

SOLAR RADIATION:

Solar radiation, often called the solar resource, is a general term for the electromagnetic radiation emitted by the sun. Solar radiation can be captured and turned into useful forms of energy, such as heat and electricity, using a variety of technologies

Solar radiation is the main source of light and heat on the planet. Solar radiation is also the source of energy for all the photosynthesis processes in the growing world as well as for all atmospheric and oceanic processes - vital processes for life on Earth.

This integrated solar irradiance is called **solar irradiation, solar exposure, solar insolation, or insolation**.

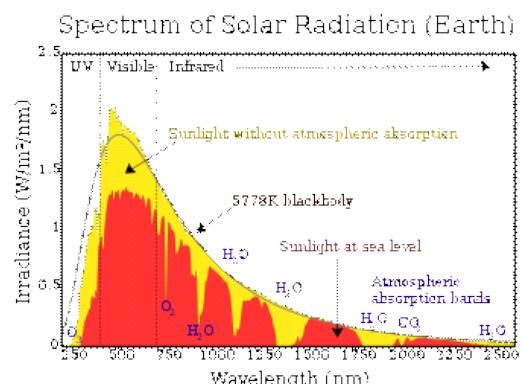
Radiation stability

The sun's radiation is very stable and almost unchanged, although in the sun, as with other stars of similar age, composition and size, there are many processes and changes. The most notable and recognizable change is the sunspots whose average intensity and total number vary in 11-year cycles, but are still unexpected. This stability has previously led to the definition of the solar constant, which is the average solar radiation source when the Earth is at an average distance from the sun. This constant was defined as 1.3 kW per square meter. Today, when accurate power measurements are possible (made on satellites), it is known that the sun's radiation is constantly changing, but to a small extent - a few tenths of a percent. Although there is a clear correlation between the periodicity of sunspots and slight changes in solar radiation, there is no clear understanding of how these phenomena affect the climate.

Although the emission from the sun is almost constant, the changes in radiation coming to us may be larger, due to atmospheric changes. The hole in the ozone and the greenhouse effect are two cases where atmospheric changes change the radiation that reaches the Earth.

Solar radiation spectrum

The surface temperature of the sun is about 6000 ° Kelvin. Accordingly, the radiation spectrum is similar to a black body radiation at the same temperature, and about half of the radiation is emitted in the visible range. The eye's sensitivity curve is the same as the spectral distribution of the sun's radiation, and its peak of sensitivity is in green light, which is also the emission peak of the sun's radiation.



Diffuse and direct solar radiation

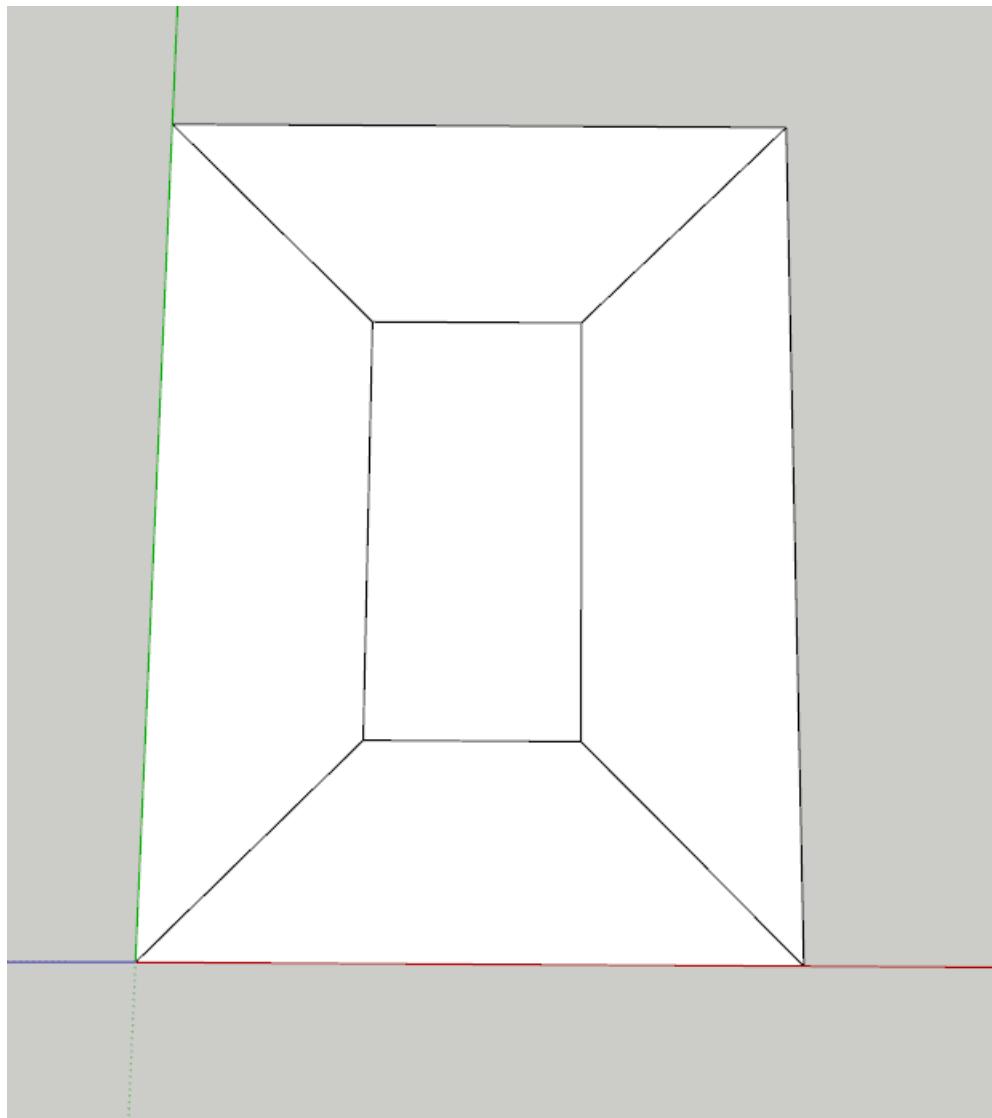
As sunlight passes through the atmosphere, some of it is absorbed, scattered, and reflected by:

- Air molecules
- Water vapor
- Clouds
- Dust
- Pollutants
- Forest fires
- Volcanoes.

This is called *diffuse solar radiation*. The solar radiation that reaches the Earth's surface without being diffused is called *direct beam solar radiation*. The sum of the diffuse and direct solar radiation is called *global solar radiation*. Atmospheric conditions can reduce direct beam radiation by 10% on clear, dry days and by 100% during thick, cloudy days.

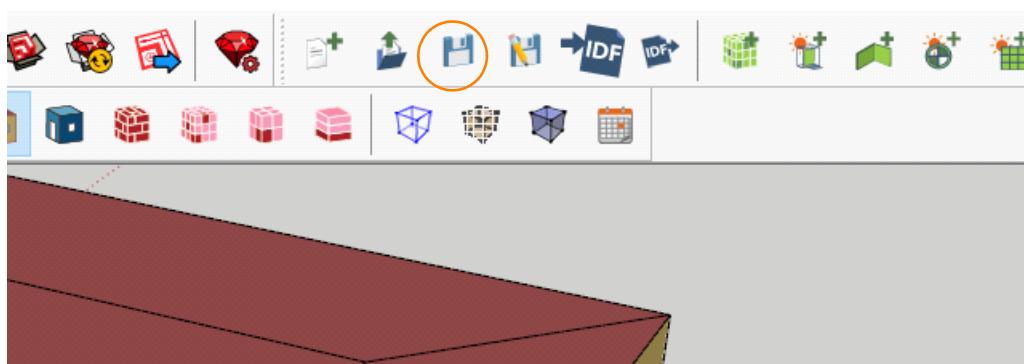
The rotation of the Earth is also responsible for hourly variations in sunlight. In the early morning and late afternoon, the sun is low in the sky. Its rays travel further through the atmosphere than at noon, when the sun is at its highest point. On a clear day, the greatest amount of solar energy reaches a solar collector around solar noon.

What do we do first:

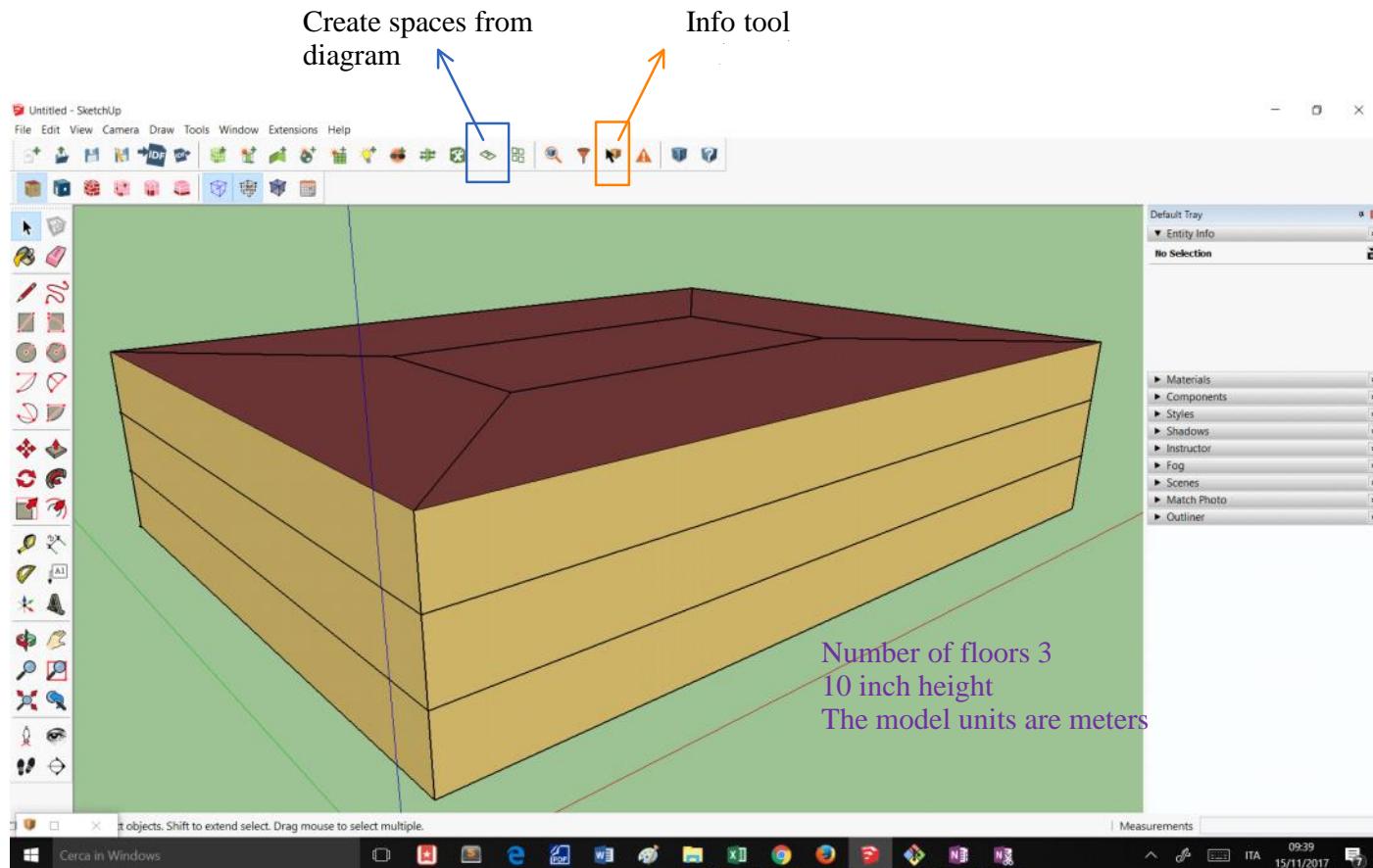


draw a rectangle 40×30 m and then offset 10 m rectangle inside it
Finally connect the edges with 4 lines

**Don't save it as a skp file - save it as an open studio file:
.osm in the end of the file name. Or save opensudio model.**

