

Task 1 Considering the same example you solved in the previous assignment (radiative heat transfer between two parallel plates), how many shields with $\epsilon = 0.1$ should you add in order to have the new heat transfer rate to be 1% of the case without shields ?

Problem (previous assignment)

Find the net radiative heat exchange between the surface 1 and the surface 2 where $A_1 = 1,5 \text{ m}^2$, $\epsilon_1 = 0,1$, $\epsilon_2 = 0,1$, $T_1 = 298 \text{ K}$, $T_2 = 308 \text{ K}$, $\sigma = 5,67 \cdot 10^{-8} \text{ W/m}^2\text{K}^4$

Answer

$$\dot{Q}_{\text{net}2-1} = A\sigma(T_2^4 - T_1^4) / (1/\epsilon_1 + 1/\epsilon_2 - 1) = 1,5 * 5,67 * 10^{-8} * (308^4 - 298^4) / (1/0,1 + 1/0,1 - 1) = 4,9823 \text{ W}$$

$$F_{21} = 1/(1/\epsilon_1 + 1/\epsilon_2 - 1) = (1/0,1 + 1/0,1 - 1) = 0,0526$$

Considering $F_{12} = 0,01$

$$\dot{Q}_{\text{net}1-2} = AF_{12}\sigma(T_2^4 - T_1^4) = 1,5 * 0,01 * 5,67 * 10^{-8} * (298^4 - 308^4) = -0,9466 \text{ W}$$

$$A_1 = A_2$$

$$\dot{Q}_{\text{net}2-1} = -\dot{Q}_{\text{net}1-2} = 0,9466 \text{ W}$$

Comparing the two values of the net heat exchange, we can see the value of emissivity would greatly affect the radiative heat exchange between the surfaces

Answer (new assignment)

$$(N + 1) * \dot{Q}_{21,N\text{shield}} = \dot{Q}_{21,\text{noshield}}$$

$$(N + 1) = \frac{100\% \dot{Q}_{21,\text{noshield}}}{1\% \dot{Q}_{21,\text{noshield}}} = \frac{100}{1} = 100$$

$$N = 100 - 1 = 99$$

$$\epsilon_{3,1} = \epsilon_{3,2} = 0,1$$

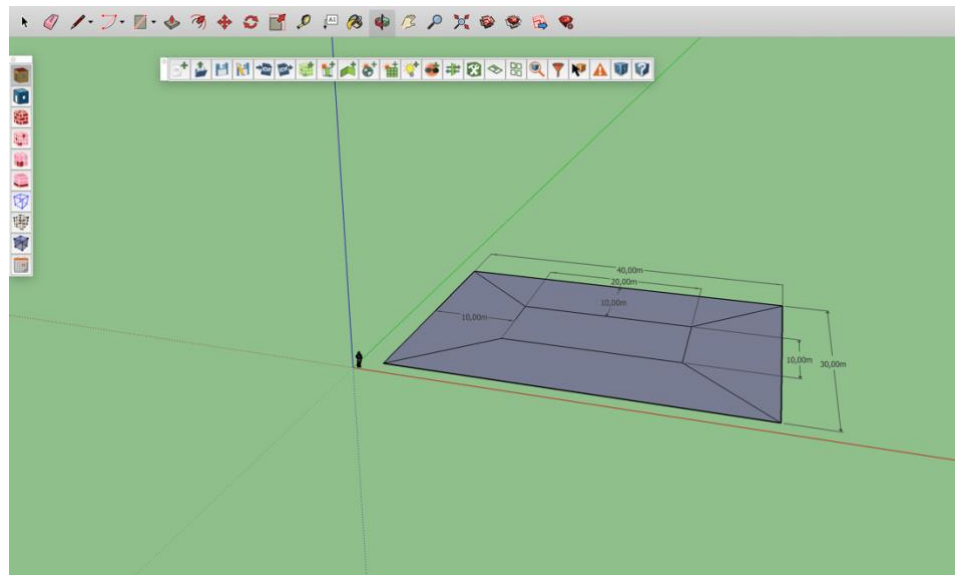
$$\dot{Q}_{21,N\text{shields}} = 1\% \text{ of } \dot{Q}_{2-1} = \frac{1}{100} * 4,9823 = 0,0049823 \text{ W}$$

$$\dot{Q}_{21,\text{noshield}} = \frac{A\sigma(T_2^4 - T_1^4)}{\left(\frac{1}{\epsilon_1} + \frac{1}{\epsilon_2} - 1\right)} = 1,5 * 5,67 * 10^{-8} * \frac{308^4 - 298^4}{\left(\frac{1}{0,1} + \frac{1}{0,1} - 1\right)} = 8,505 * 10^{-8} * \frac{1113028080}{19} = 4,9823 \text{ W}$$

