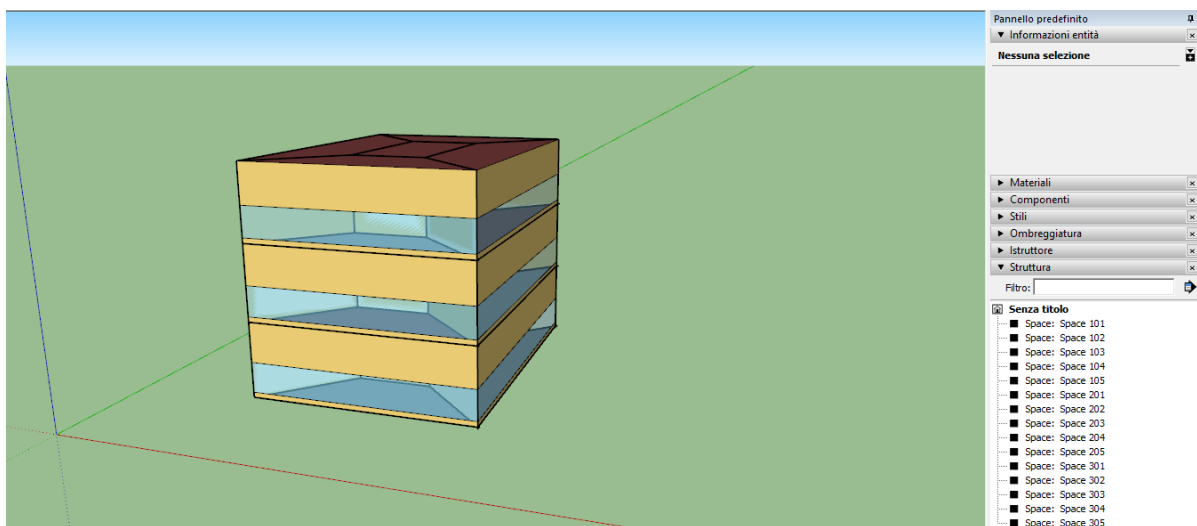
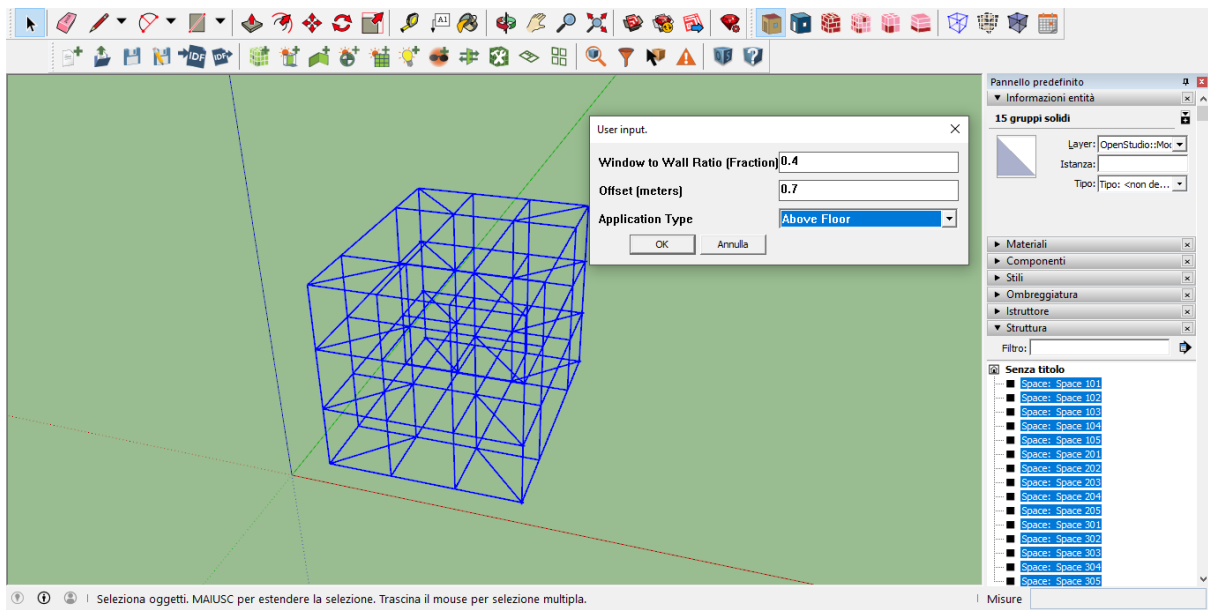


By using the tool Create Spaces From 2nd Floor Plan I have created a building of 3-floor height 10m. Selecting all the buildings and using Info Tool, I can see all the properties of each element that compose it.

