

## Week 6

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**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?

**Previous Homework.**

$$\dot{Q}_{no\ shield} = 1035.81\ W/m^2$$

**Formulas.**

$$\dot{Q}_{N\ shields} = \frac{A\sigma(T_1^4 - T_2^4)}{(N+1)\left(\frac{1}{\epsilon} + \frac{1}{\epsilon} - 1\right)}$$
$$\dot{Q}_{N\ shields} = \frac{1}{(N+1)}(\dot{Q}_{no\ shield})$$

**Solution.**

$$(1\%)(\dot{Q}_{no\ shield}) = \left(\frac{1}{N+1}\right)(100\%)(\dot{Q}_{no\ shield})$$

$$(0.01)(1035.81) = \left(\frac{1}{N+1}\right)(1)(1035.81)$$

$$N = \frac{1}{(0.01)} - 1$$

$$N = 99$$

**Checking.**

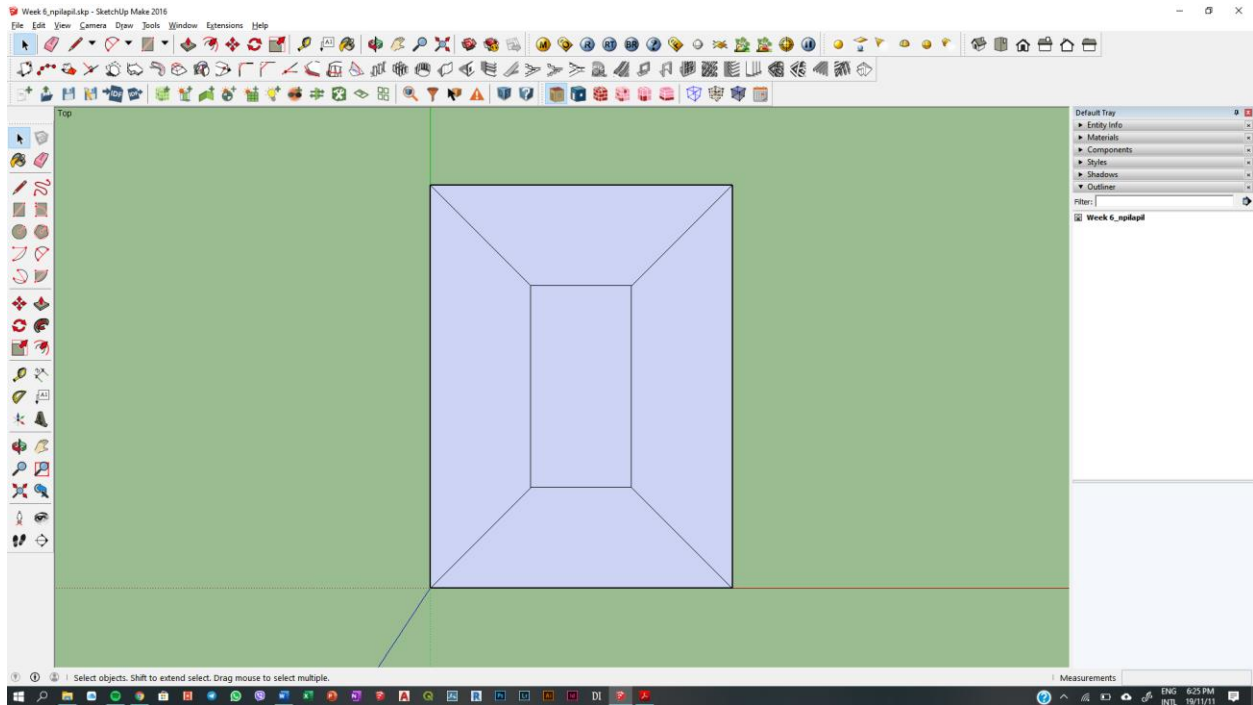
$$\dot{Q}_{N\ shields} = (1\%)(\dot{Q}_{no\ shield})$$