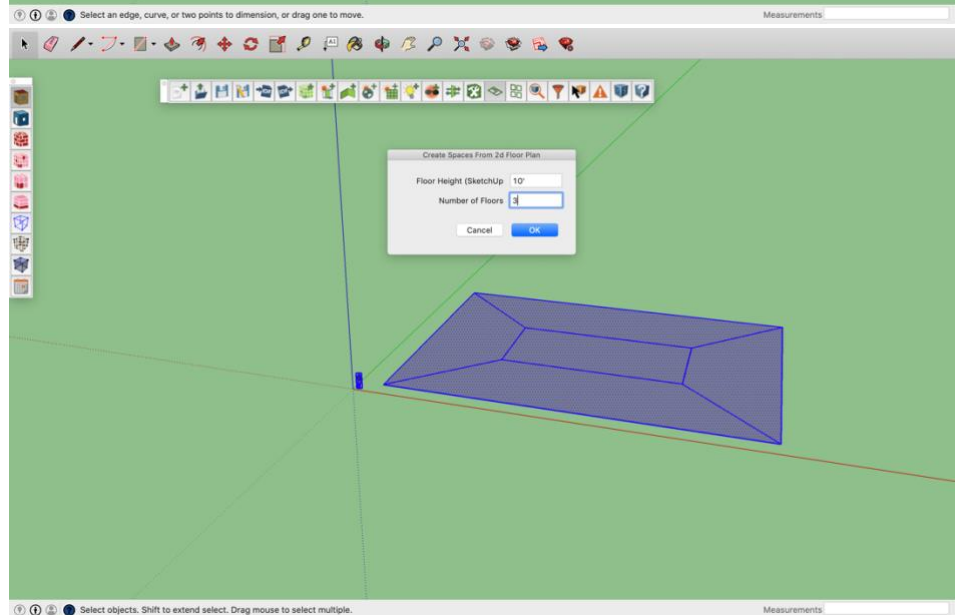
$$\begin{aligned}
 \dot{Q}_{21,Nshield} &= \frac{A\sigma(T_2^4 - T_1^4)}{(N+1) * \left(\frac{1}{\varepsilon} + \frac{1}{\varepsilon} - 1\right)} = \frac{1}{N+1} * \dot{Q}_{21,noshield} \\
 &= 1,5 * 5,67 * 10^{-8} * \frac{308^4 - 298^4}{(99+1) \left(\frac{1}{0,1} + \frac{1}{0,1} - 1\right)} = 8,505 * 10^{-8} * \frac{1113028080}{19+100} \\
 &= 0,0049823 \text{ W}
 \end{aligned}$$

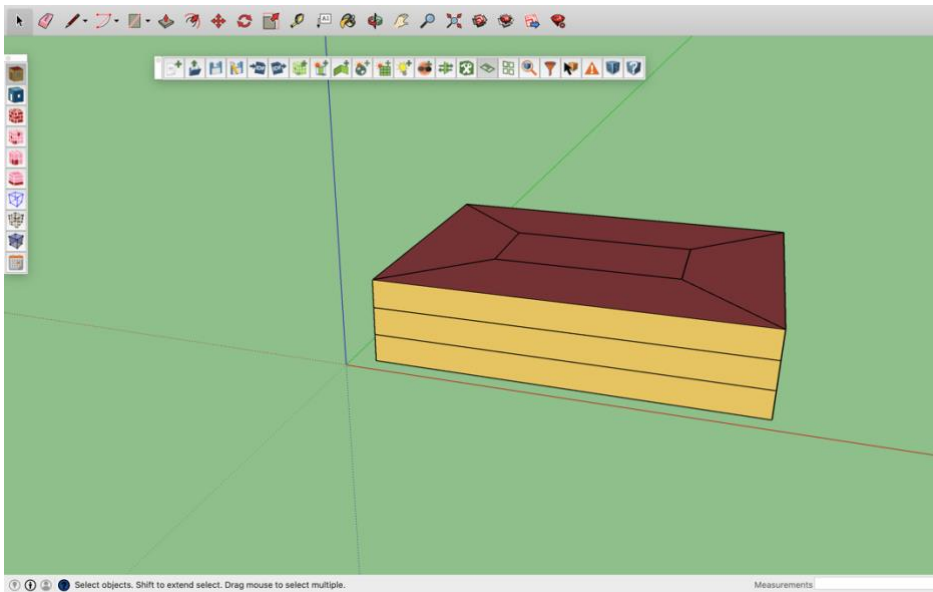
Task 2 You should create a pdf file with screenshots of all of the steps we went through (clearly from your own file) and explain briefly the reason behind the use of each step (in your own words!)

First step : open sketch up and draw a rectangular 40*30 m, draw another rectangular 20*10 m inside of it and connect the corners of the two rectangular together