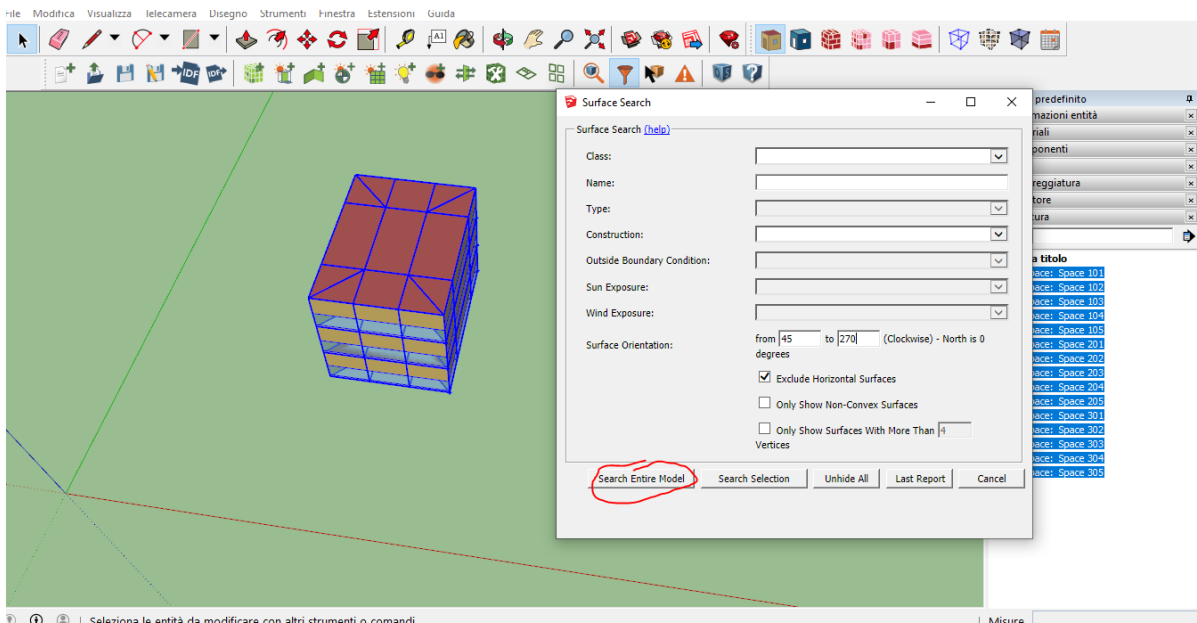


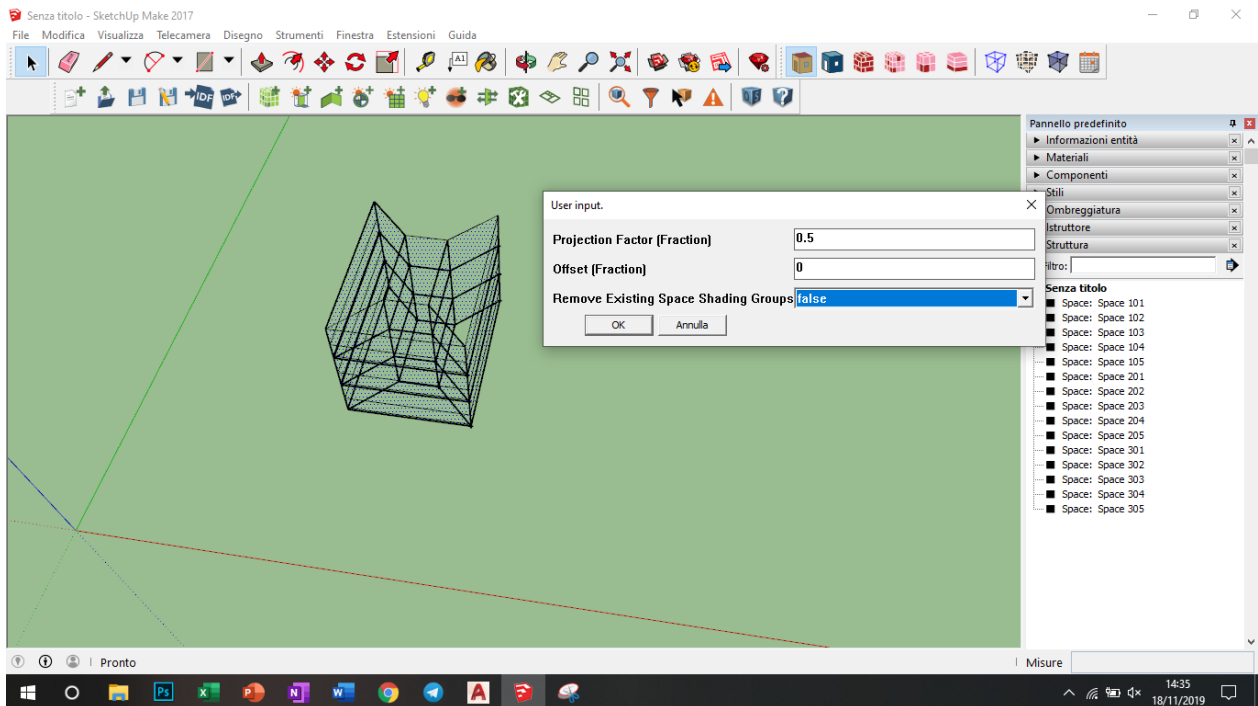
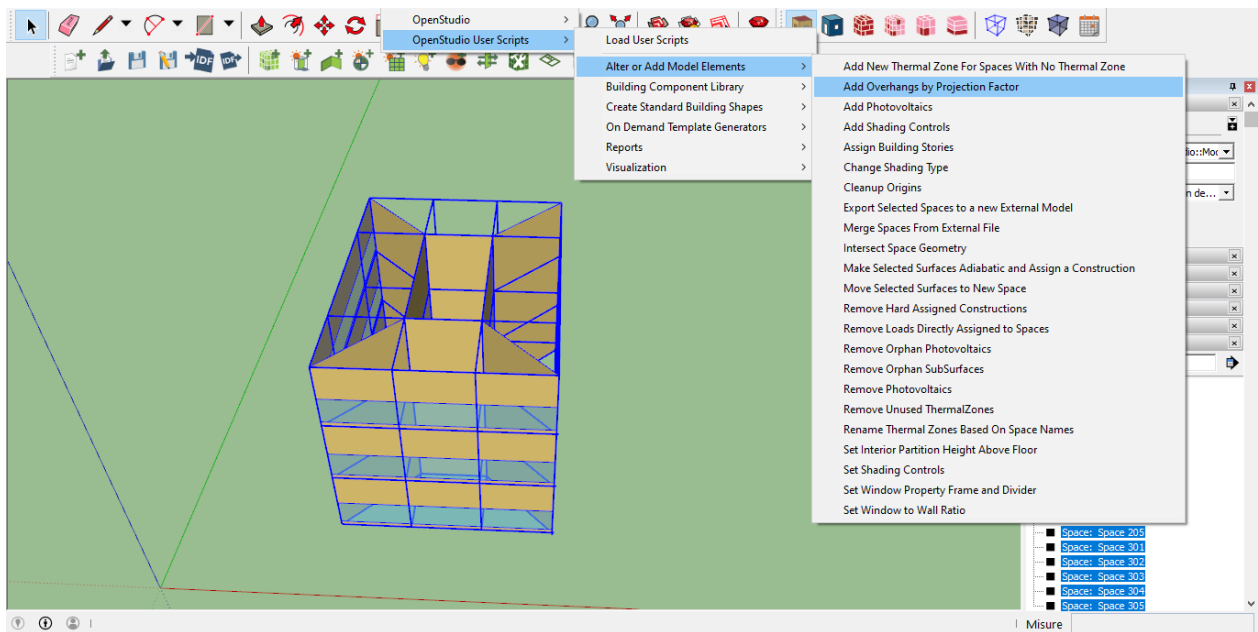
Selecting all the building >> Surface Matching >> Match the Entire Model. Doing these passages, in the following passages I won't create windows inside my building.