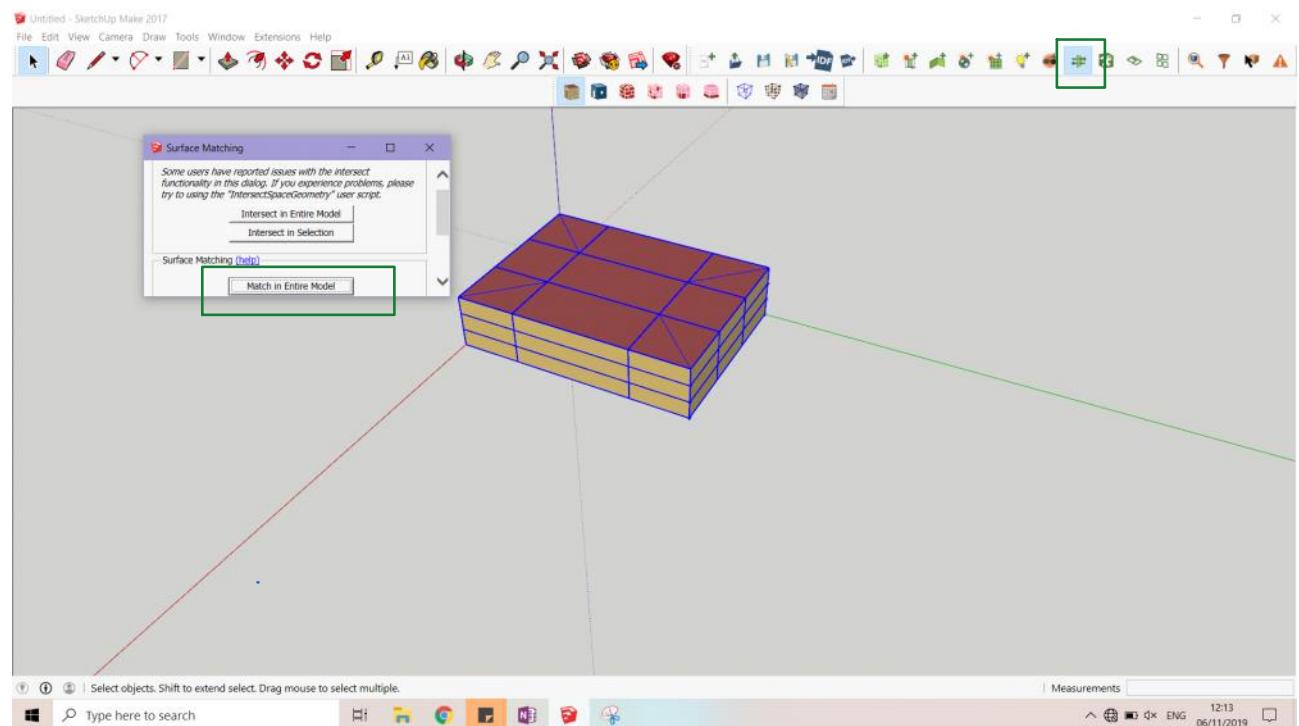
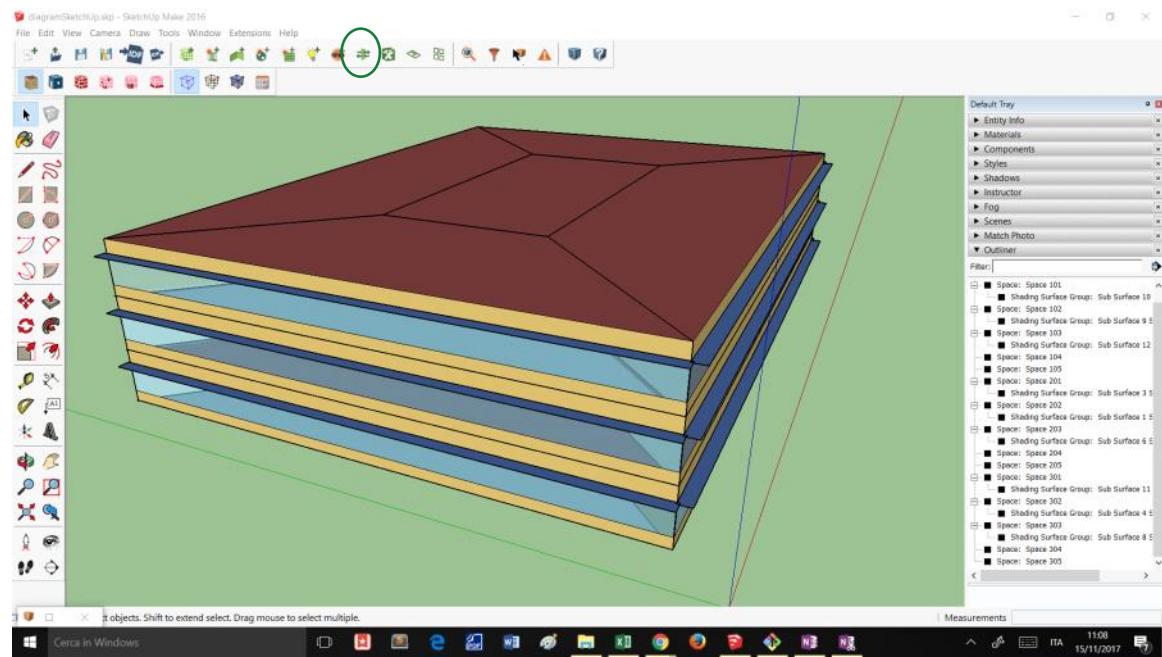


Once you made the diagram, select all of it and then click on: "create spaces from diagram"



Once you created the building you can use info tool to see the properties of each surface, and you will see that the boundary conditions have been automatically assigned.

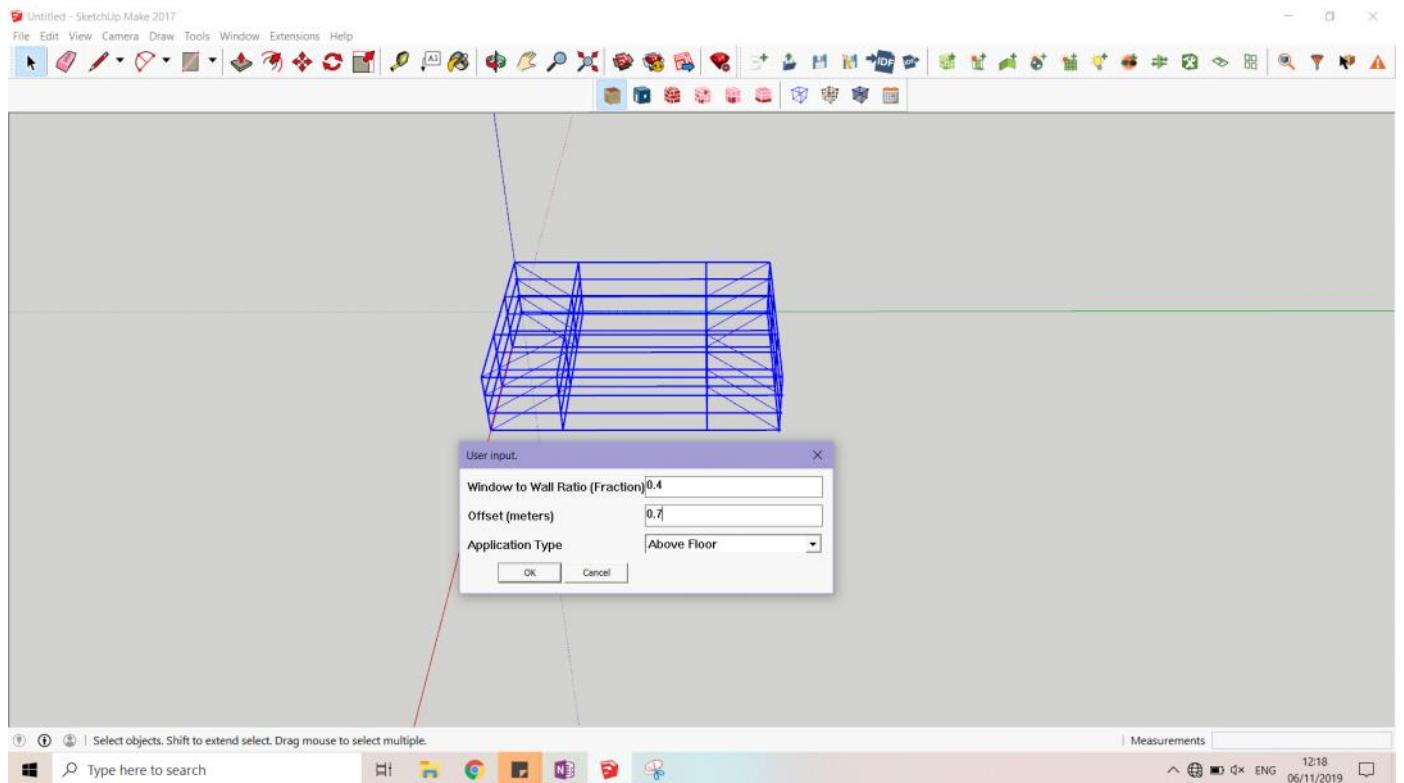
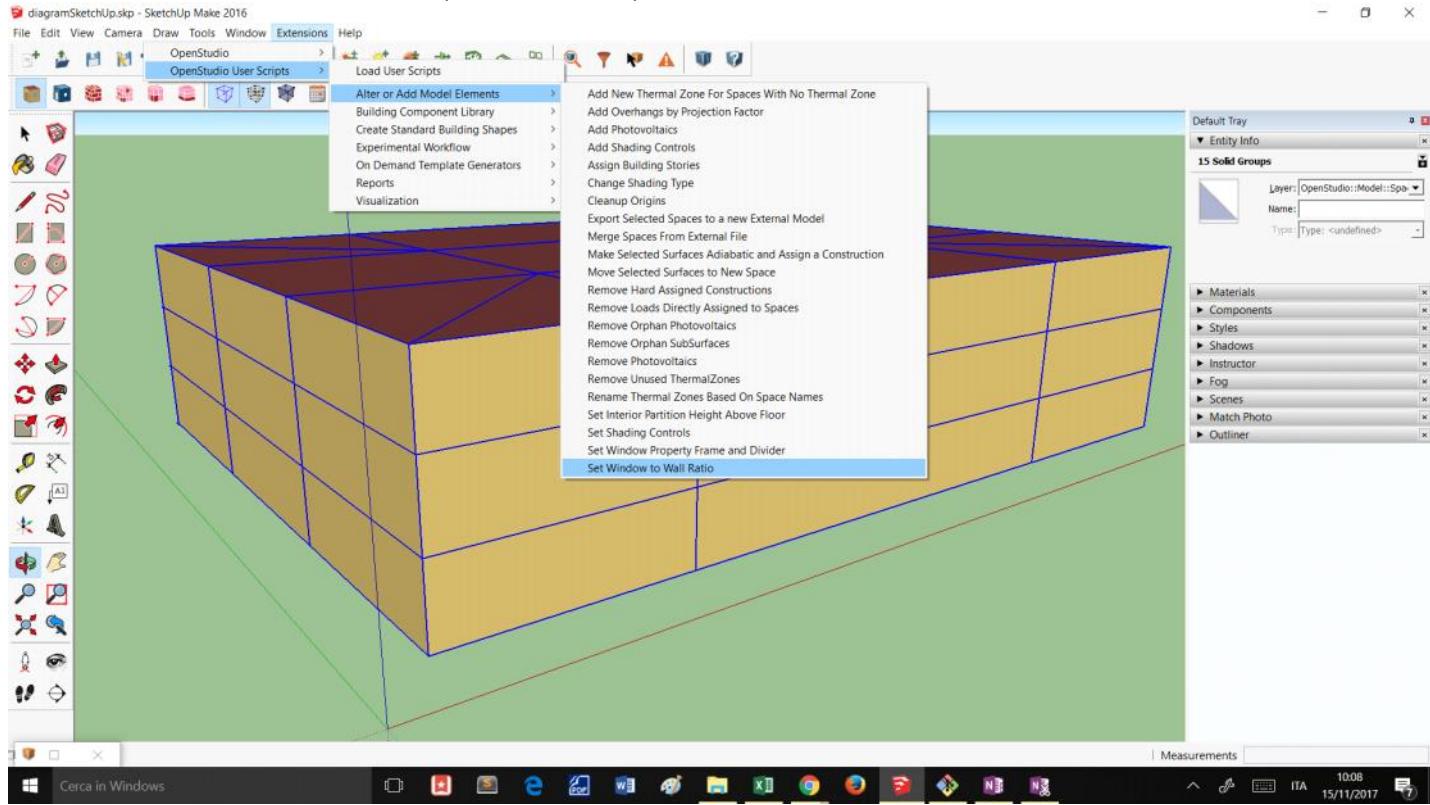
Doing surface matching:



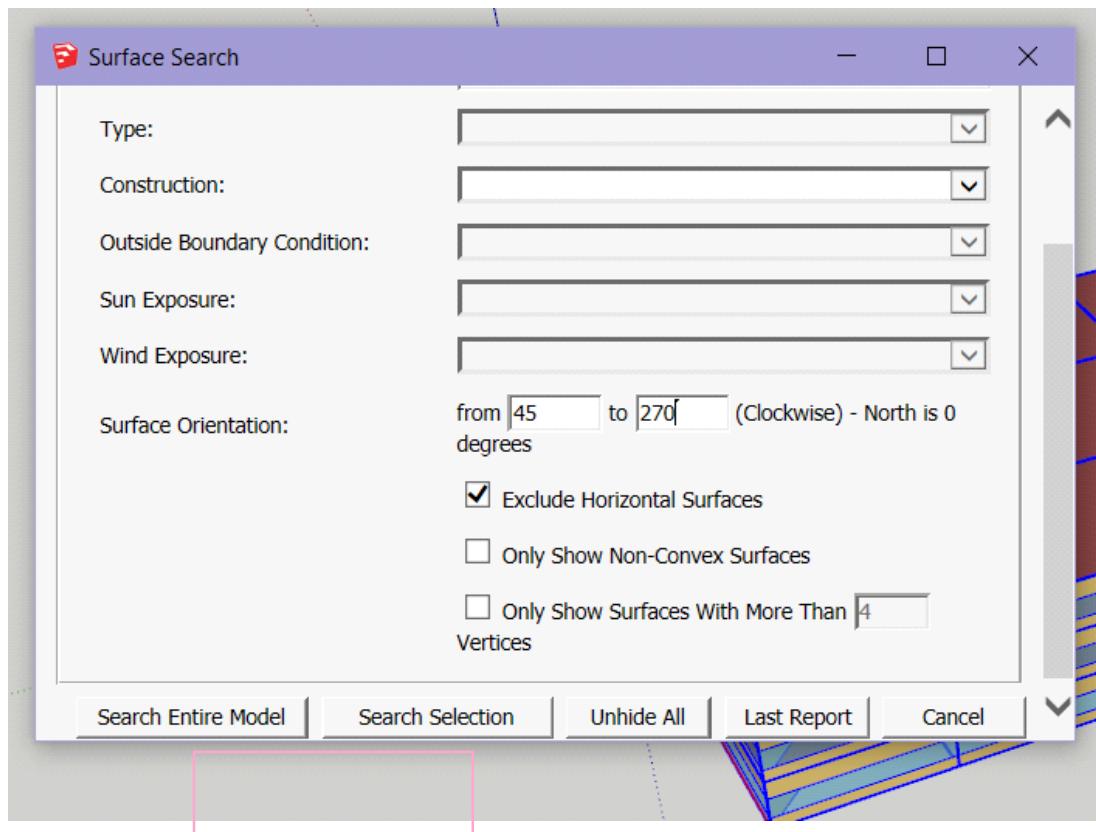
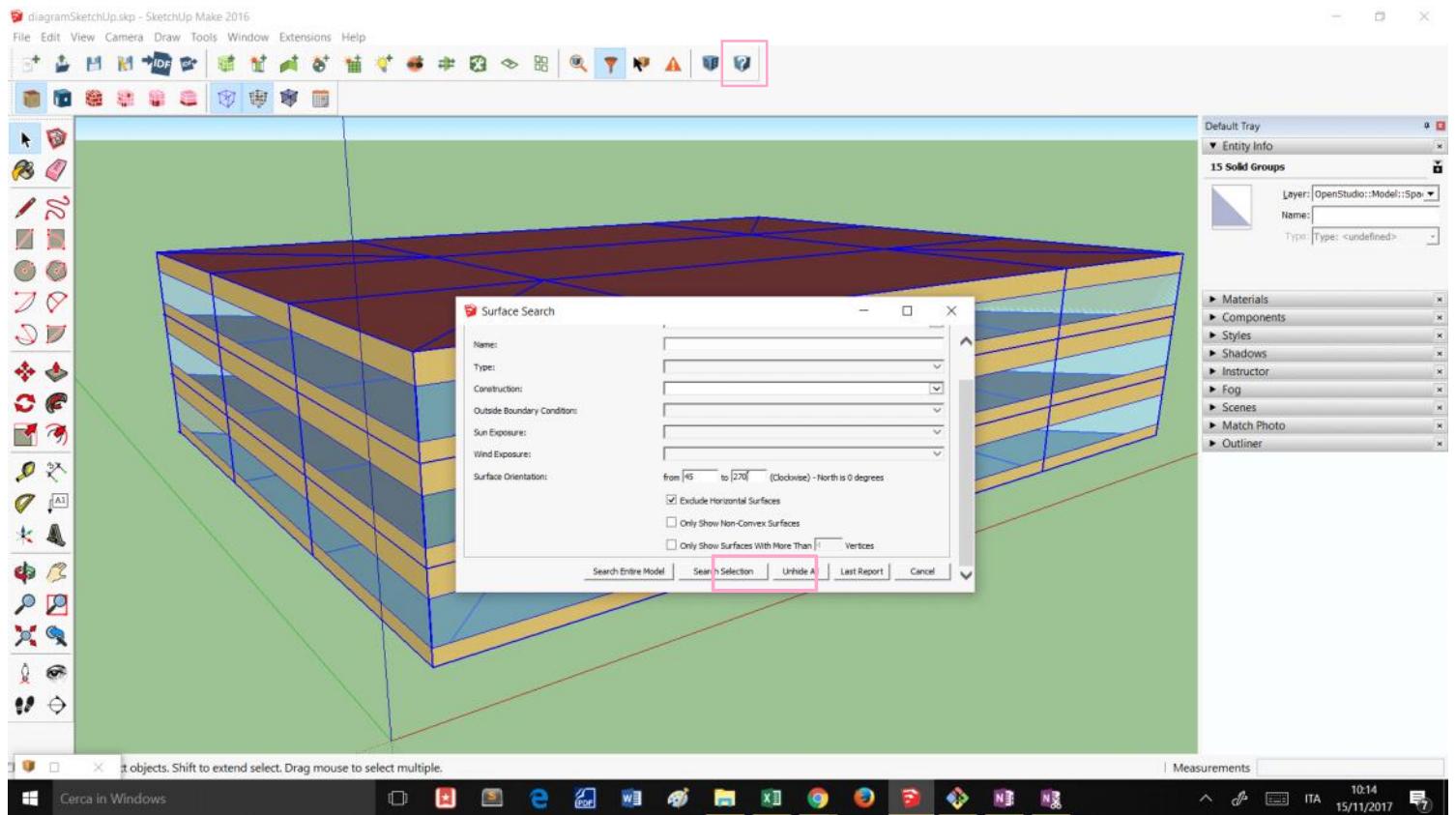
Choose the whole model → Choose surface matching → match the entire model → ok