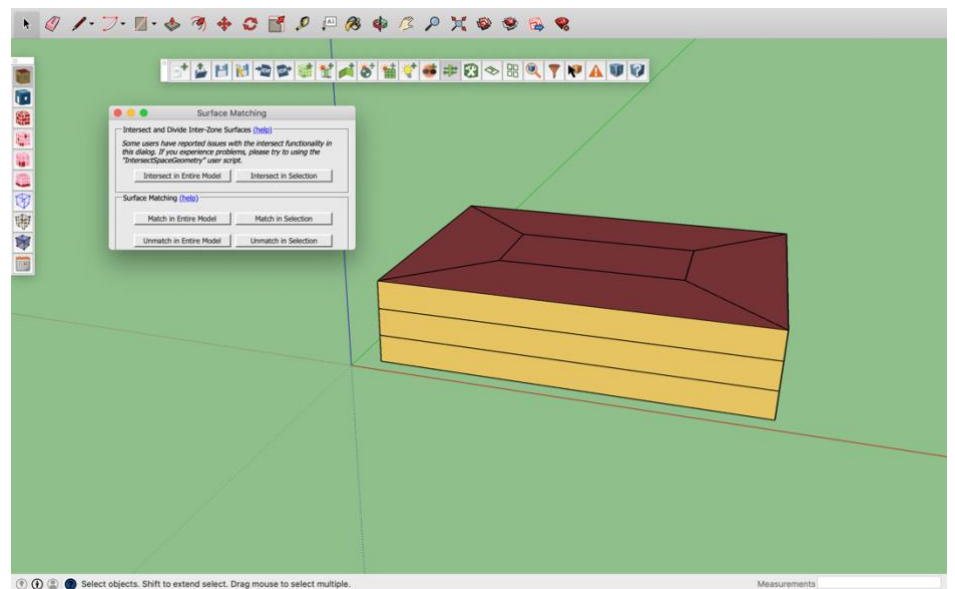


Second step: Create the diagram using the OpenStudio tool (3 number of floors)