$$(1\%)(\dot{Q}_{no\ shield}) = (1\%)(1035.81) = 10.3581$$

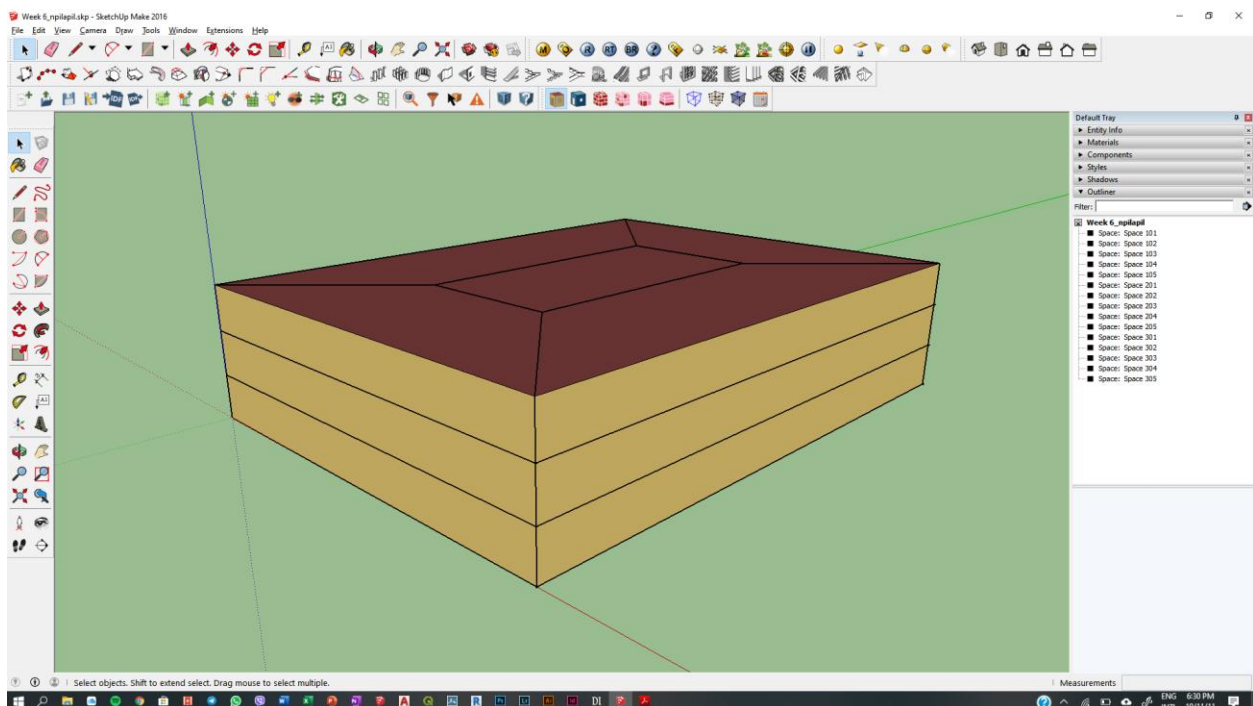
$$\dot{Q}_{99\ shields} = \frac{\sigma(T_1^4 - T_2^4)}{(N+1)\left(\frac{1}{\epsilon} + \frac{1}{\epsilon} - 1\right)} = \frac{(5.67)(10^{-8})(800^4 - 500^4)}{(99+1)\left(\frac{1}{0.1} + \frac{1}{0.1} - 1\right)} = 10.3581$$

**Task 2.** Create a PDF file with screenshots of all of the steps we went through and explain briefly the reason behind the use of each step.

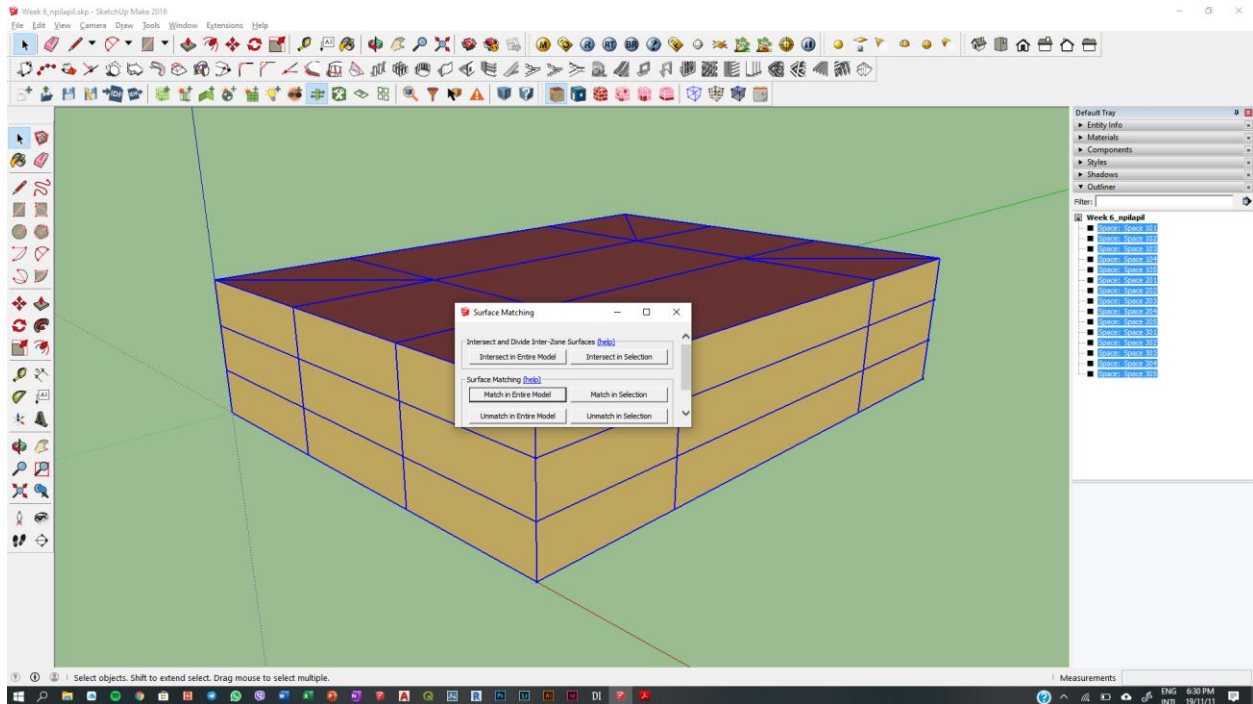
**1. Open Sketchup Make 2016 and create a 40x30m rectangle. Offset 10m and connect the 4 corners.**