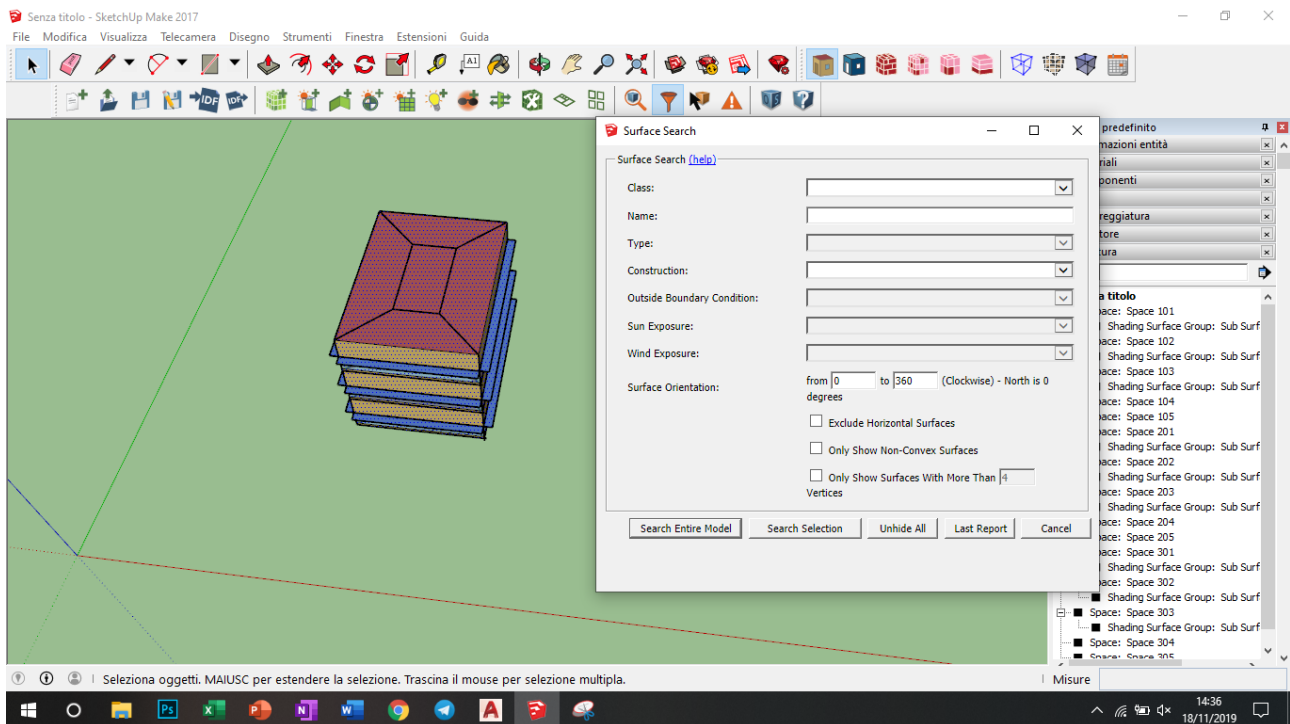




Doing these passages, I have created the windows on each surface of the building.