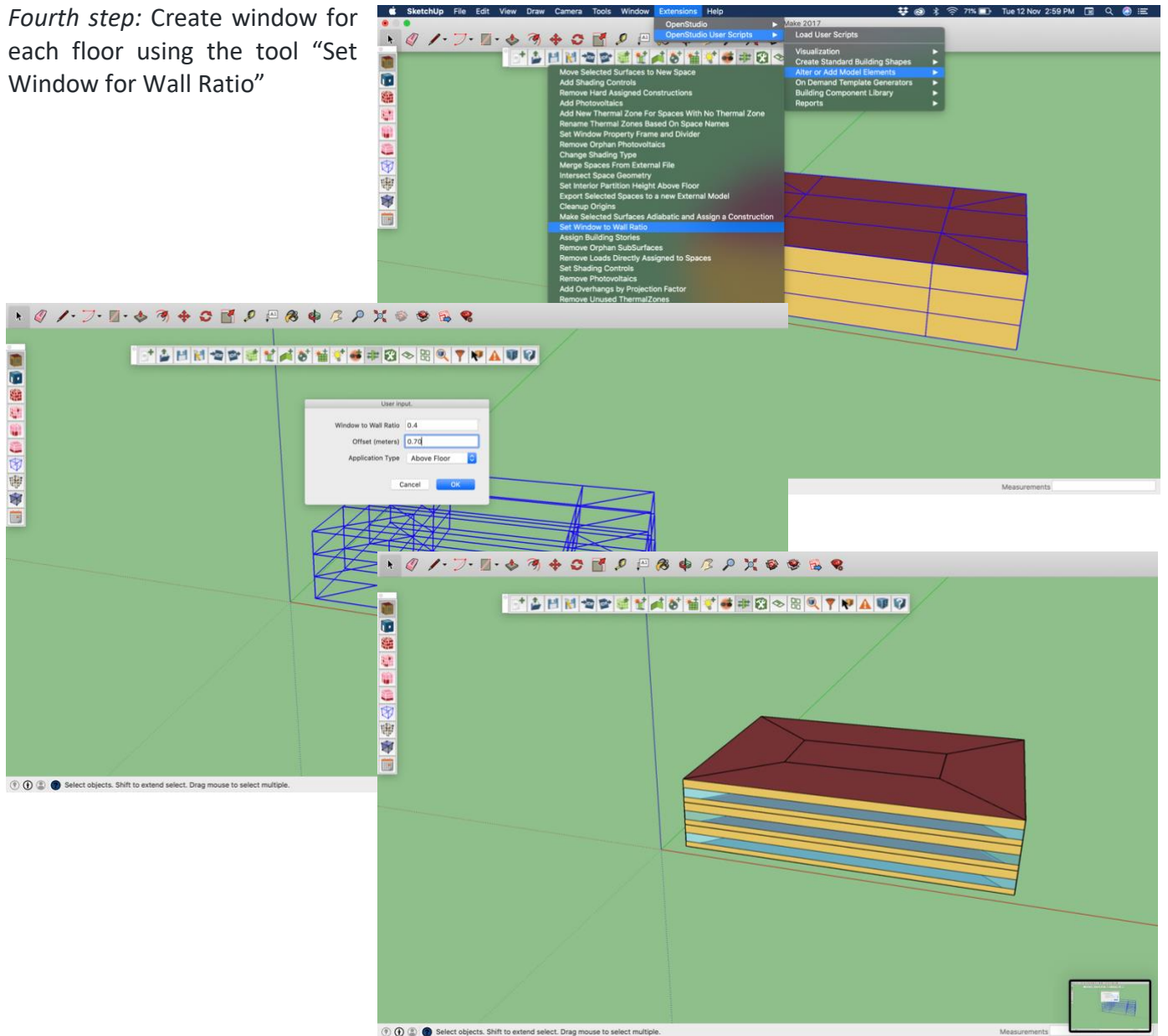




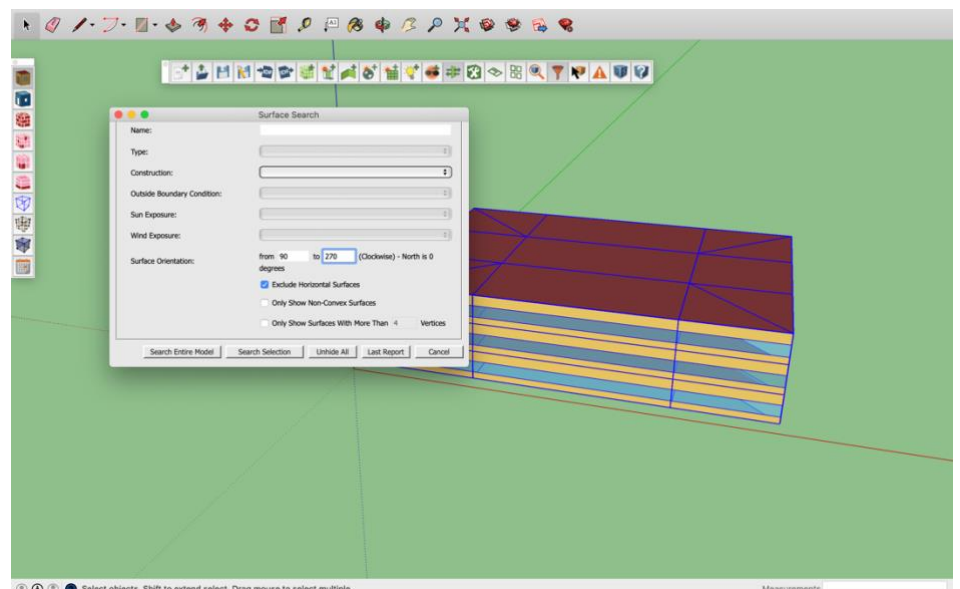
Third step: Select all the buildings and use “Surface matching tool” in order to create windows inside the building

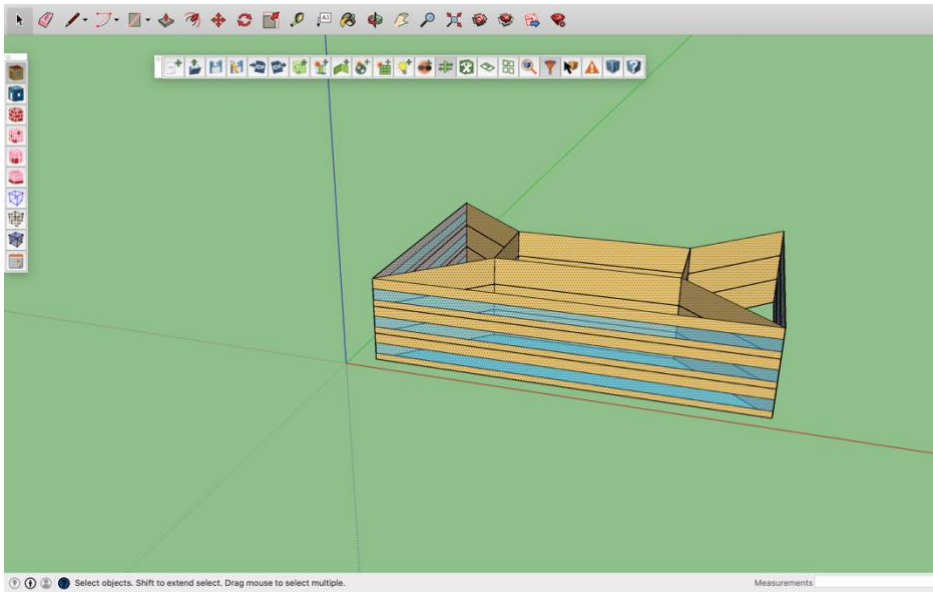


Fourth step: Create window for each floor using the tool “Set Window for Wall Ratio”