In order to add / create windows:

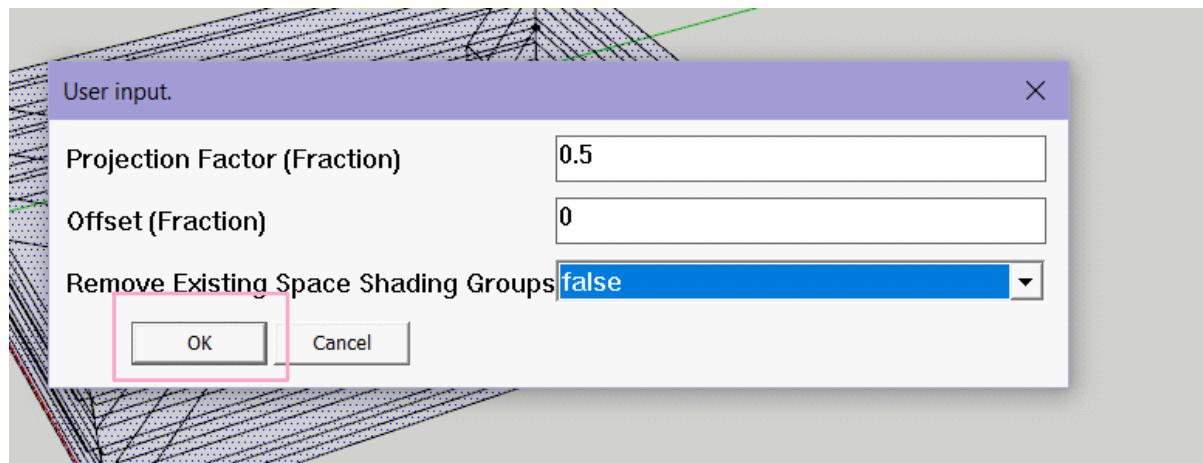
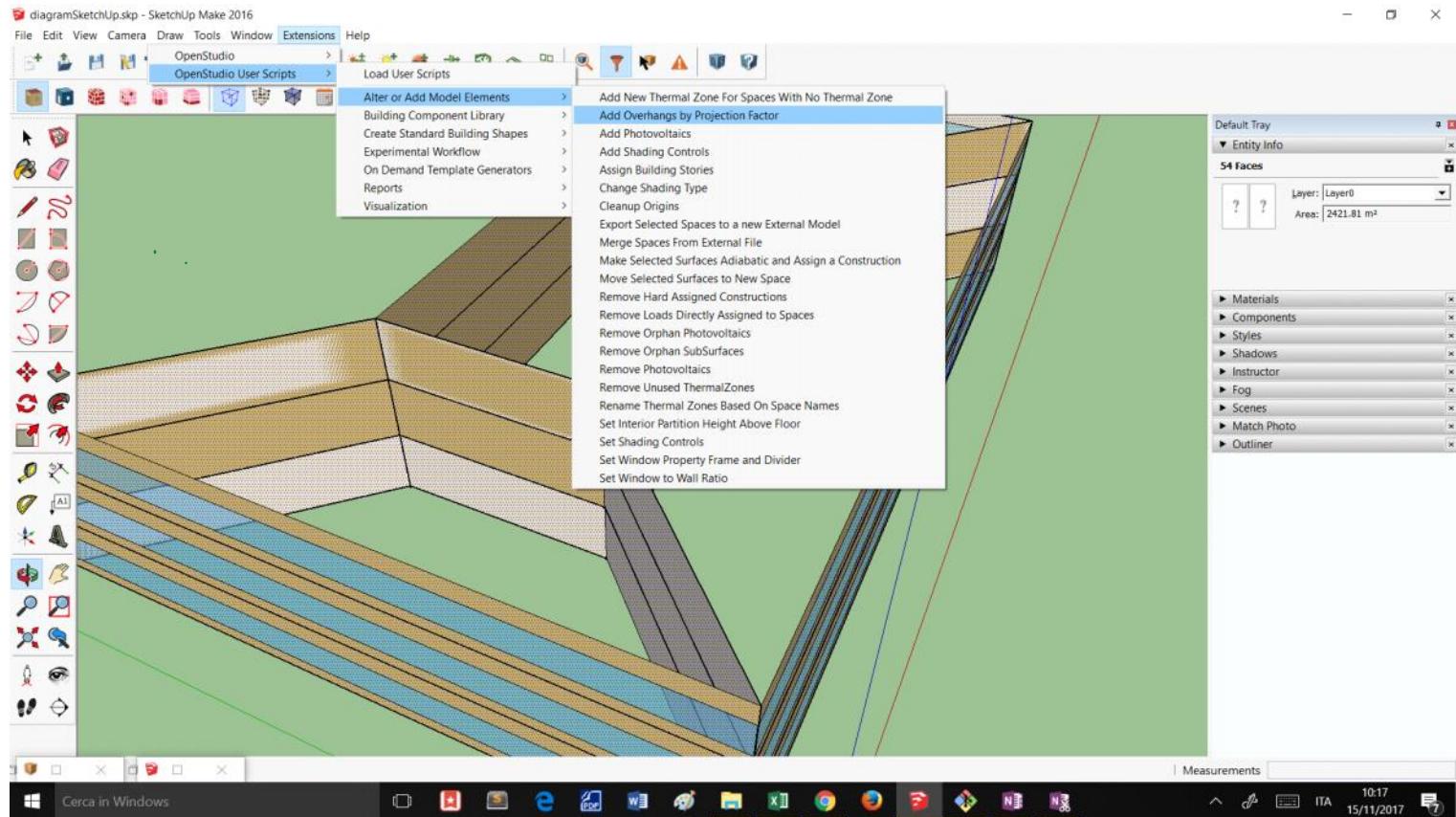
Choose the whole model → extensions → openstudio user scripts → alter or add model elements → set window to wall ratio



Choose all of the surfaces except the north:

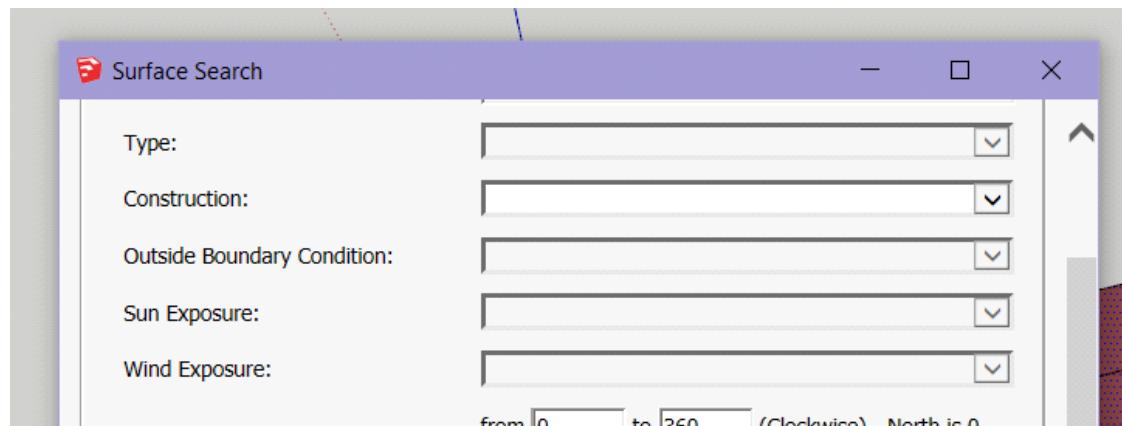


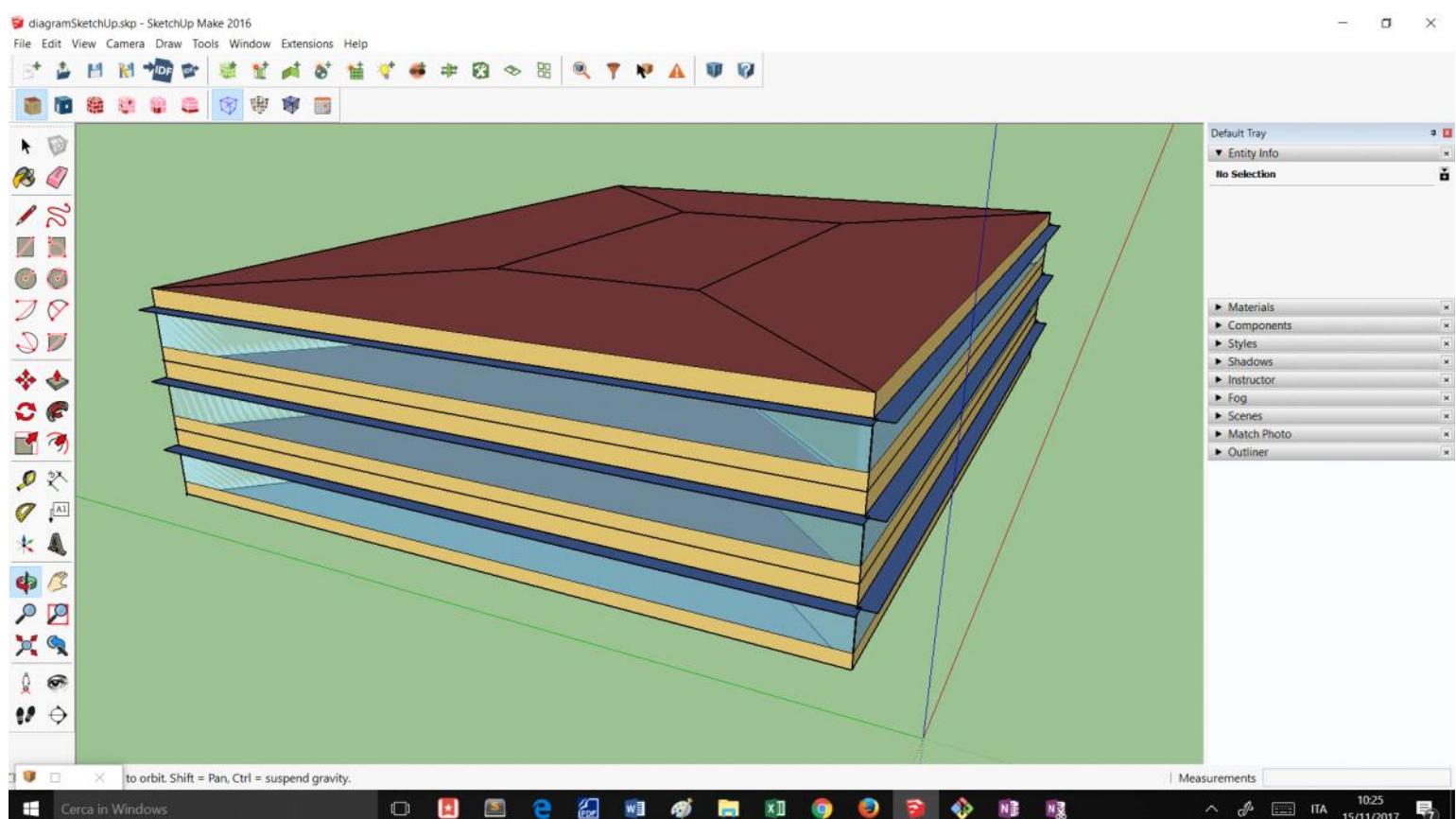
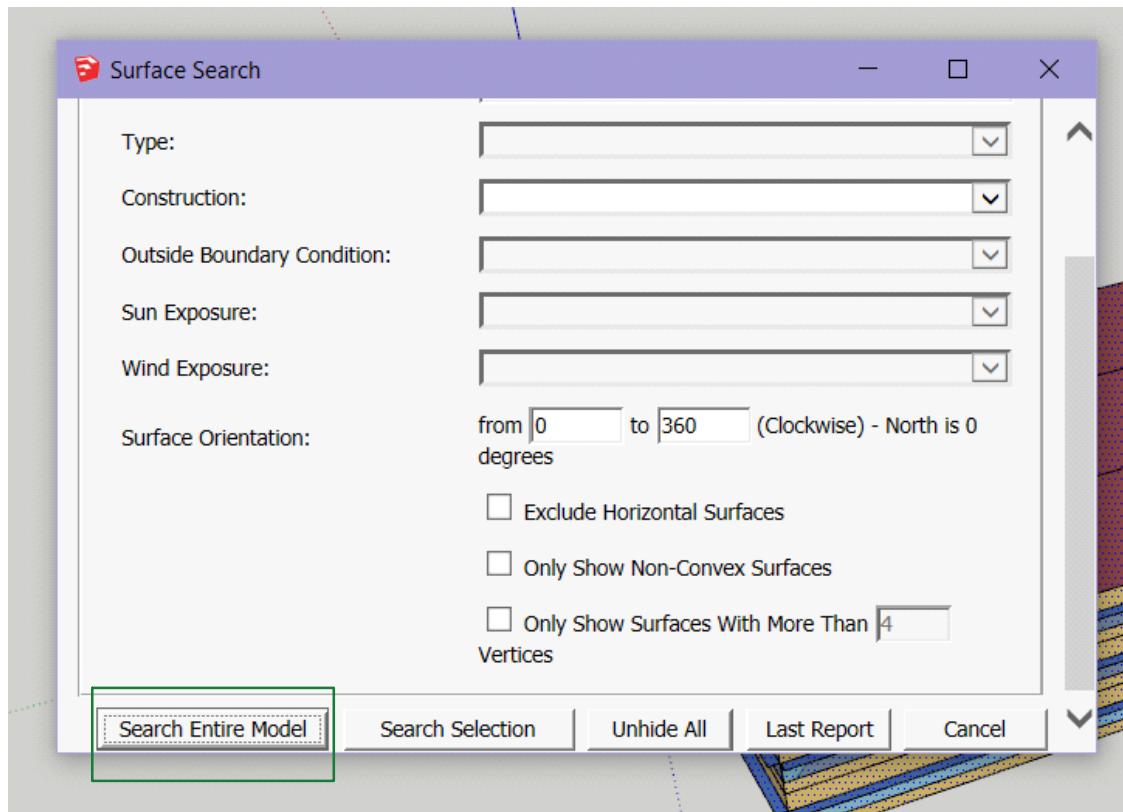
Now that we have selected our desired surfaces , we can add overhang (external shading)
We choose where we want to put the shading on