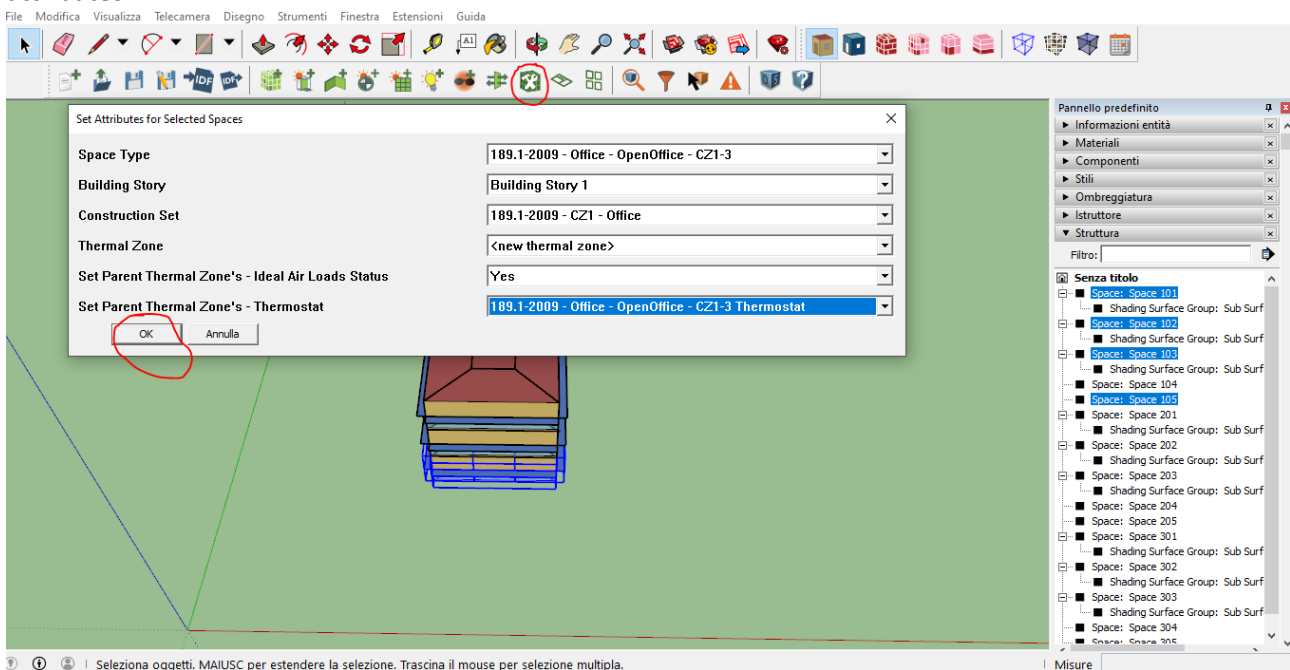




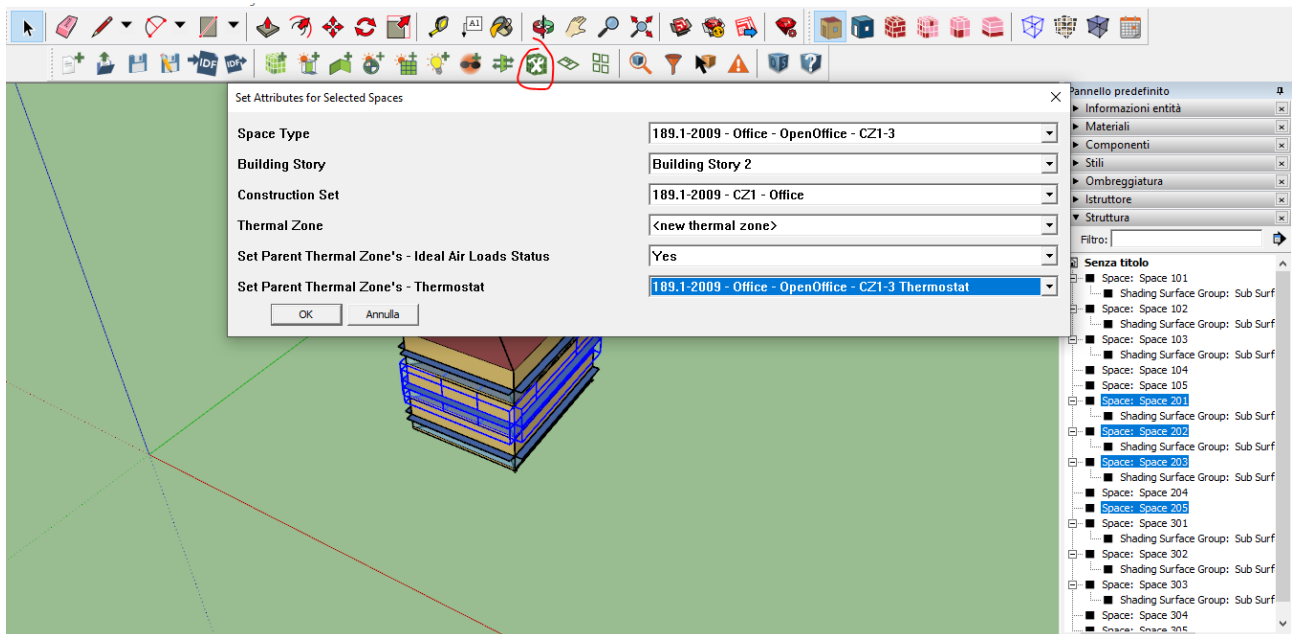
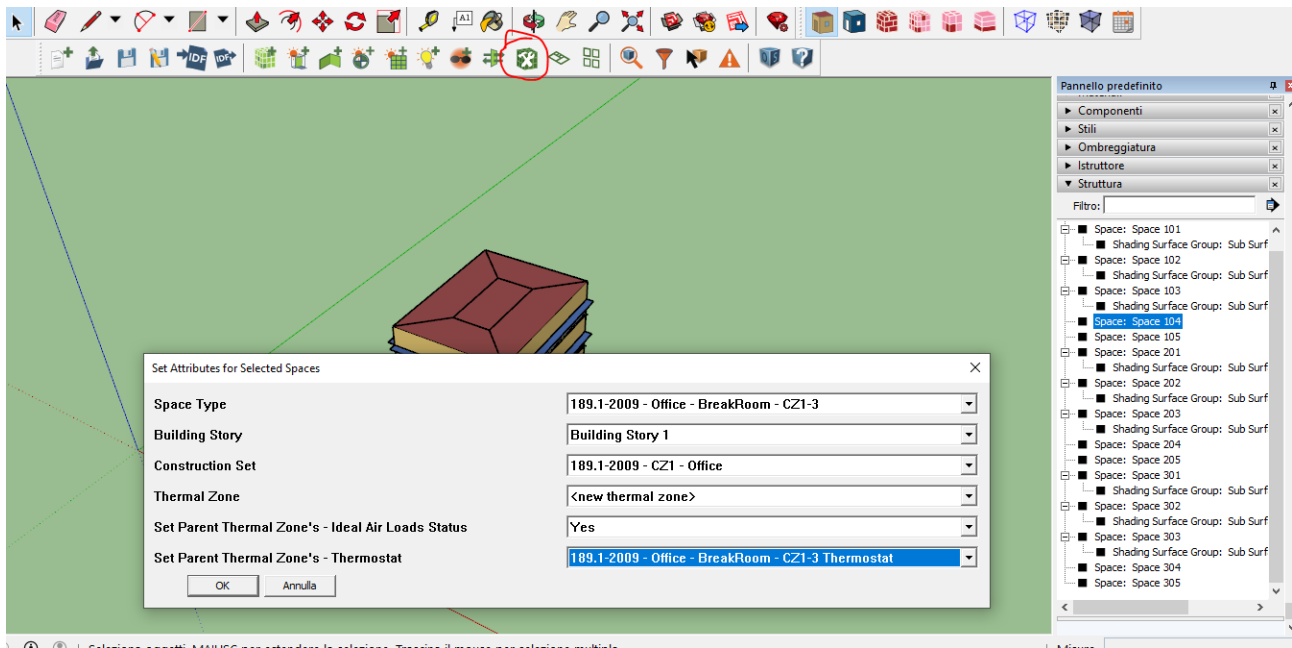


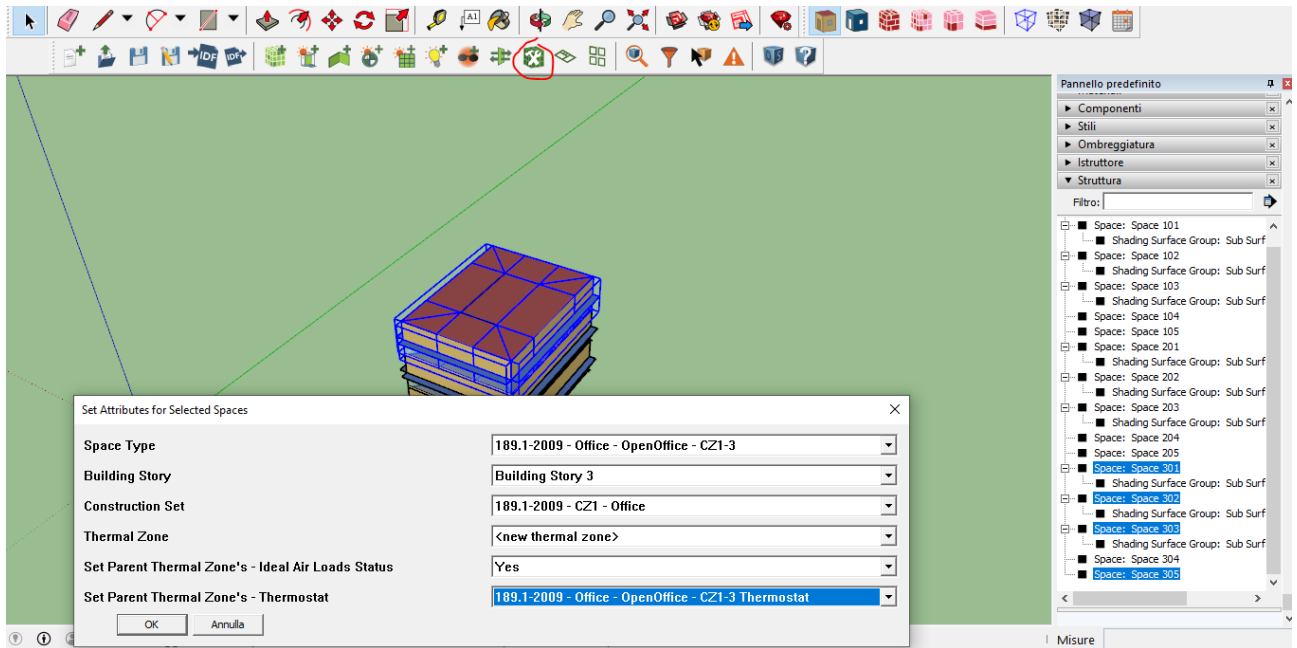
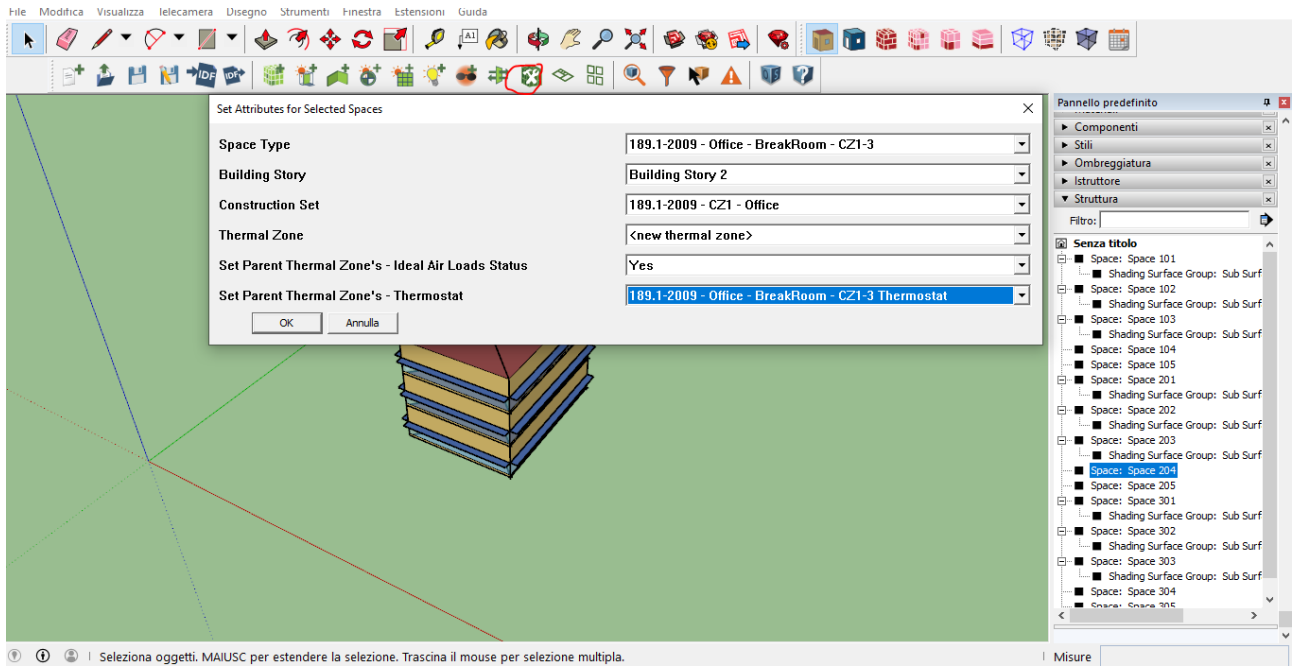
Pressing finally “Search the entire model” I am putting the overhang on all the tree surfaces excluded the north surface.