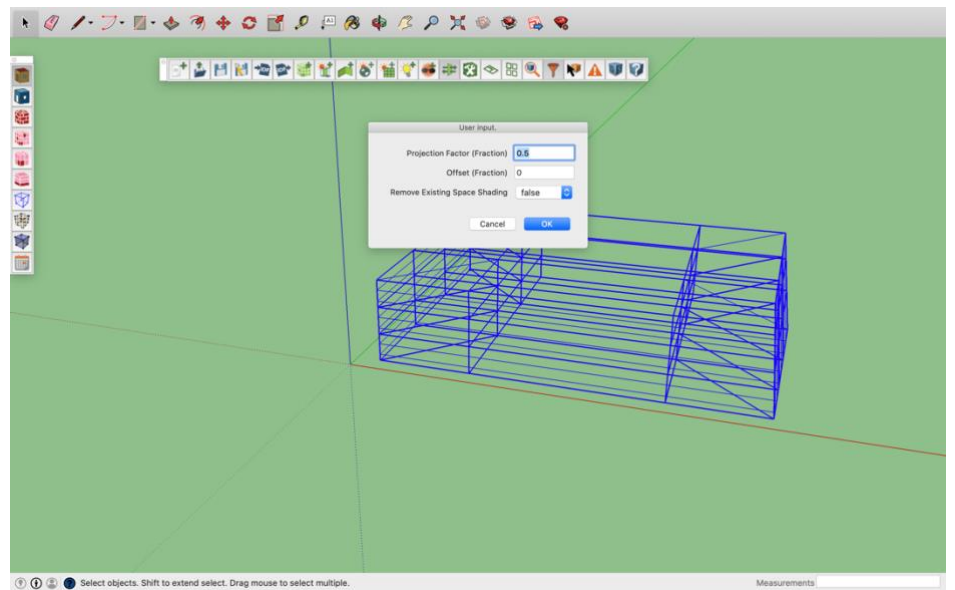


Fifth step: Use the tool “surface search” and set the surface orientation from 90 to 270° in order to select only the three surface of the building (est-ovest-sud) except the surface oriented to the north

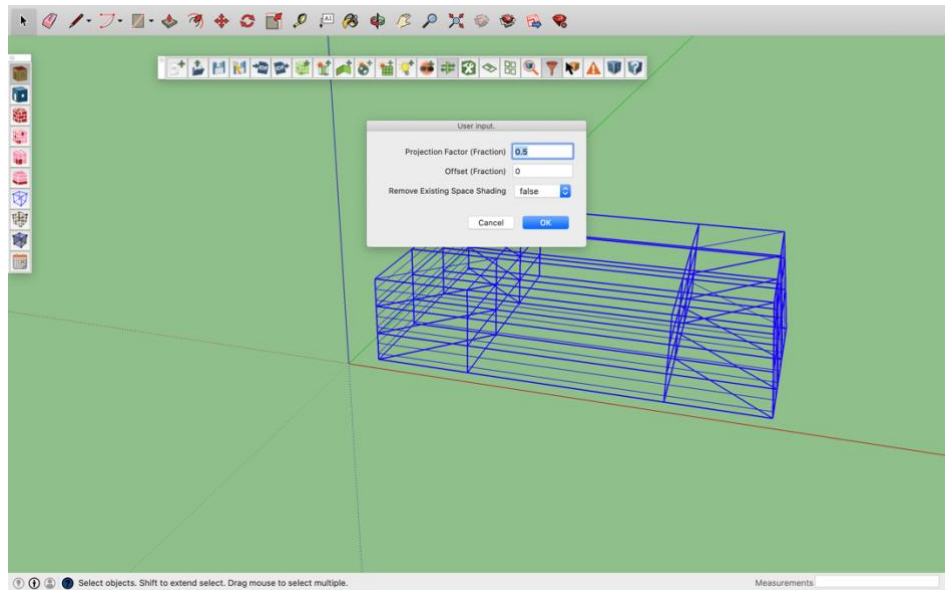




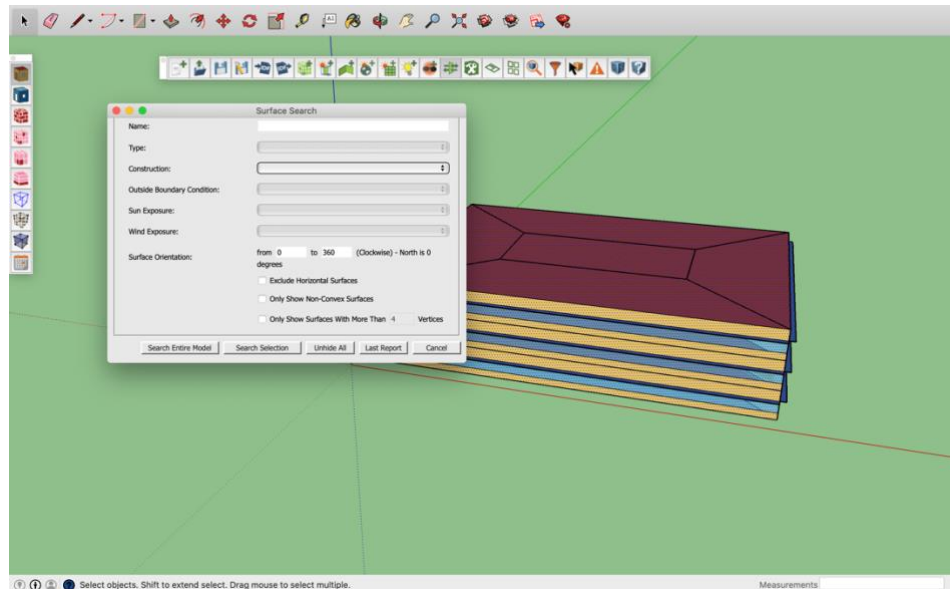
Sixth step: Put the external shadows in the building using the tool “add overhang by projection factor”