Then you should choose 0-360 surfaces so that you would go back to the previous selection

Choose the whole model → Choose surface matching → match the entire model → ok





15 apply the schedule

On the schedule set up change the number of people, activities, lightning, equipment → add yours.

In the space tub:

The screenshot shows the 'Space Properties' dialog for a project named '061119 example.osm'. The 'General' tab is selected. The 'Space Name' column lists 'Space 101', 'Space 102', 'Space 103', and 'Space 104'. The 'Load Name' column contains various load types: 'J - Office - OpenOffice - C21-3 People', 'J - Office - OpenOffice - C21-3 Lights', 'OpenOffice - C21-3 Electric Equipment', and 'Office - OpenOffice - C21-3 Infiltration'. Multipliers for these loads range from 1.000000 to 1.400000. The 'Definition' column provides detailed descriptions for each load type. The 'Schedule' column shows 'Office Work Day' for all spaces. The 'Activity Schedule (People Only)' column also shows 'Office Activity' for all spaces. The 'Apply to Selected' buttons are checked for most rows.

The load tub:

Select people definition and set the load:

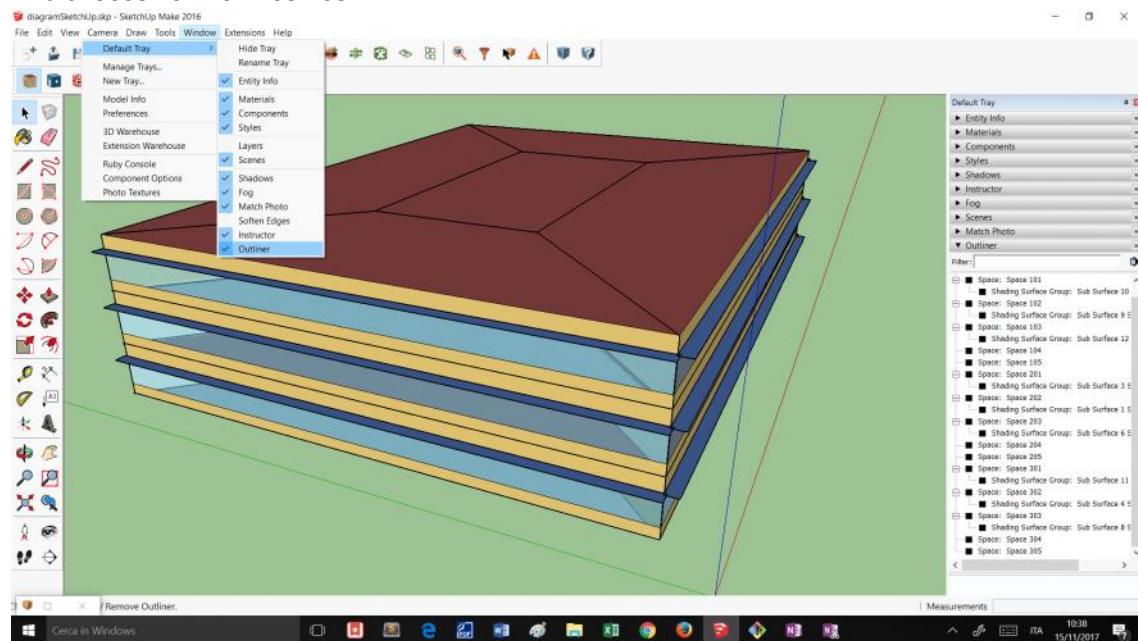
The screenshot shows the 'People Definitions' dialog. On the left is a tree view of definitions: People Definitions, Lights Definitions, Luminaire Definitions, Electric Equipment Definitions, Gas Equipment Definitions, Steam Equipment Definitions, Other Equipment Definitions, Internal Mass Definitions, and Water Use Equipment Definitions. The 'People Definitions' node is expanded. The main panel shows a 'People Definition' card with fields: 'Number of People' (0.538166 people/m²), 'Space Floor Area per Person' (0.0001038 m²/person), 'Fraction Radiant' (0.300000), 'Sensible Heat Fraction' (0.0001038), and 'Carbon Dioxide Generation Rate' (0.0001038 U/gW). A 'Calculate' button is present. At the bottom, there is a 'Drag From Library' button and a toolbar with standard file operations.

Define also lights and other equipment.

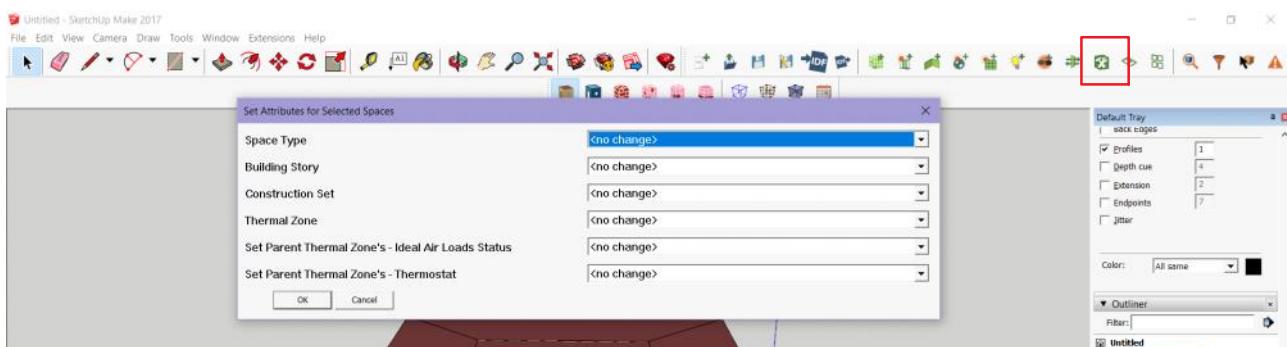
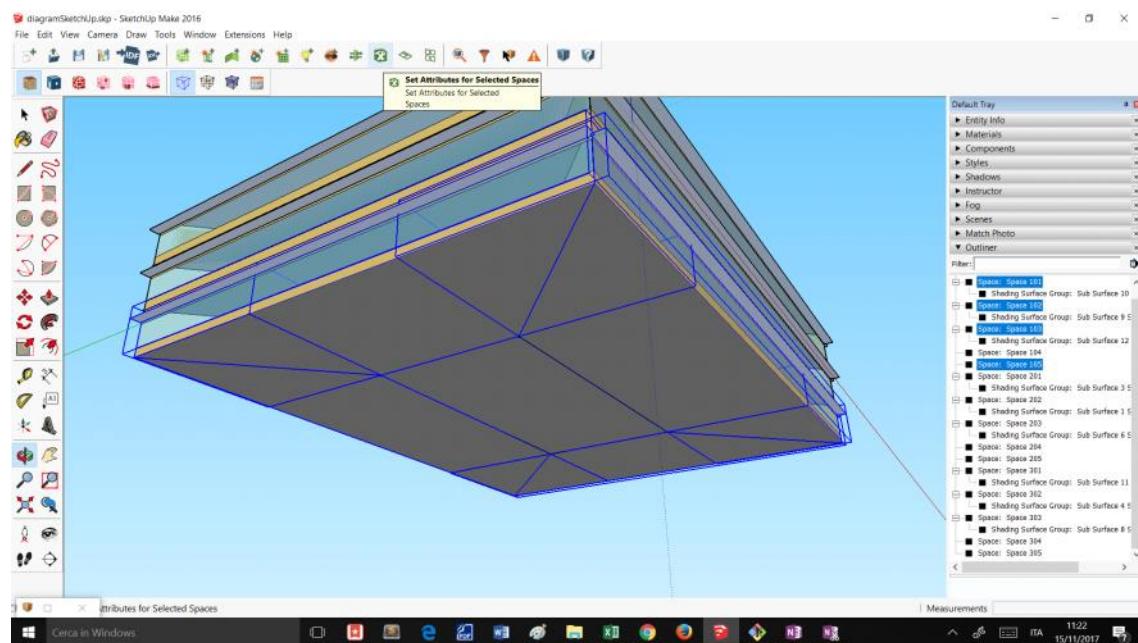
In order to add thermal zones :

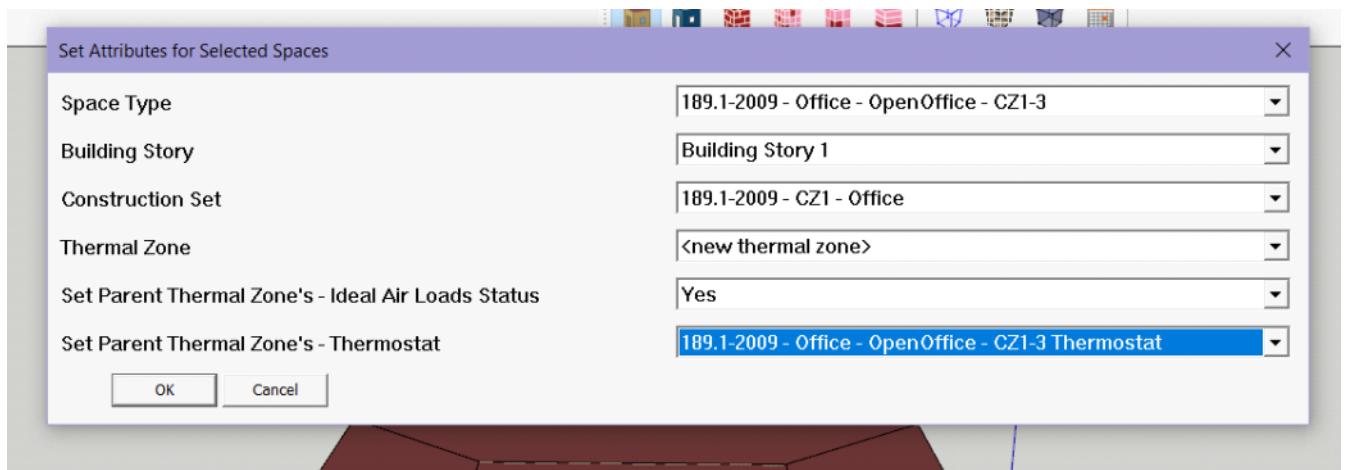
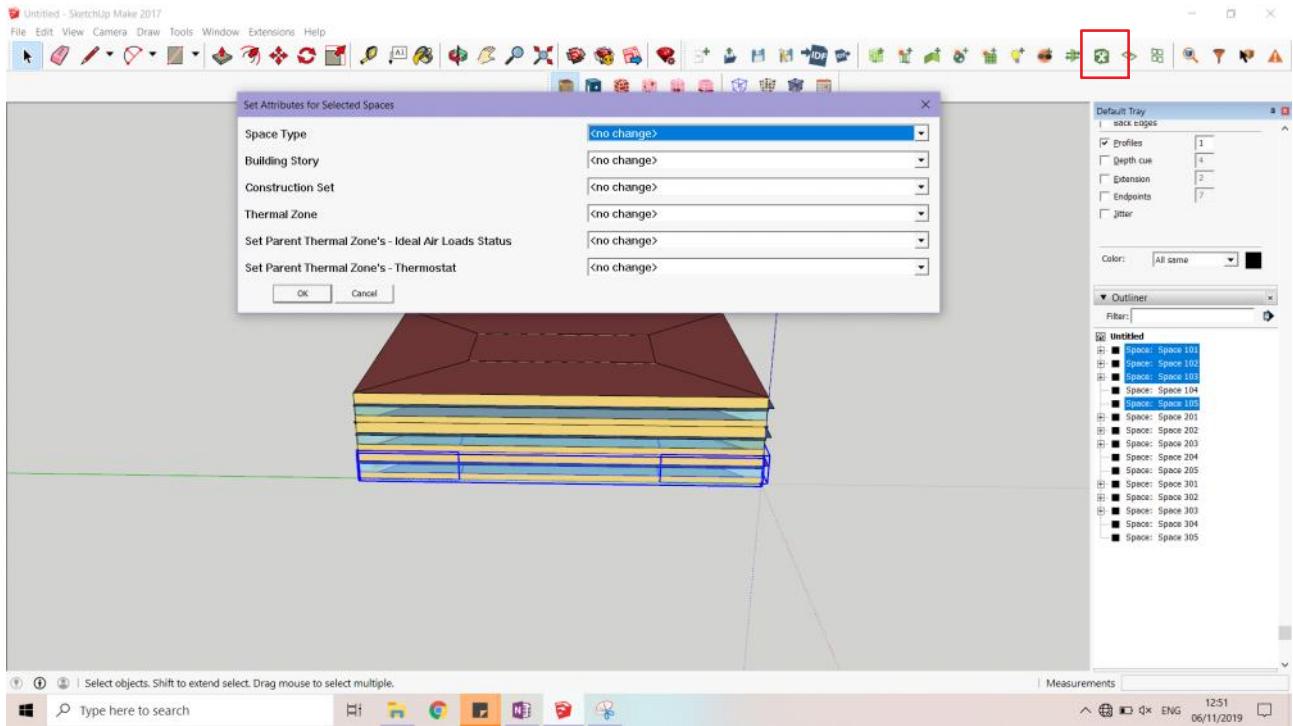
To perform this step you will need to have outliner in your tray:

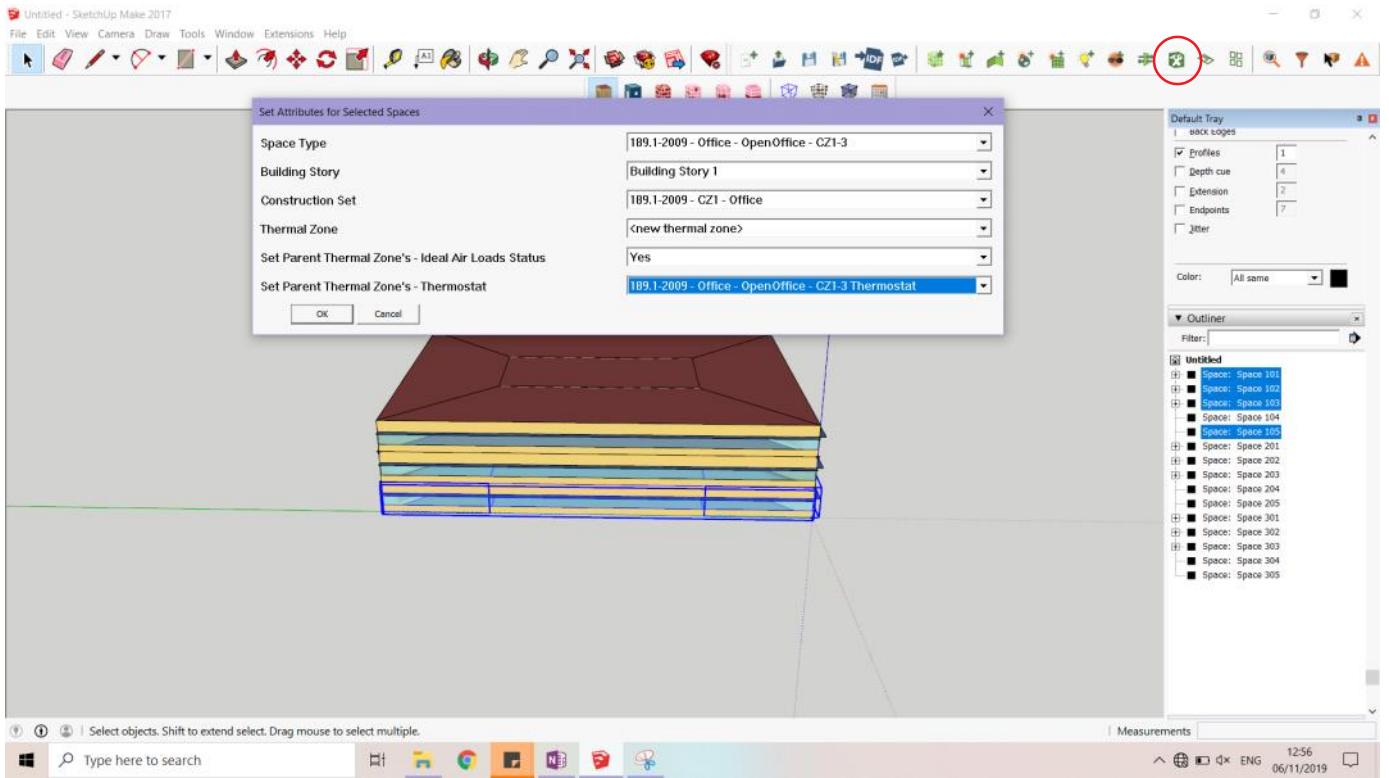
And choose 101 102 103 105



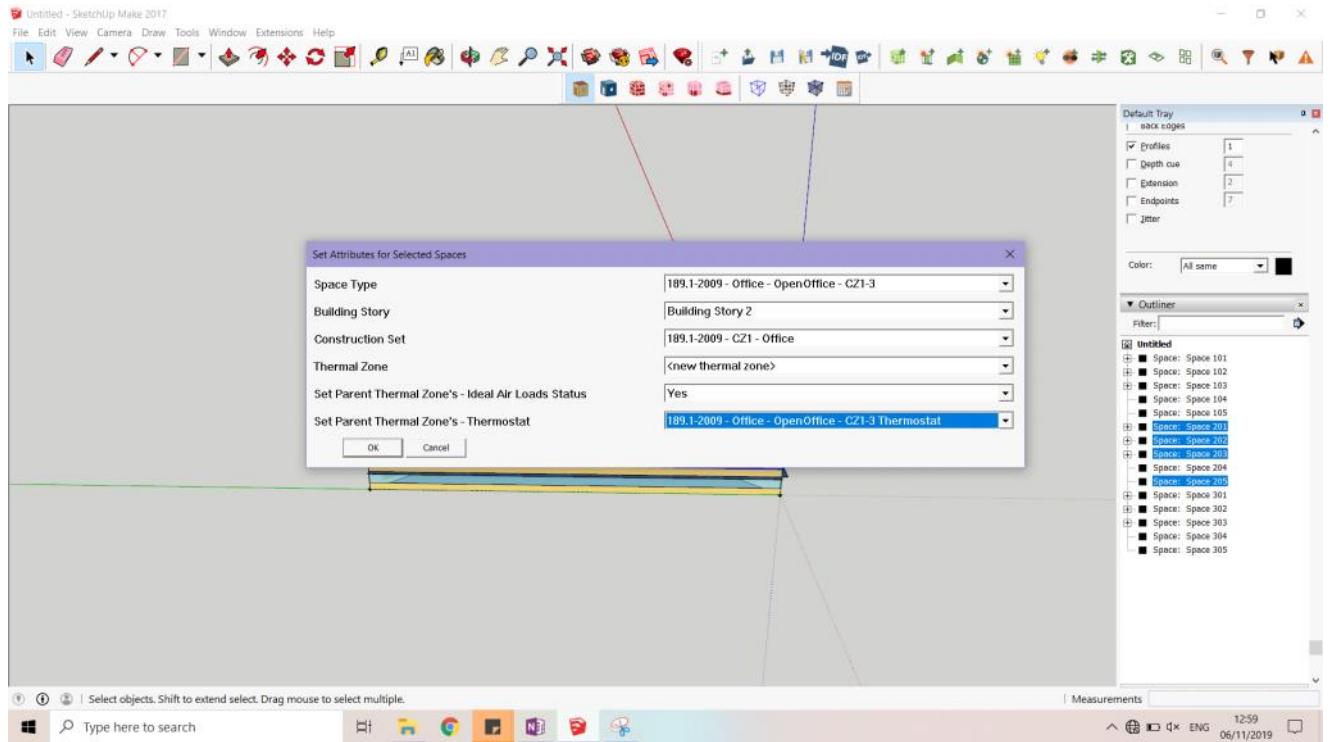
choose the spaces of each thermal zone and we add specifications:



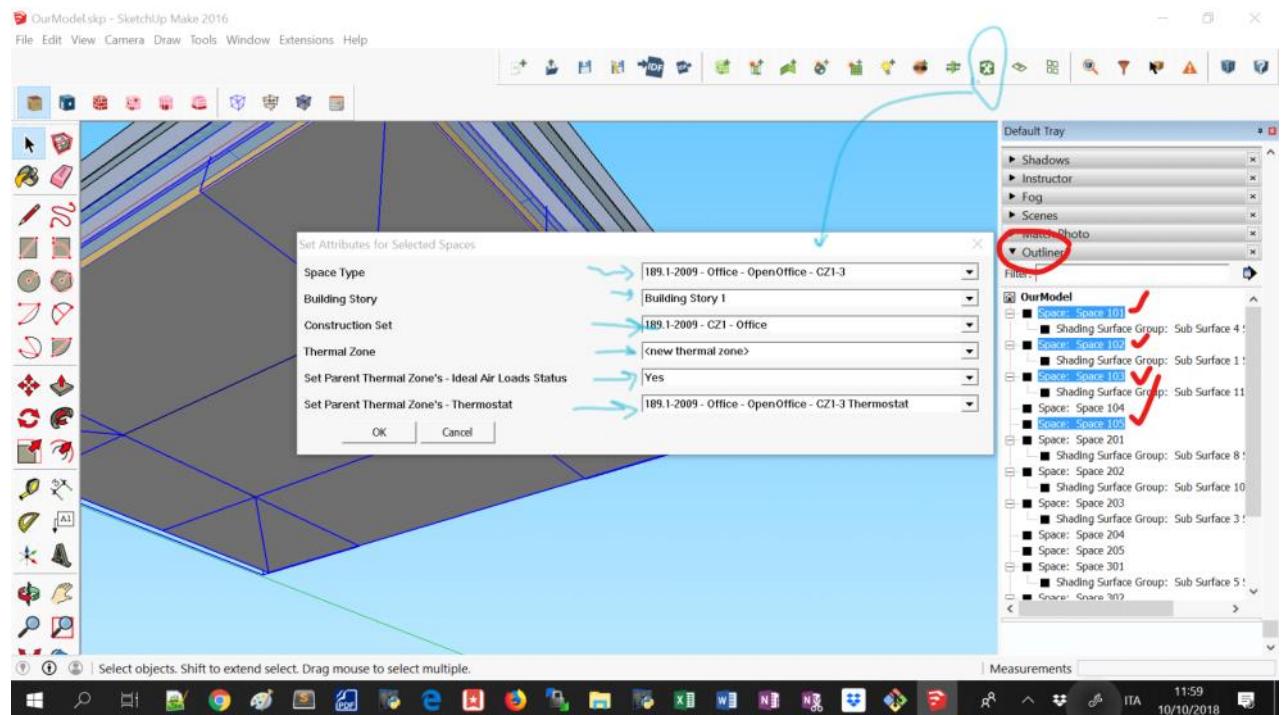
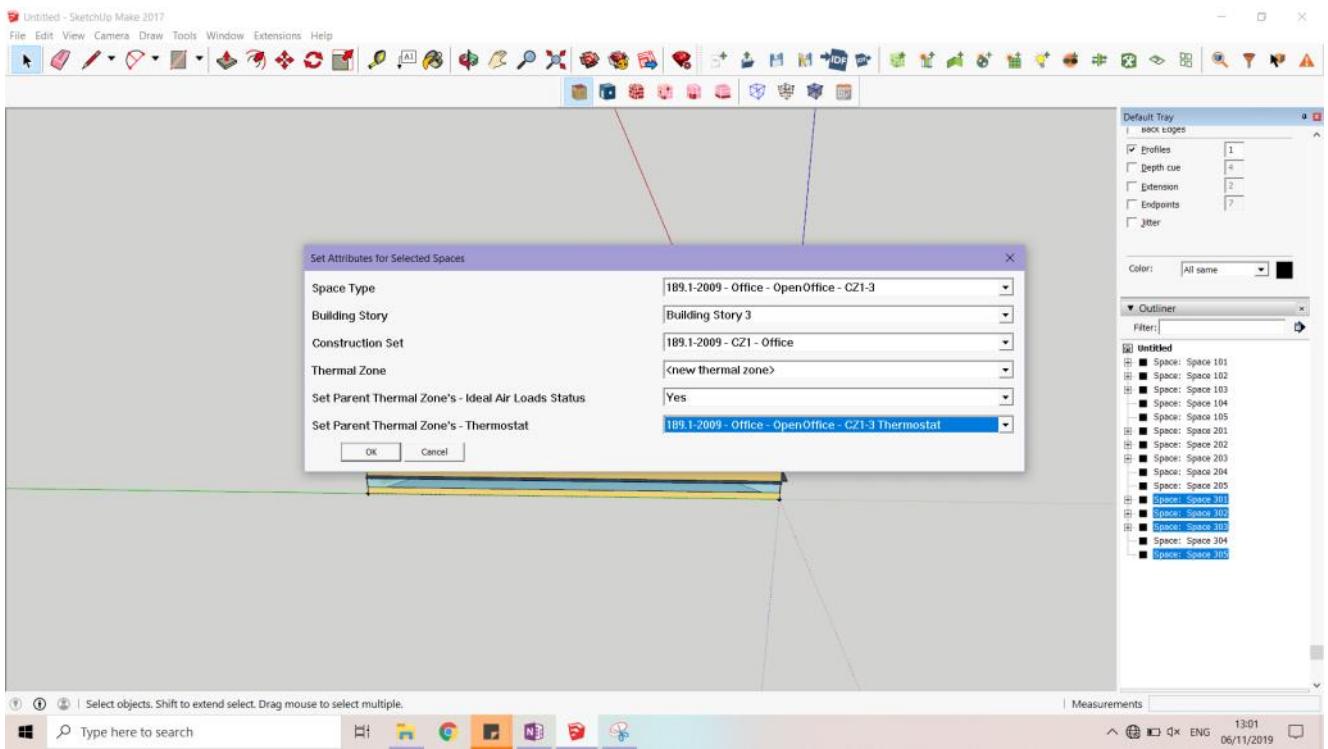




This is just for the first floor. We need to do the same for each floor.
201 202 203 205