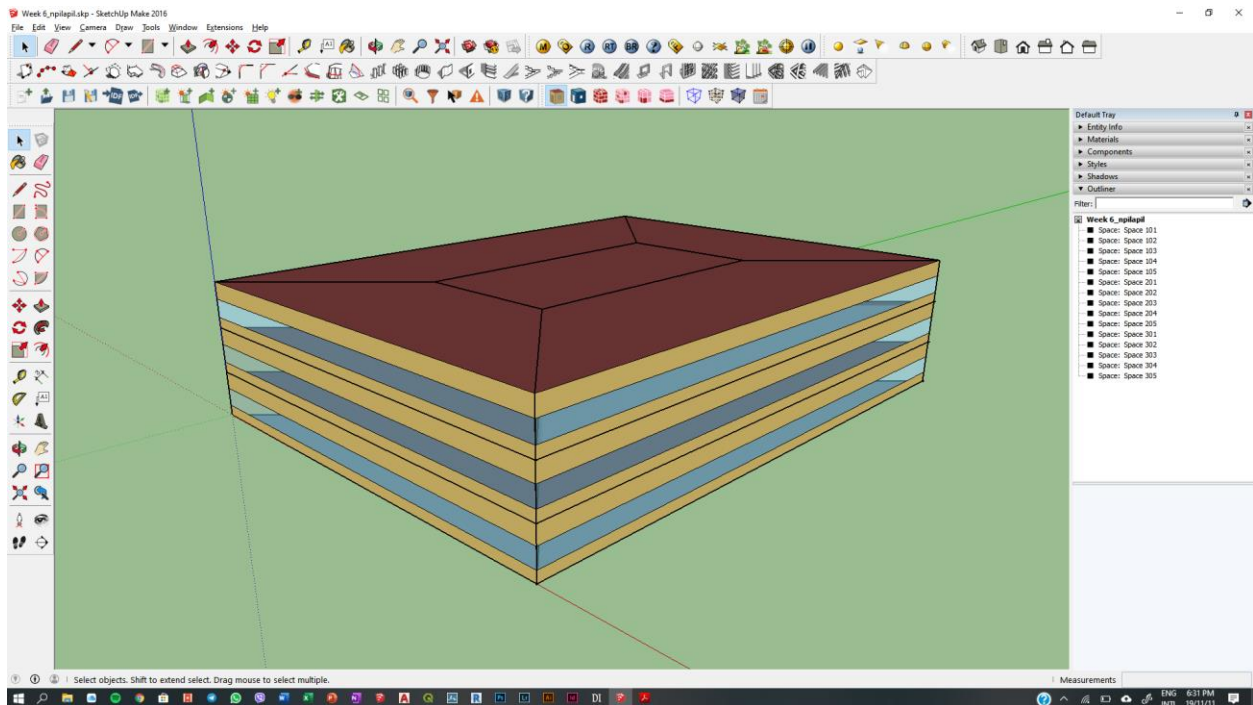
**2. Select the diagram and click Create Spaces from Diagram.**