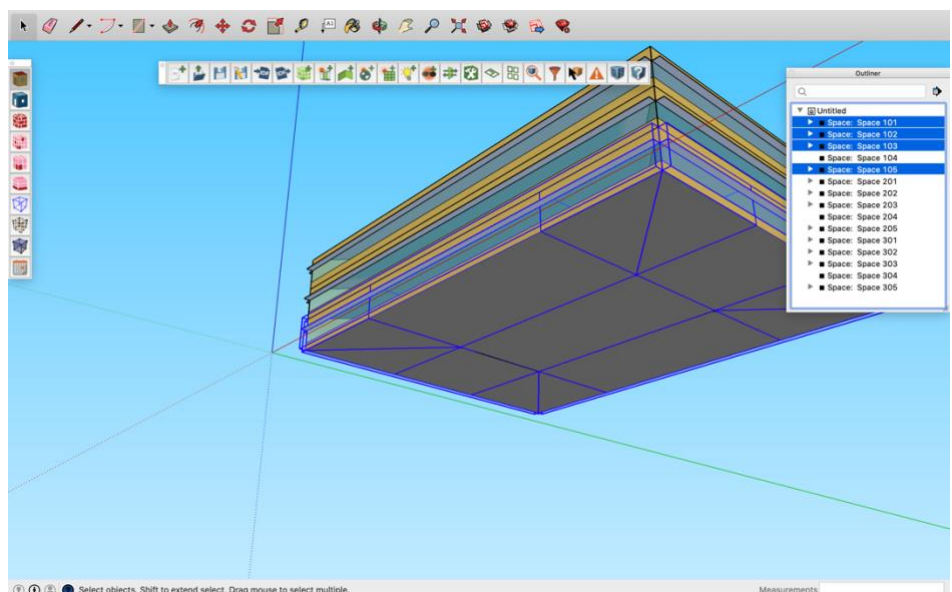
Seventh step: Put the external shadows in the building using the tool “add overhang by projection factor”

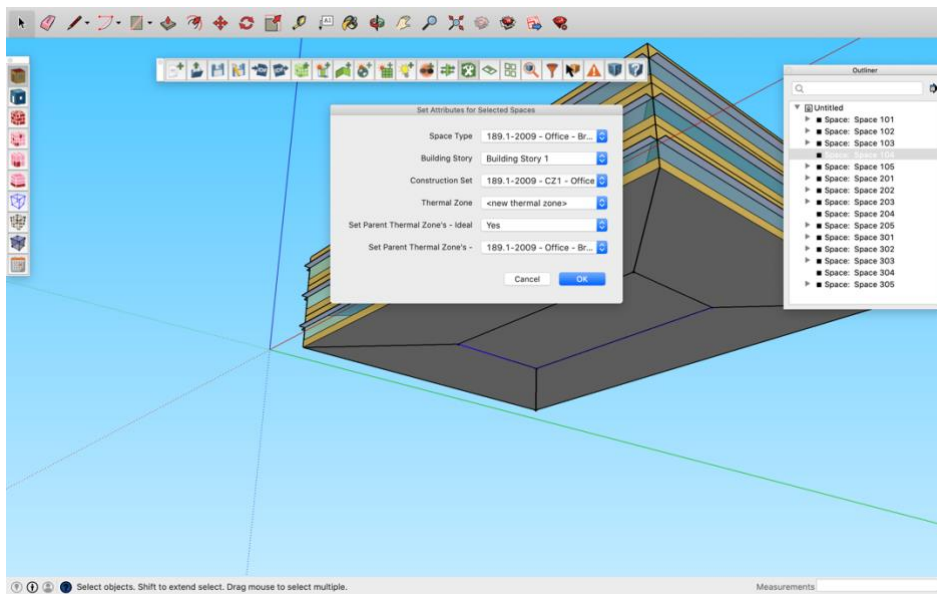


Eighth step: Restore the entire building using the “surface search” (0-360° surface)