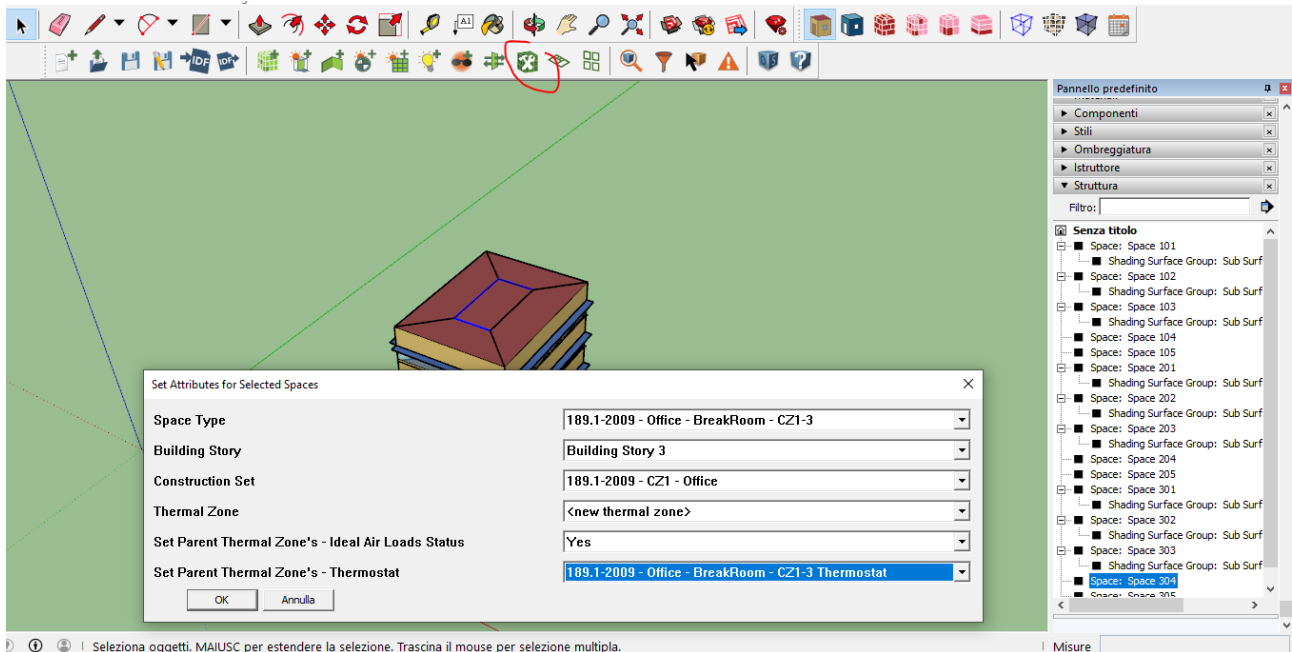
Now, by the tool “Set Attributes for Selected Spaces”, I highlight the space 101,102,103,105 and put their attributes.



I repeat this last passage for all the other spaces in order to assign to each one the characteristics.