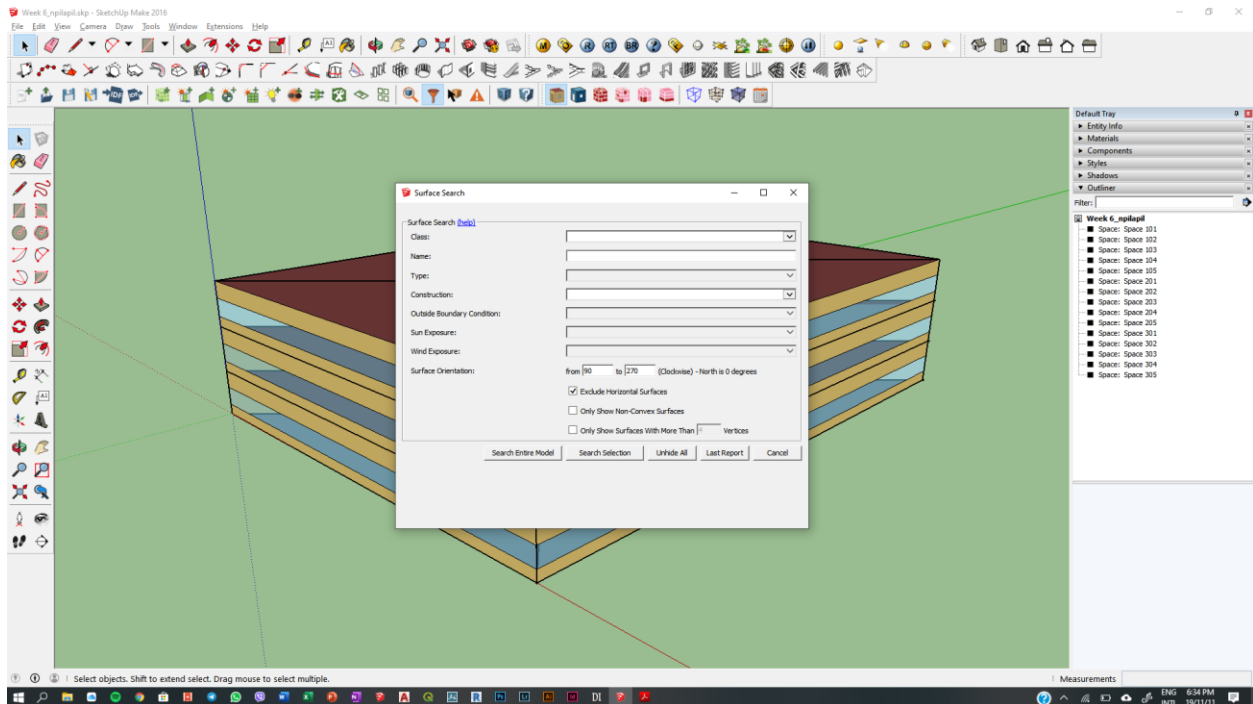
**3. Select entire model and carry out Surface Matching command. Choose Match in Entire Model. If this step is skipped, there might be windows inside the model.**



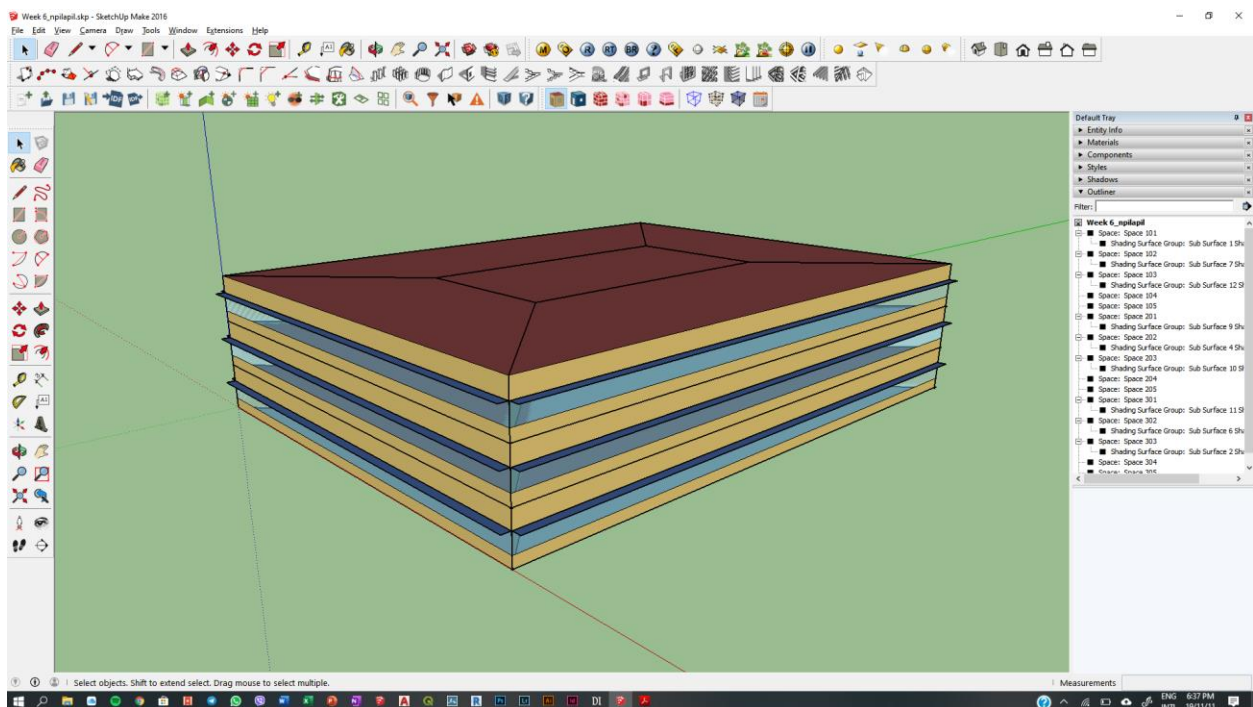
**4. To add windows, select all and go to Extensions > OpenStudio User Scripts > Alter or Add Model Elements > Set Window to Wall Ratio.**