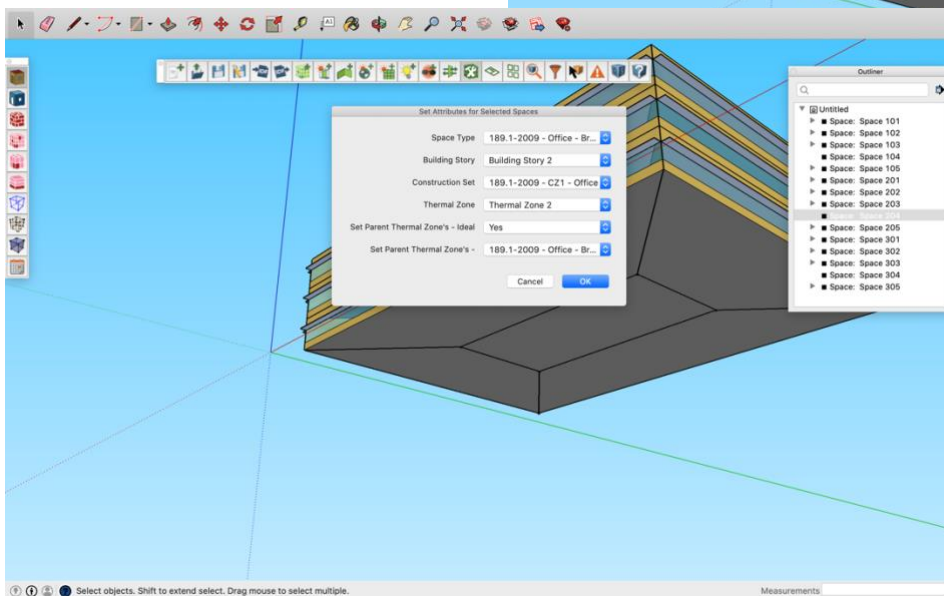
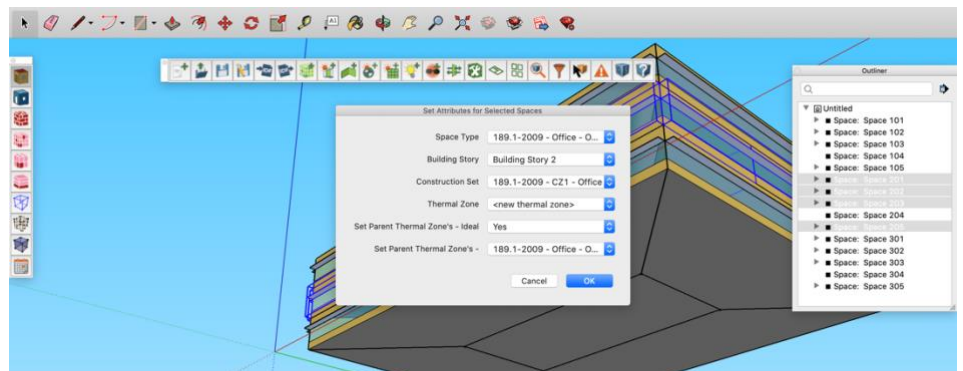


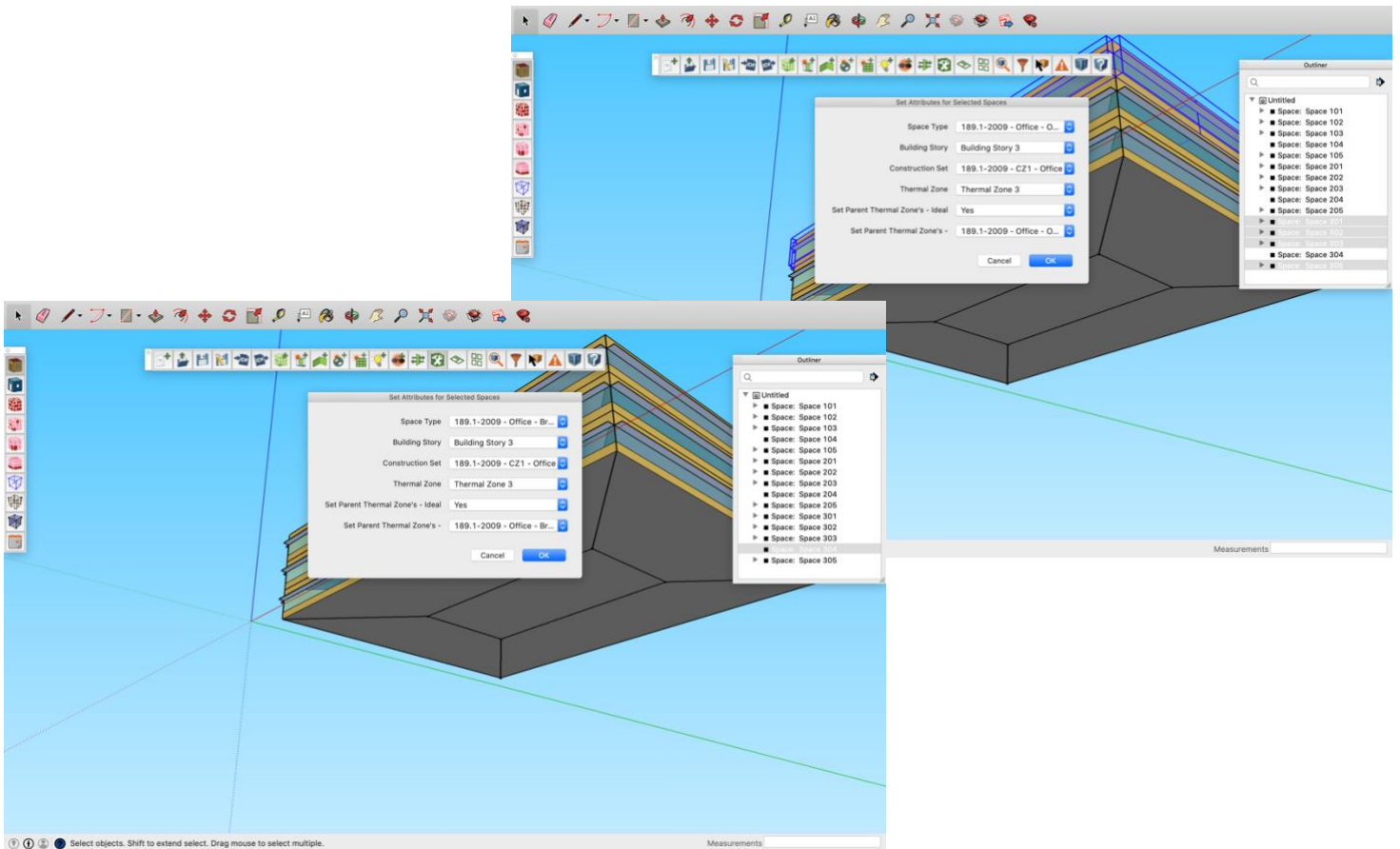
Ninth step: Put the “outliner” in the tray and after choose each thermal zone and add the specifications. The first selection takes in account the three zone of the office in the first level and after the break room in the first floor