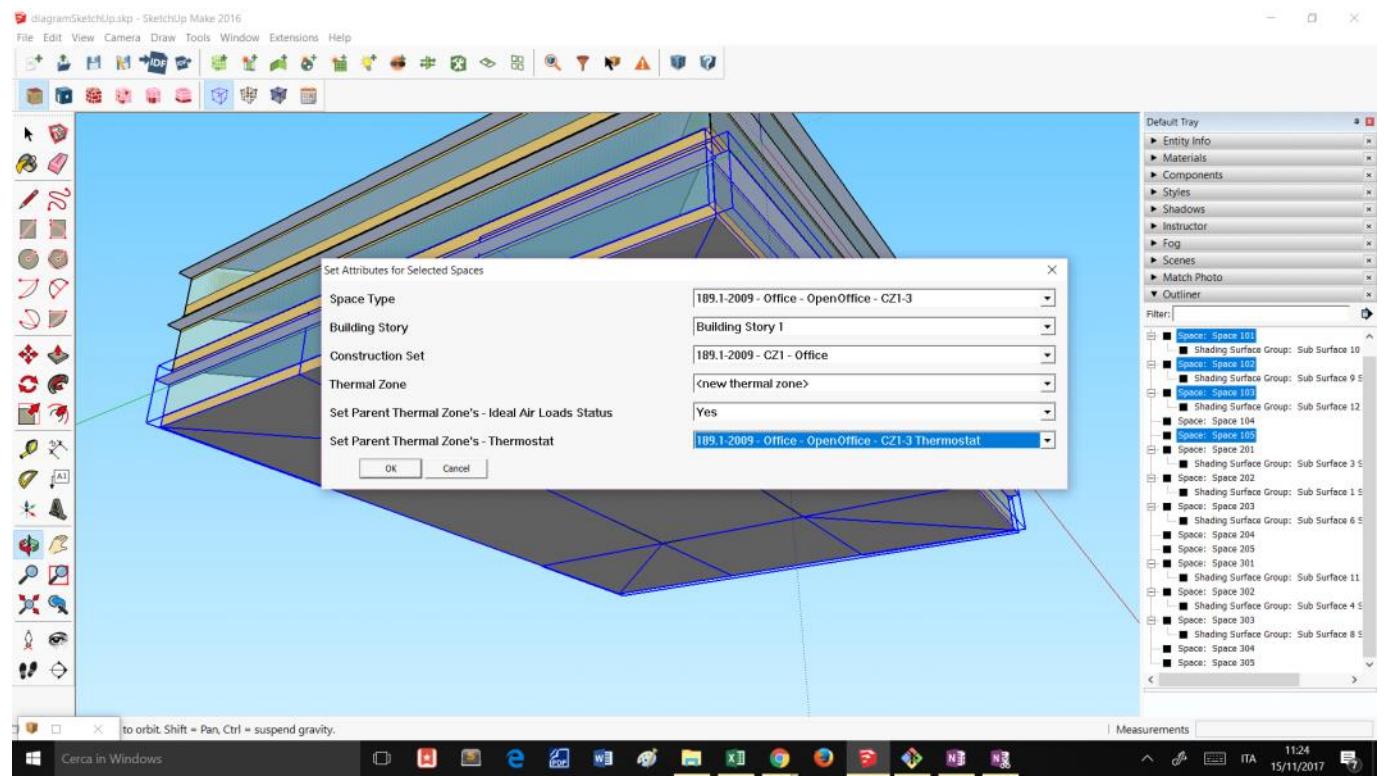


This is just for the first floor. We need to do the same for each floor.
301 302 303 305

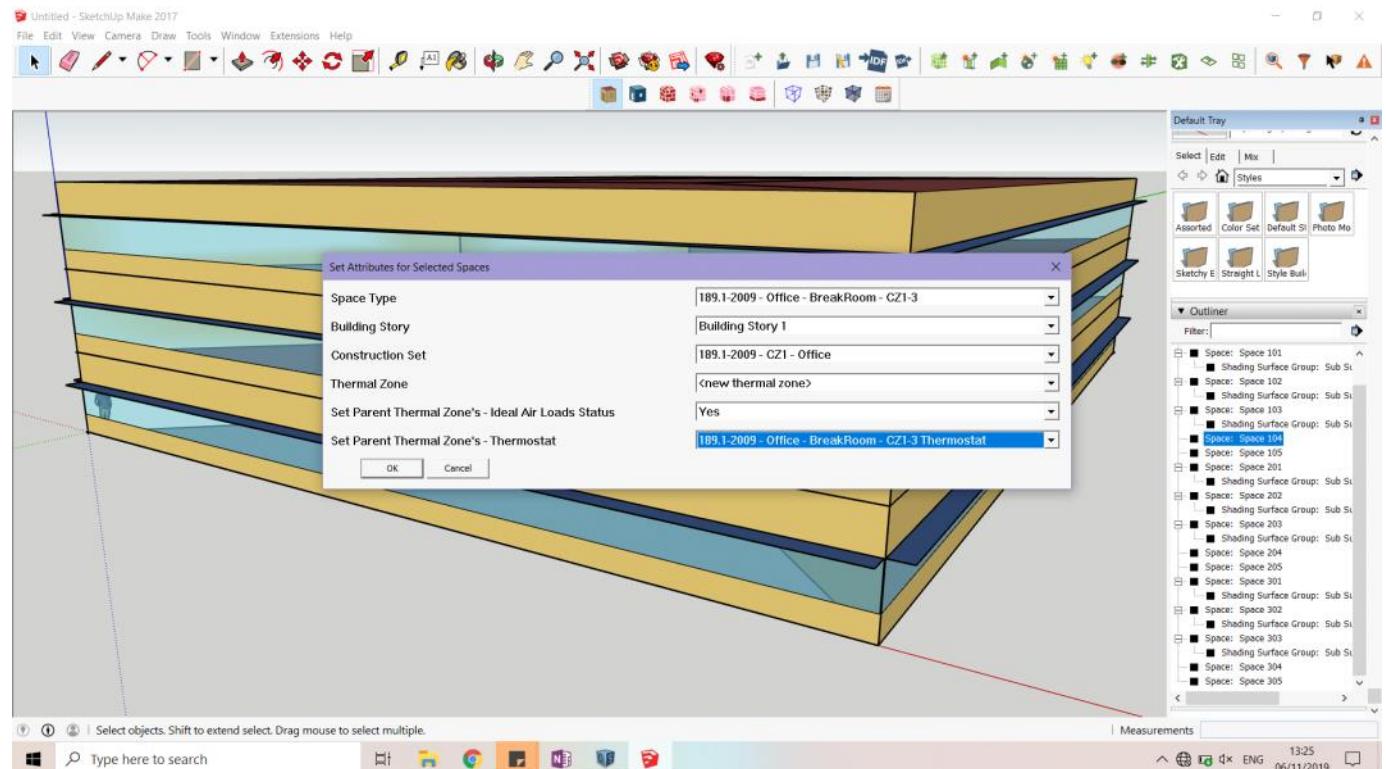


1

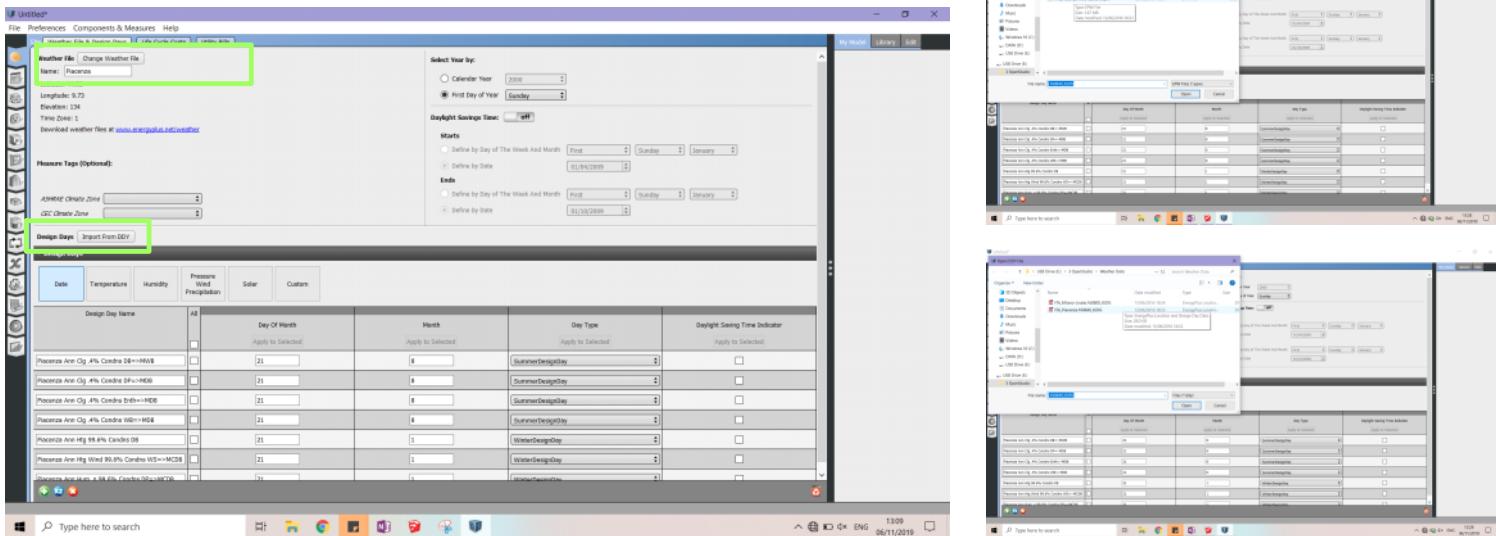
After choosing the mentioned button:



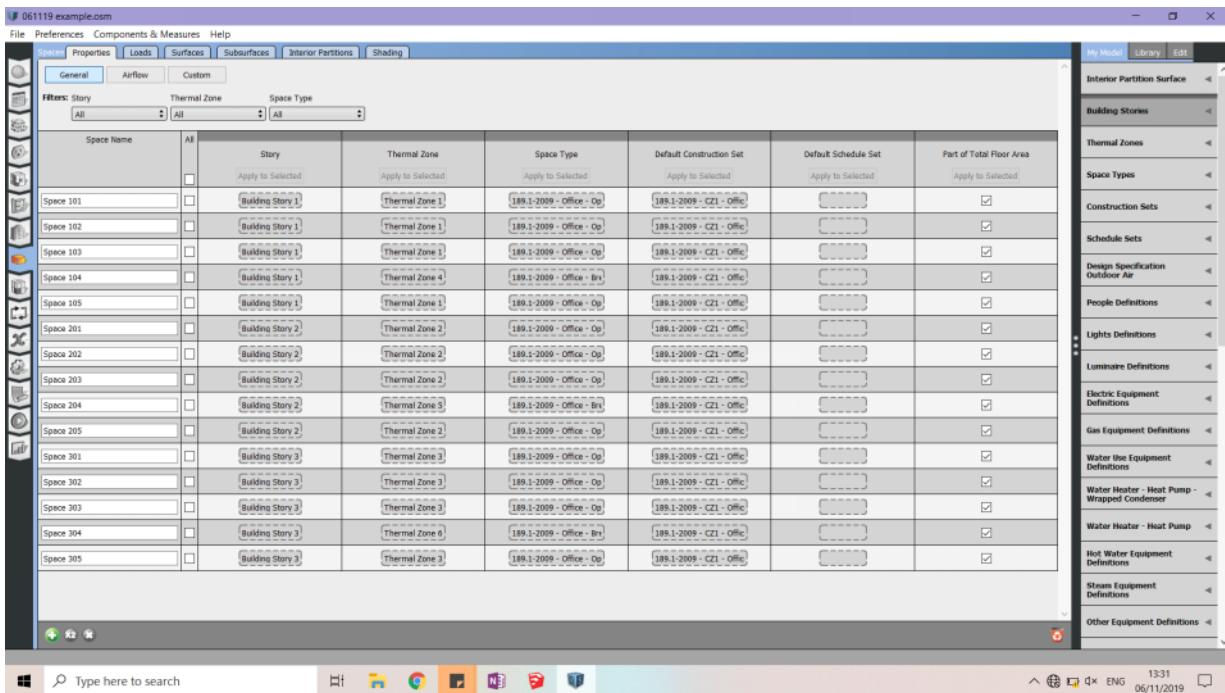
For each floor 104 204 304



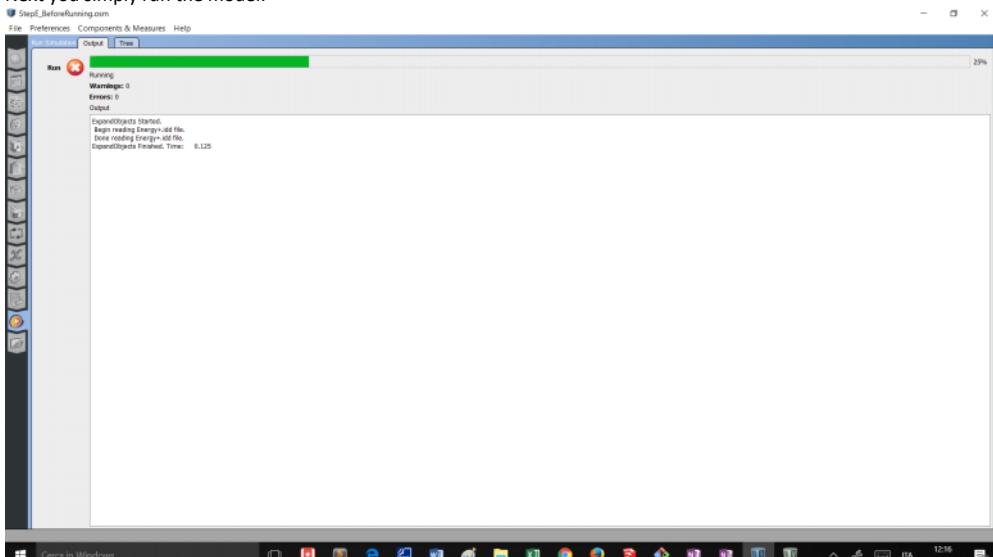
First you will need to launch Openstudio using sketchUpNext you will need to add the weather Data