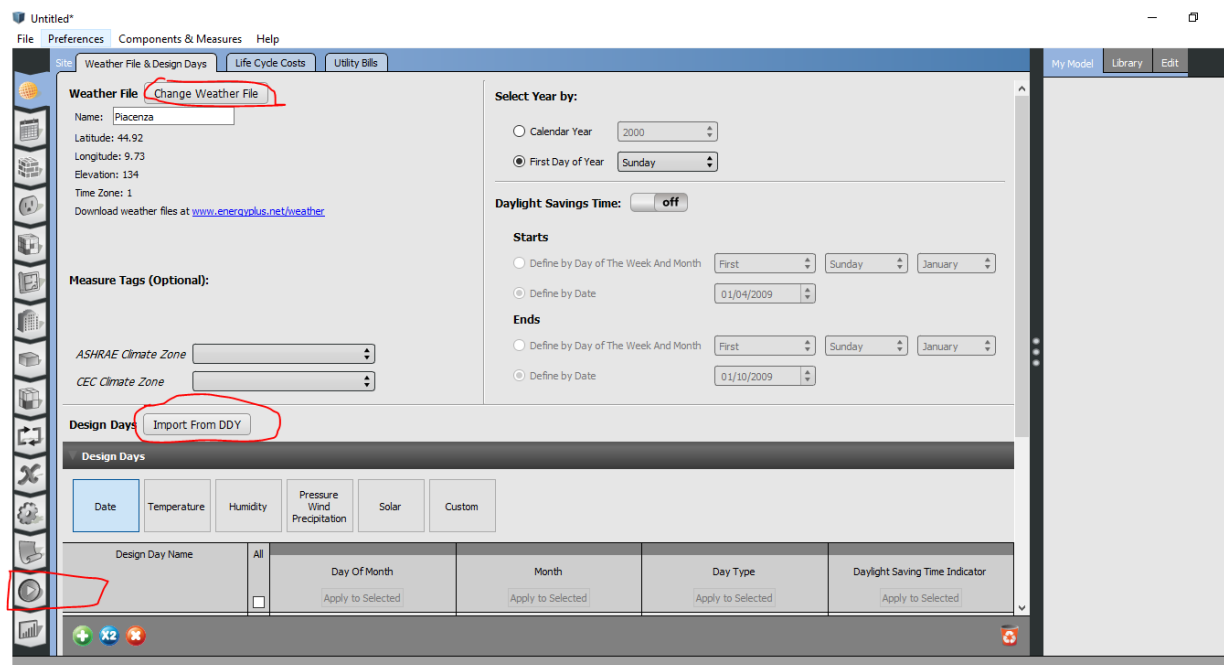




Basing of the function I want to put in the building, I can guess the number of people that will be into.

FINISH THE SKETCHUP PART.

Now I can open Open Studio, insert the file created in SketchUp and insert the Weather File and the Design Days. Doing this, I have put the coordination of Piacenza. Then, I press Run.



File
Preferences
Components & Measures
Help

Results Summary

Reports:
EnergyPlus Results

Refresh

Open DView f
Detailed Repo

Program Version: **EnergyPlus**, Version 9.2.0-921312falld, YMD=2019.11.18 15:07
[Table of Contents](#)

Tabular Output Report in Format: **HTML**

Building: **Building 1**

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

Simulation Timestamp: **2019-11-18 15:07:28**

Report: **Annual Building Utility Performance Summary**
[Table of Contents](#)

For: **Entire Facility**

Timestamp: **2019-11-18 15:07:28**

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	3288.80	913.55	913.55
Net Site Energy	3288.80	913.55	913.55
Total Source Energy	9601.31	2667.03	2667.03
Net Source Energy	9601.31	2667.03	2667.03

Here I can see the Results Summary of my building.

Part 2

File Preferences Components & Measures Help

Site Weather File & Design Days Life Cycle Costs Utility Bills

ASHRAE Climate Zone

CEC Climate Zone

Design Days

Design Days

Date Temperature Humidity Pressure Wind Precipitation Solar Custom

Design Day Name	All	Maximum Dry Bulb Temperature	Daily Dry Bulb Temperature Range	Daily Wet Bulb Temperature Range	Dry Bulb Temperature Range Modifier Type	Dry Bulb Temperature Range Modifier Schedule
acenza Ann Clg .4% Conds DB=>MWB	<input type="checkbox"/>	33.100000 MAX C	11.900000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>
acenza Ann Clg .4% Conds DP=>MDB	<input type="checkbox"/>	27.400000 C	11.900000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>
acenza Ann Clg .4% Conds Enth=>MDB	<input type="checkbox"/>	30.300000 C	11.900000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>
acenza Ann Clg .4% Conds WB=>MDB	<input type="checkbox"/>	30.100000 C	11.900000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>
Piacenza Ann Htg 99.6% Conds DB	<input type="checkbox"/>	-6.100000 MIN C	0.000000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>
in Htg Wind 99.6% Conds WS=>MCDB	<input type="checkbox"/>	5.800000 C	0.000000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>
Ann Hum_n 99.6% Conds DP=>MCDB	<input type="checkbox"/>	3.500000 C	0.000000 K	<input type="text"/> K	DefaultMultipliers	<input type="text"/>

In the first part on the left I can find all the details about my place: for example the max and min temperature in Piacenza, its humidity, its pressure-wind precipitation and the solar.