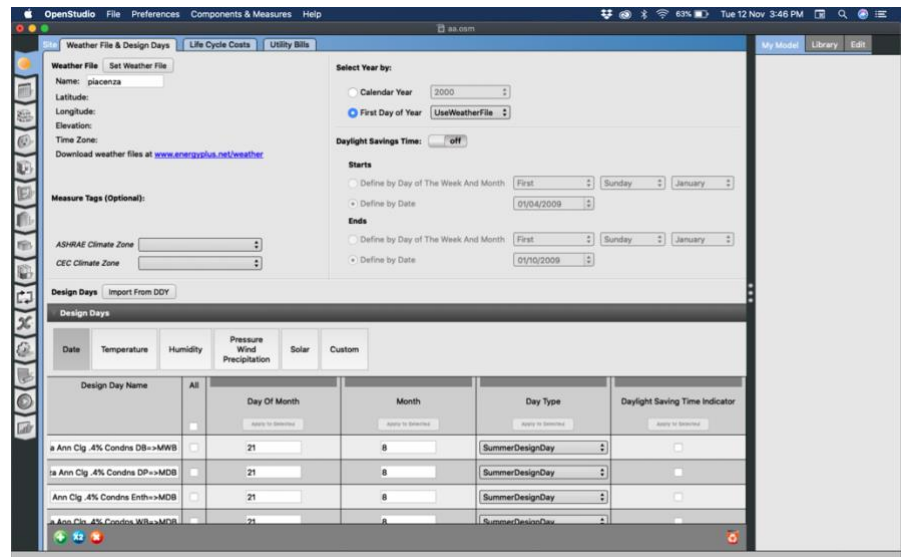


Tenth step: Repeat the previous passage for the others levels

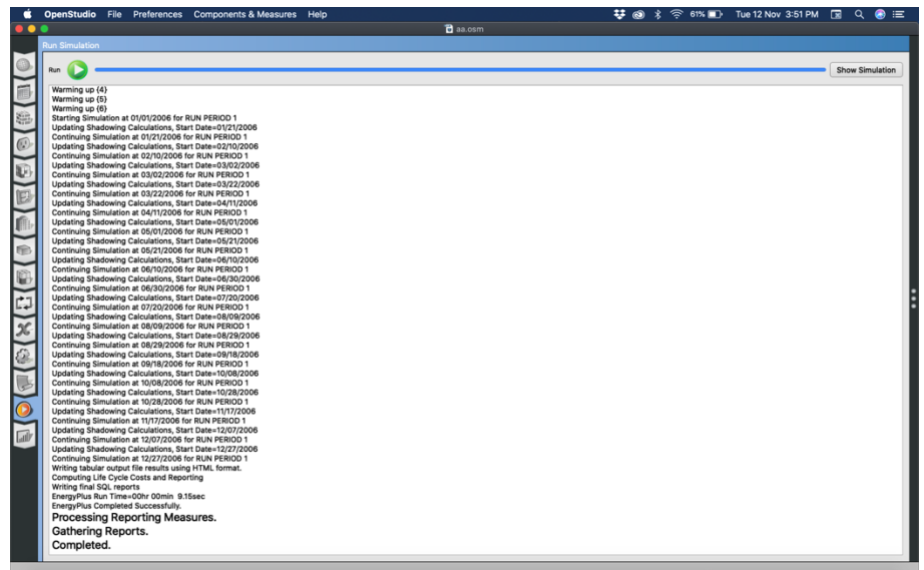




Eleventh step: Save the file in .osm format and open Open Studio. Add the data related to Piacenza weather in Open studio



Twelfth: Run the model to obtain the final simulation



Final passage: Check and review the final result

The screenshot shows the 'Results Summary' window in OpenStudio. The 'Reports' dropdown is set to 'EnergyPlus Results'. The window displays the following information:

- Program Version: EnergyPlus, Version 9.2.0-921312fa1d, YMD=2019.11.12 15:51
- Tabular Output Report in Format: HTML
- Building: Building 1
- Environment: RUN PERIOD 1 ** Piacenza - ITA IGDG WMO#=160840
- Simulation Timestamp: 2019-11-12 15:51:18
- Report: Annual Building Utility Performance Summary
- For: Entire Facility
- Timestamp: 2019-11-12 15:51:18
- 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	2368.97	658.05	658.05
Net Site Energy	2368.97	658.05	658.05
Total Source Energy	6121.20	1700.33	1700.33
Net Source Energy	6121.20	1700.33	1700.33

Site to Source Energy Conversion Factors

	Site=>Source Conversion Factor
Electricity	3.167
Natural Gas	1.084