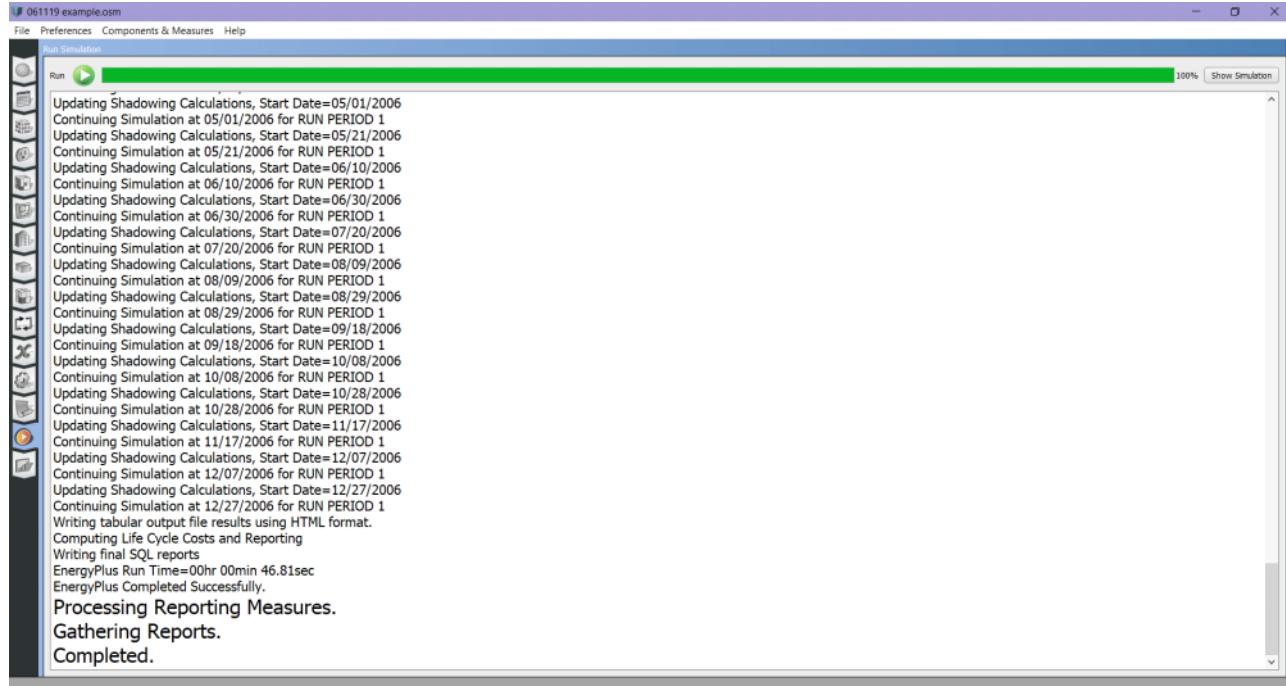
Close the skp file. And open open studio
Load the weather diagrams of piacenza.
When open op select file → open file (the skp file) and then discard and load again the weather data.



Next you simply run the model:



To see the results of the weather data:



After the simulation has finish go to results summary.

The screenshot shows the "Results Summary" page for the "061119 example.osm" project. The top navigation bar includes "Reports: EnergyPlus Results" and "Table of Contents".

Program Version: EnergyPlus, Version 9.2.0-921312f4d, YMD=2019.11.06 13:33

Tabular Output Report in Format: HTML

Building: Building 1

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

Simulation Timestamp: 2019-11-06 13:33:27

Report: Annual Building Utility Performance Summary

For: Entire Facility

Timestamp: 2019-11-06 13:33:27

Values gathered over \$760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m ²]	Energy Per Conditioned Building Area [MJ/m ²]
Total Site Energy	2375.76	659.93	659.93
Net Site Energy	2375.76	659.93	659.93
Total Source Energy	6136.52	1704.59	1704.59
Net Source Energy	6136.52	1704.59	1704.59

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
-	-

Finally you can review your results in the last tab

The screenshot shows the EnergyPlus Results window for a project named "StepE_BeforeRunning.osm". The main title bar includes "File", "Preferences", "Components & Measures", and "Help". A toolbar on the left contains various icons for file operations like Open, Save, Print, and Export.

Results Summary

Reports: EnergyPlus Results

Program Version: EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2017.11.15 12:16

Tabular Output Report in Format: HTML

Building: Building 1

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

Simulation Timestamp: 2017-11-15 12:16:21

Report: Annual Building Utility Performance Summary

For: Entire Facility

Timestamp: 2017-11-15 12:16:21

Values gathered over 8760.00 hours

Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m ²]	Energy Per Conditioned Building Area [MJ/m ²]
Total Site Energy	2421.76	672.71	672.71
Net Site Energy	2421.76	672.71	672.71
Total Source Energy	6320.91	1755.81	1755.81
Net Source Energy	6320.91	1755.81	1755.81

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

To find extra weather database / other cities weather data:
 Search on google Energy plus data weather
 Go to energyplus.net/weather → download the epw file

Design Days		Import From DDY			
Design Days					
Date	Temperature	Humidity	Pressure Wind Precipitation	Solar	Custom
Design Day Name		All	Day Of Month		Month
		<input type="checkbox"/>	Apply to Selected		Apply to Selected
Piacenza Ann Clg .4% Condns DB=>MWB		<input type="checkbox"/>	21	8	
Piacenza Ann Clg .4% Condns DP=>MDB		<input type="checkbox"/>	21	8	
Piacenza Ann Clg .4% Condns Enth=>MDB		<input type="checkbox"/>	21	8	
Piacenza Ann Clg .4% Condns WB=>MDB		<input type="checkbox"/>	21	8	
Piacenza Ann Htg 99.6% Condns DB		<input type="checkbox"/>	21	1	
Piacenza Ann Htg Wind 99.6% Condns WS=>MCDB		<input type="checkbox"/>	21	1	
Piacenza Ann Hum_n 99.6% Condns DP=>MCDB		<input type="checkbox"/>	21	1	

Warmer day in Piacenza is on the 21.8
 And the coldest day in Piacenza is 21.1

Design Days		Import From DDY			
Design Days					
Date	Temperature	Humidity	Pressure Wind Precipitation	Solar	Custom
Design Day Name		All	Maximum Dry Bulb Temperature		Daily Dry Bulb Temperature Range
		<input type="checkbox"/>	Apply to Selected		Apply to Selected
Piacenza Ann Clg .4% Condns DB=>MWB		<input type="checkbox"/>	33.100000	C	11.900000 K
Piacenza Ann Clg .4% Condns DP=>MDB		<input type="checkbox"/>	27.400000	C	11.900000 K
Piacenza Ann Clg .4% Condns Enth=>MDB		<input type="checkbox"/>	30.300000	C	11.900000 K
Piacenza Ann Clg .4% Condns WB=>MDB		<input type="checkbox"/>	30.100000	C	11.900000 K
Piacenza Ann Htg 99.6% Condns DB		<input type="checkbox"/>	-6.100000	C	0.000000 K
Piacenza Ann Htg Wind 99.6% Condns WS=>MCDB		<input type="checkbox"/>	5.800000	C	0.000000 K
Piacenza Ann Hum_n 99.6% Condns DP=>MCDB		<input type="checkbox"/>	3.500000	C	0.000000 K

With average temperature of 33.1°C-27.4°C on August
 And 5.8°C-3.5°C on January

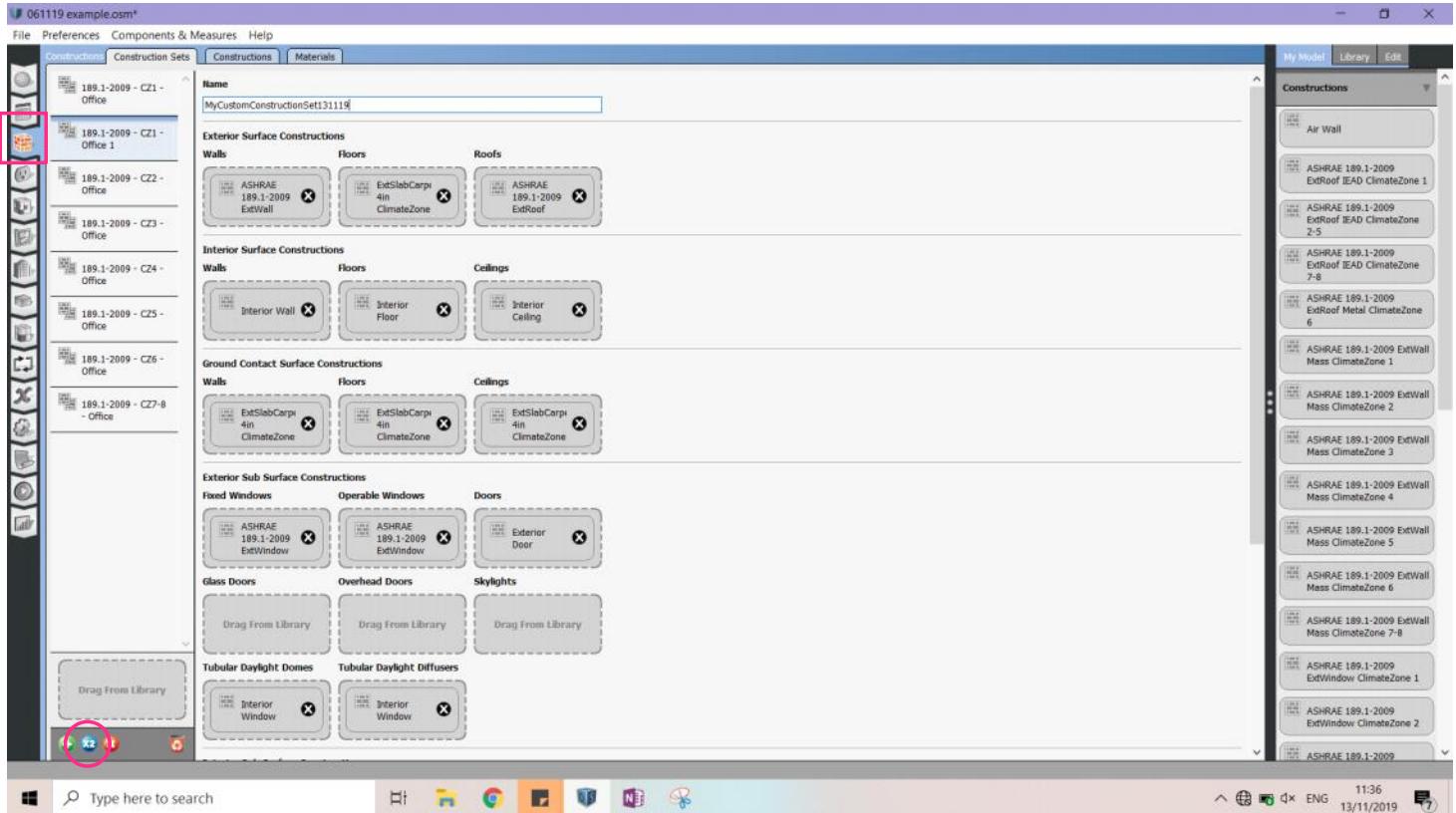
Constructions sets:

Different between the constructions and the constructions set

The set has the walls, floors, windows. Sets are the details of every element of the set.
Never start from scratch- choose something similar and modify it.

To define the construction set → third tab

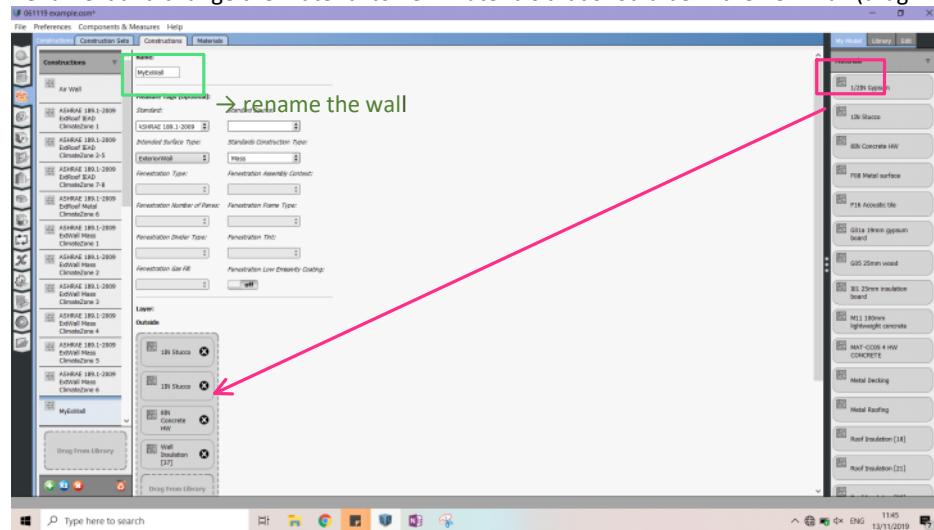
And duplicate the data



define a new wall

In the tab of construction define a new all by duplicate an existing wall.