File Preferences Components & Measures Help

Constructions Construction Sets Constructions Materials

My Model Library Edit

Constructions

Name

189.1-2009 - CZ1 MY NEW Office 1

Exterior Surface Constructions

Walls Floors Roofs

ASHRAE 189.1-2009 ExtWall Mass ClimateZone 1

ExtSlabCarpet 4in ClimateZone 1-2

ASHRAE 189.1-2009 ExtRoof IEAD ClimateZone 1

Interior Surface Constructions

Walls Floors Ceilings

Interior Wall

Interior Floor

Interior Ceiling

Ground Contact Surface Constructions

Walls Floors Ceilings

ExtSlabCarpet 4in ClimateZone 1-2

ExtSlabCarpet 4in ClimateZone 1-2

ExtSlabCarpet 4in ClimateZone 1-2

Exterior Sub Surface Constructions

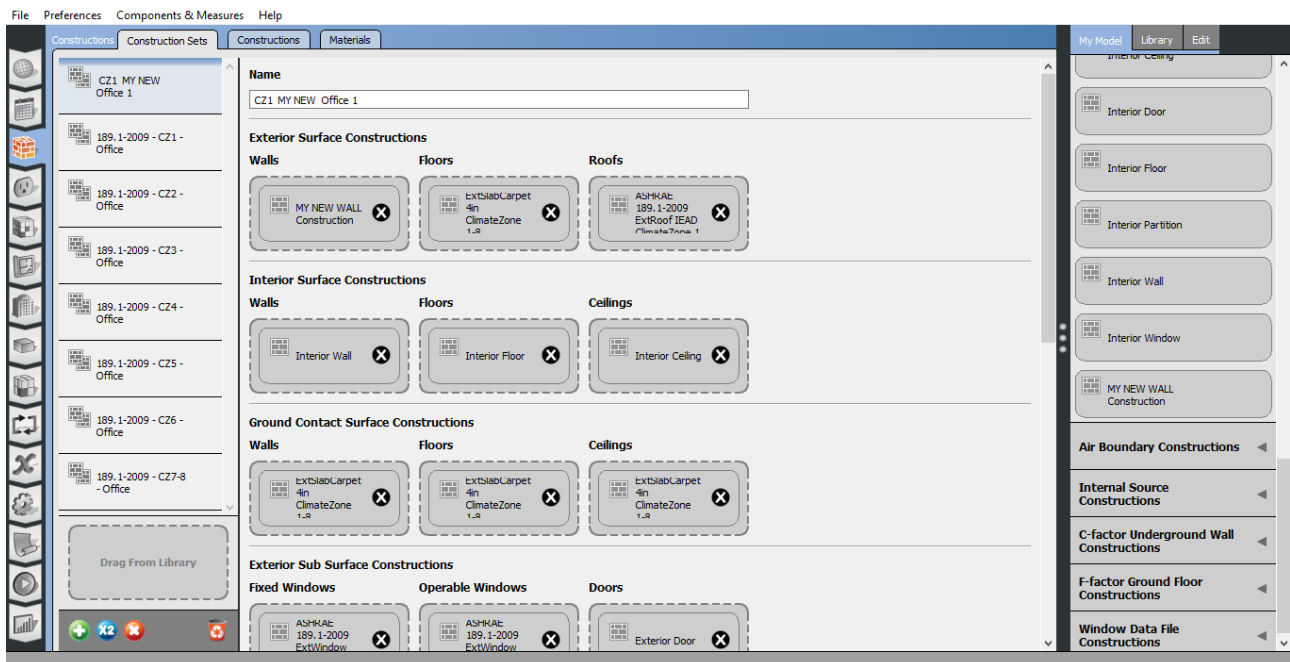
Fixed Windows Operable Windows Doors

ASHRAE 189.1-2009 ExtWindow

ASHRAE 189.1-2009 ExtWindow

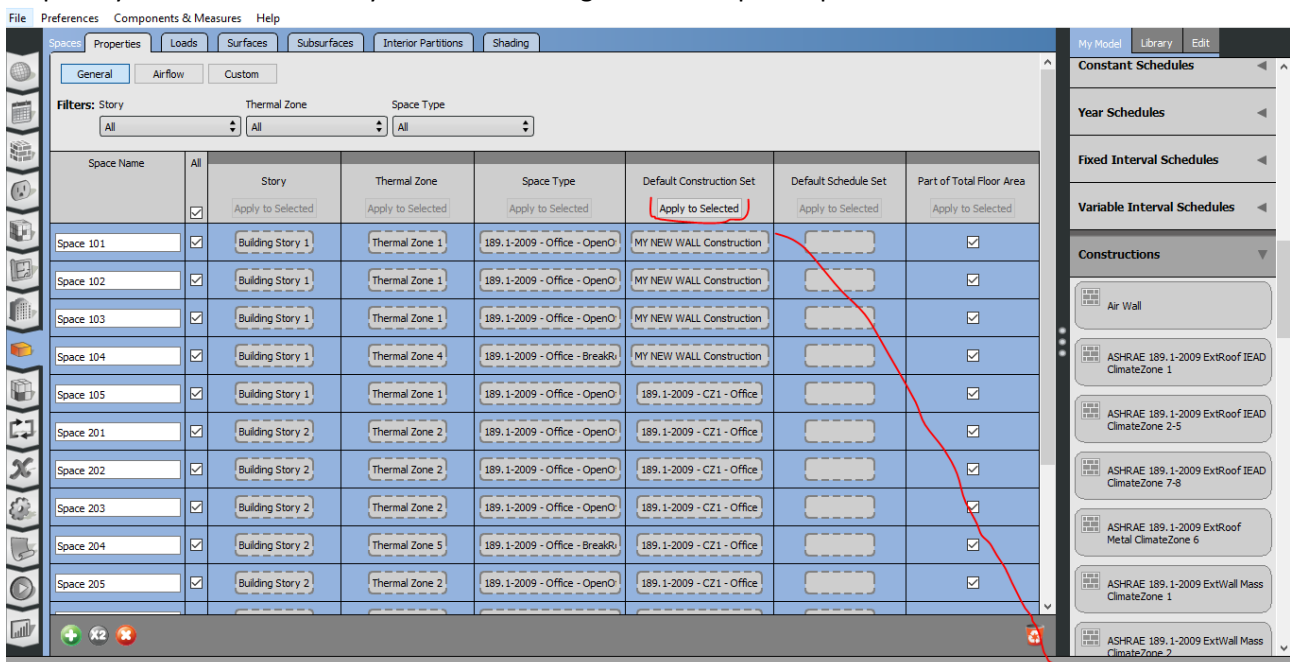
Exterior Door

To define the construction of all of the components of the building, I need to go in the third part on the left in the Construction Sets. I then create a duplication of the first component

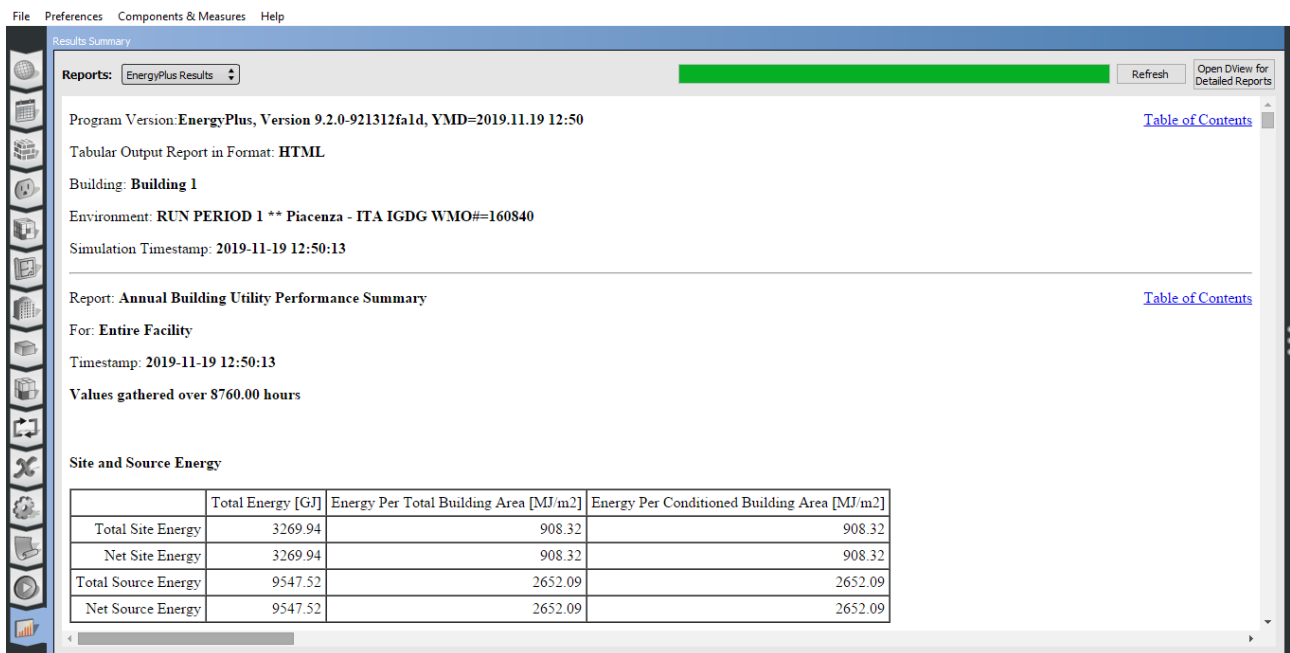


Going on Construction Set I replace the walls (and the eventual all the new elements I have to create) with my new wall with the layers I have chosen before.
But at this moment, I haven't already changed and put my material in my building.