Rename it and change the material to new materials that should be in the new wall (drag material from the right menu under materials



Define materials:

Define the insulation like this:

Thickness: 0.1 m
Conductivity: 0.3
Density: 100
Specific heat: 900

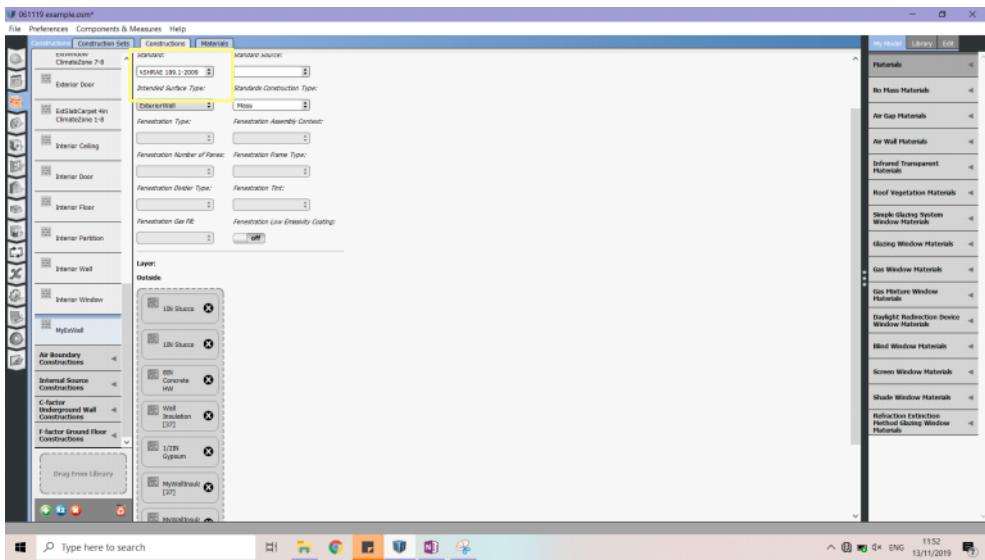
Roughness:	Thickness:
MediumRough	0.100000 m

Conductivity:	Density:
0.300000 W/m·K	100.000000 kg/m ³

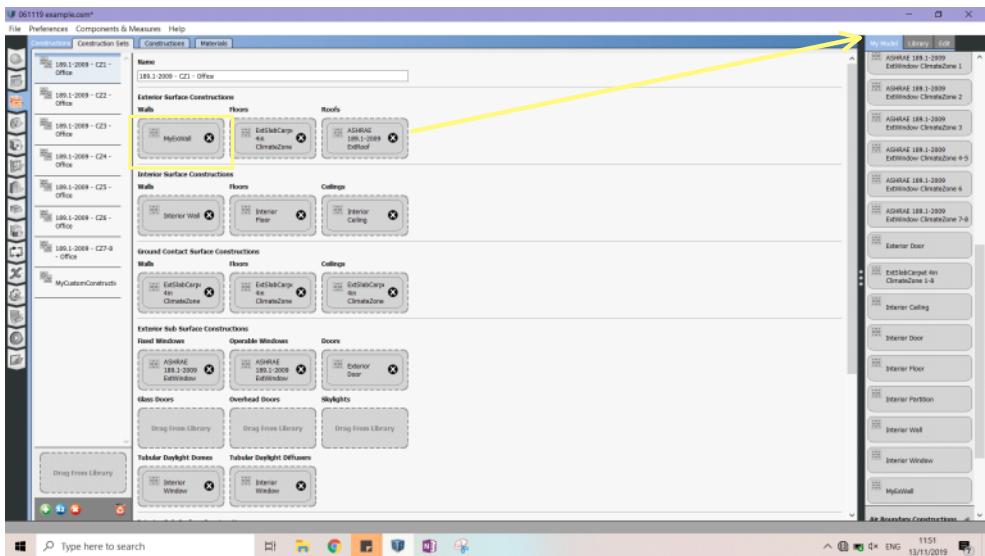
Specific Heat:	Thermal Absorptance:
900.000000 J/kg·K	0.900000

Solar Absorptance:	Visible Absorptance:
0.500000	0.500000

Once you created the materials → back to construction and define again the wall with the new material



On the construction set → find the new wall / new material and replace / add it with the old material
From the list on the materials on the right.



Change the materials into the skp model

Change the materials in the skp model with the new material that we create.

Spaces tab → properties → general:

Choose all

Default construction set → choose one of the floor (like 101) → apply to selected

Space Name	Story	Thermal Zone	Space Type	Default Construction Set	Default Schedule Set	Part of Total Floor Area
Space 101	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 102	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 103	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 104	Building Story 1	Thermal Zone 4	189.1-2009 - Office - Br	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 105	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 201	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 202	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 203	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 204	Building Story 2	Thermal Zone 5	189.1-2009 - Office - Br	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 205	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 301	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 302	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 303	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 304	Building Story 3	Thermal Zone 6	189.1-2009 - Office - Br	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 305	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>

And the with the new materials..:

Space Name	Story	Thermal Zone	Space Type	Default Construction Set	Default Schedule Set	Part of Total Floor Area
Space 101	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 102	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 103	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 104	Building Story 1	Thermal Zone 4	189.1-2009 - Office - Br	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 105	Building Story 1	Thermal Zone 1	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 201	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 202	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 203	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 204	Building Story 2	Thermal Zone 5	189.1-2009 - Office - Br	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 205	Building Story 2	Thermal Zone 2	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 301	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 302	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 303	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 304	Building Story 3	Thermal Zone 6	189.1-2009 - Office - Br	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>
Space 305	Building Story 3	Thermal Zone 3	189.1-2009 - Office - Op	189.1-2009 - CZ1 - Offic		<input checked="" type="checkbox"/>

Schedule tab:

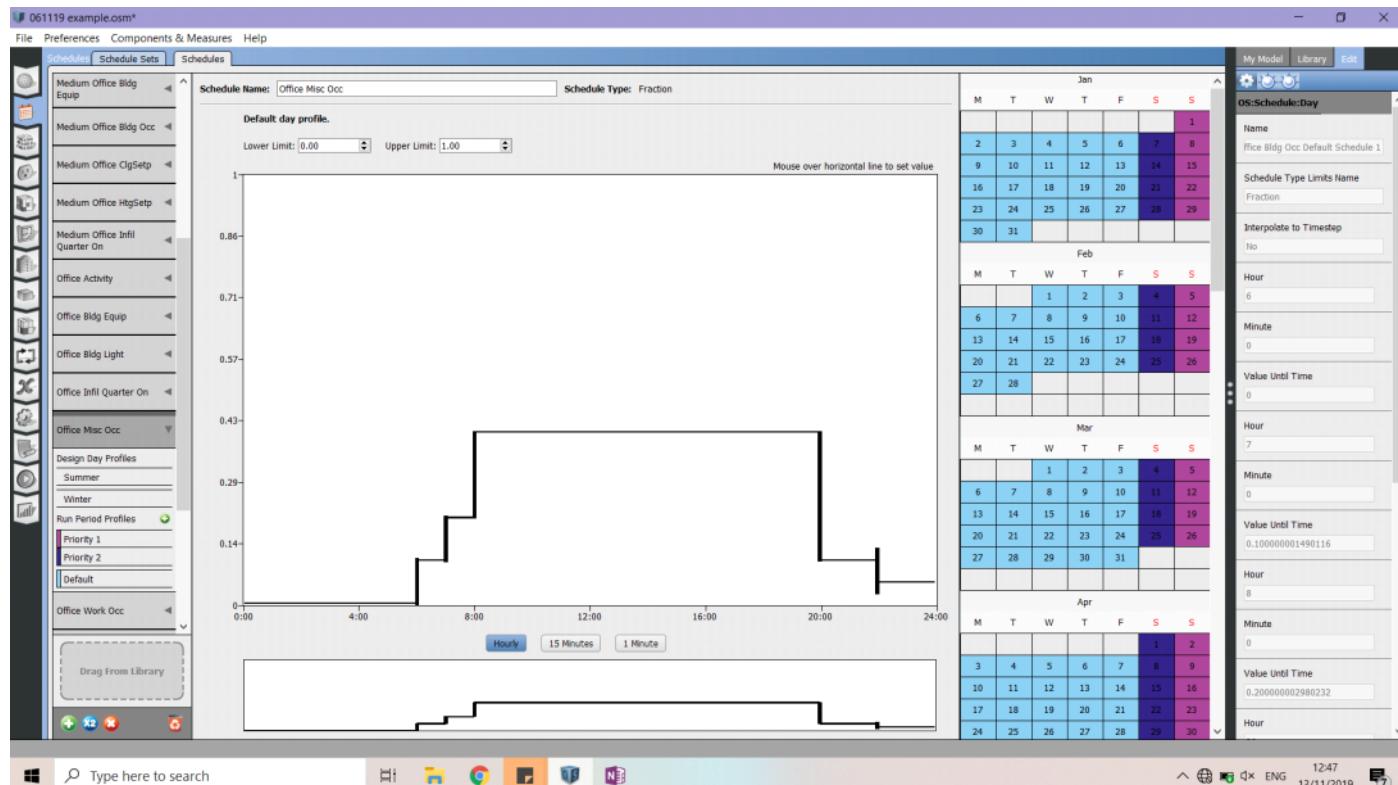
Its define the feeling inside the building. (indoor temperature)



Define the worst case scenarios to set the temperature inside the offices.

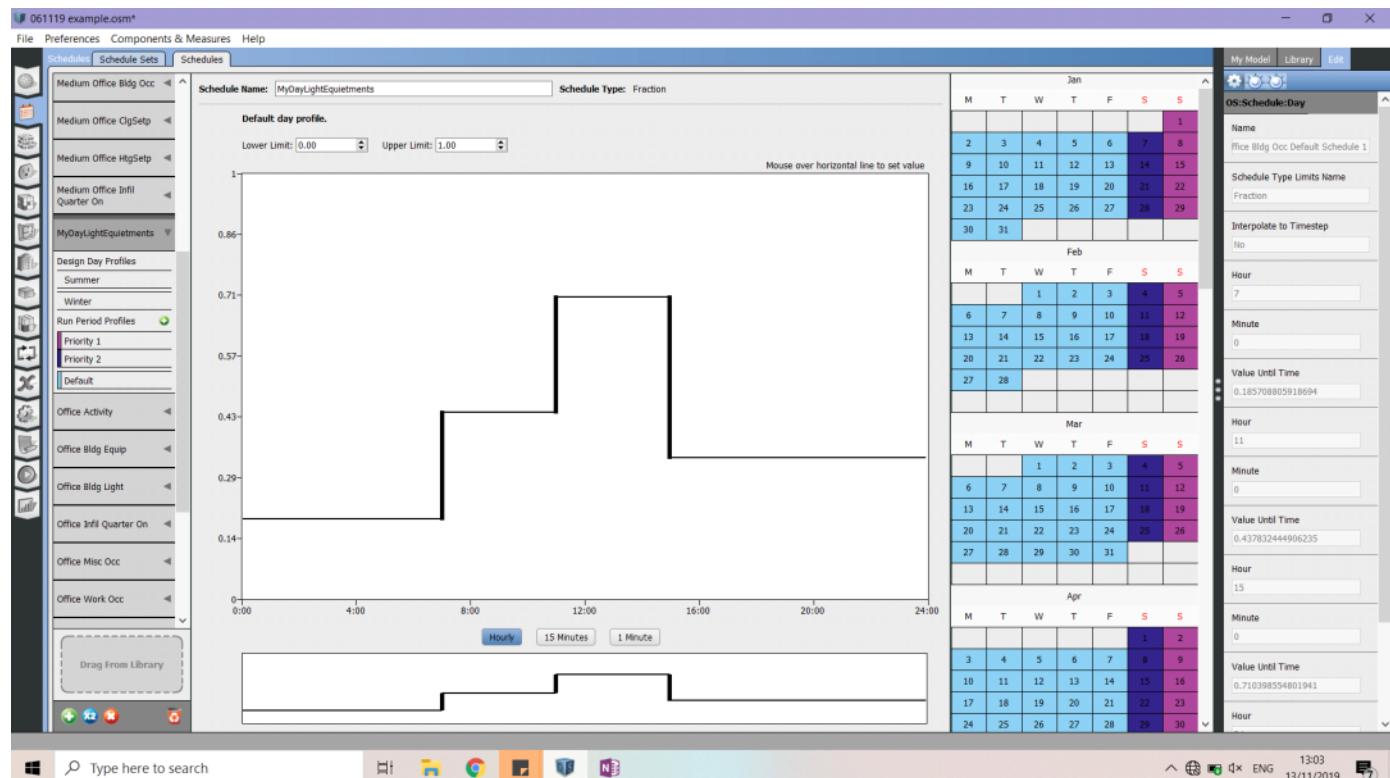
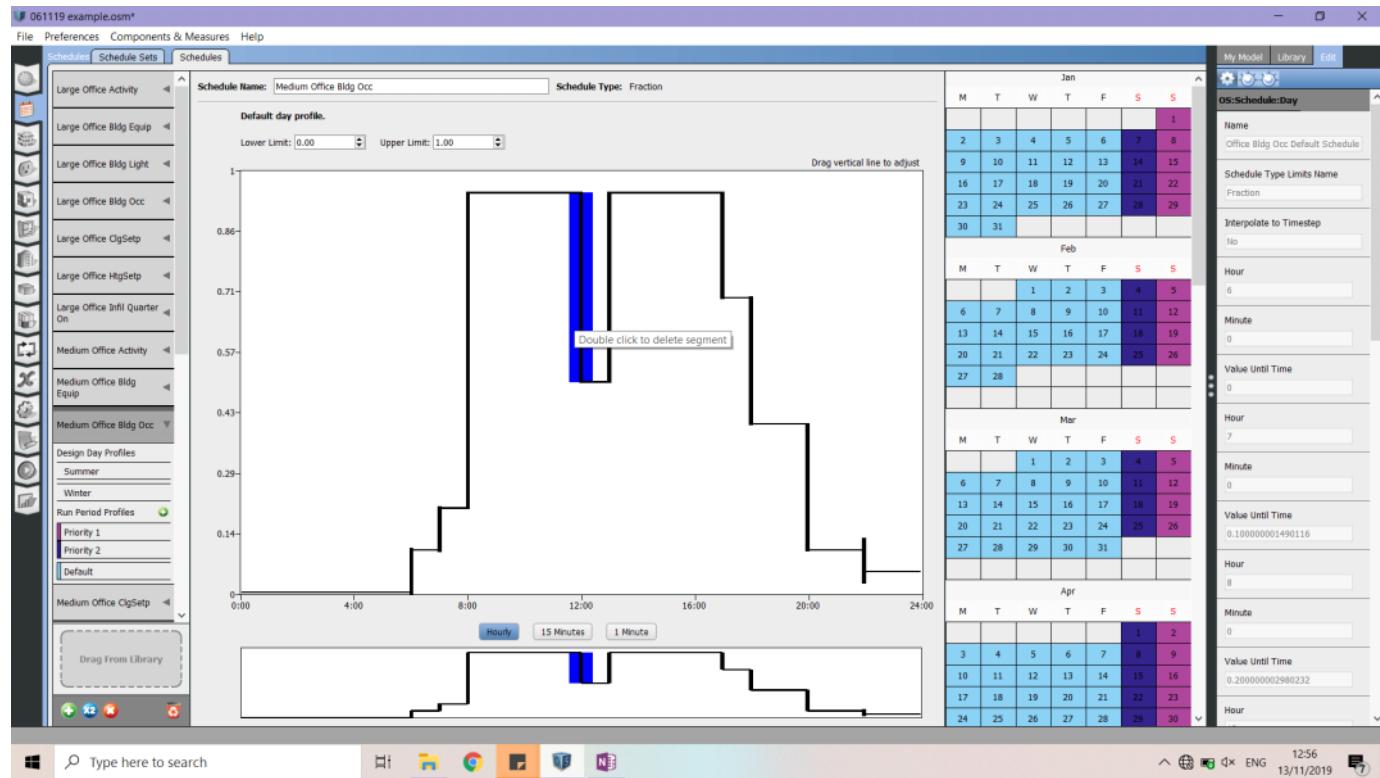
In winter time- no one in the office that could help the room stay warmer.

In summer time- long office hours a lot of people inside



0-1 on the graph: the effect of the light (day profile).

To change the graph - just double click one what need to be modify, and its changes.



Define a new schedule :