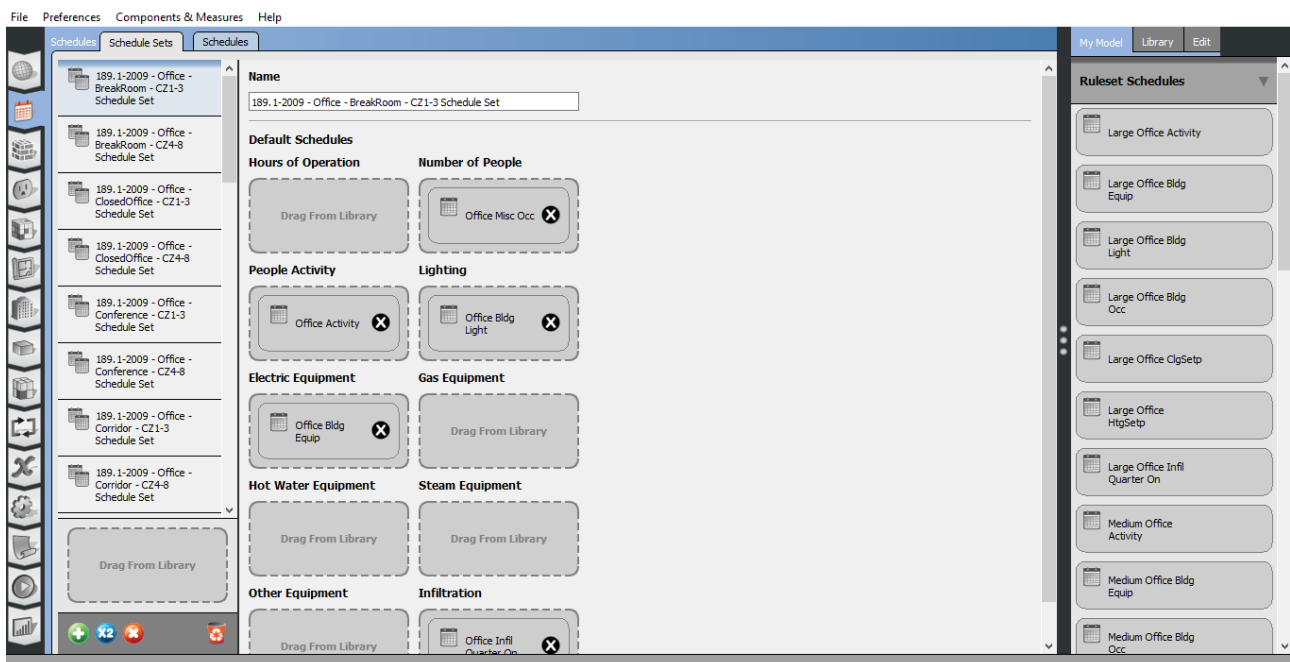
To put my modification into my model I have to go in the left part "Spaces"

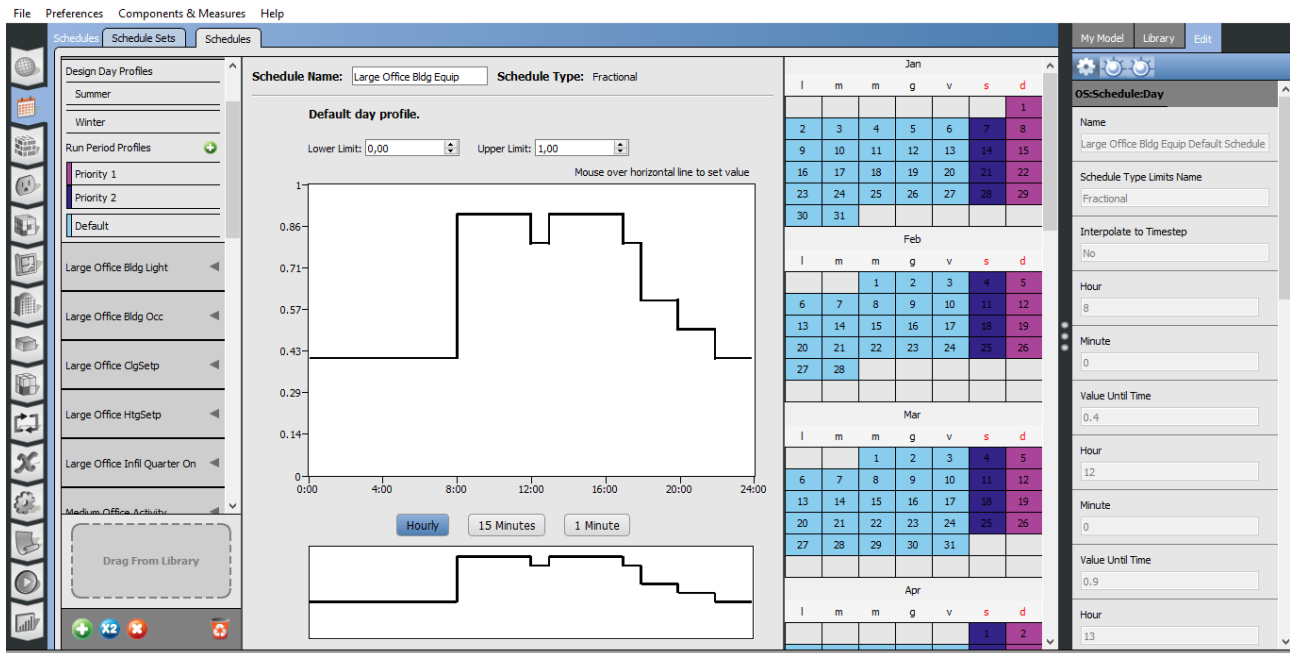


To insert my new wall replacing the existing I go in the "Spaces" part, in the fourth column I select all the element I want to replace and in the right area "Model", going in the Constructions part, I choose my new element and I put it in the Default Construction Set.
Click on Apply to Scheduled, I finally modify my SketchUp building with my new materials.



Here I can see the new Results Summary of my building.





In this section, I can see the Schedule Sets of my building, and in the Schedules part, I can change the amount of loads during the year and in all the different functions.