## 5. To add shading, select all surfaces except the North by using the Surface Search tool.



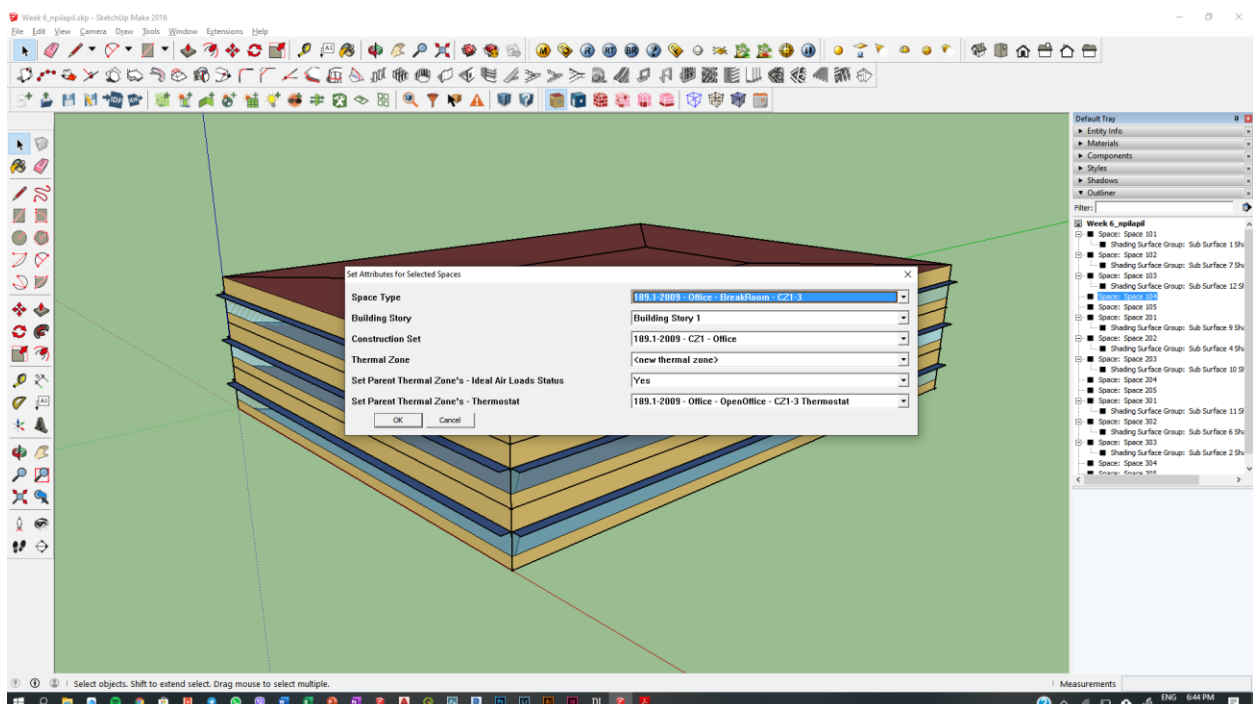
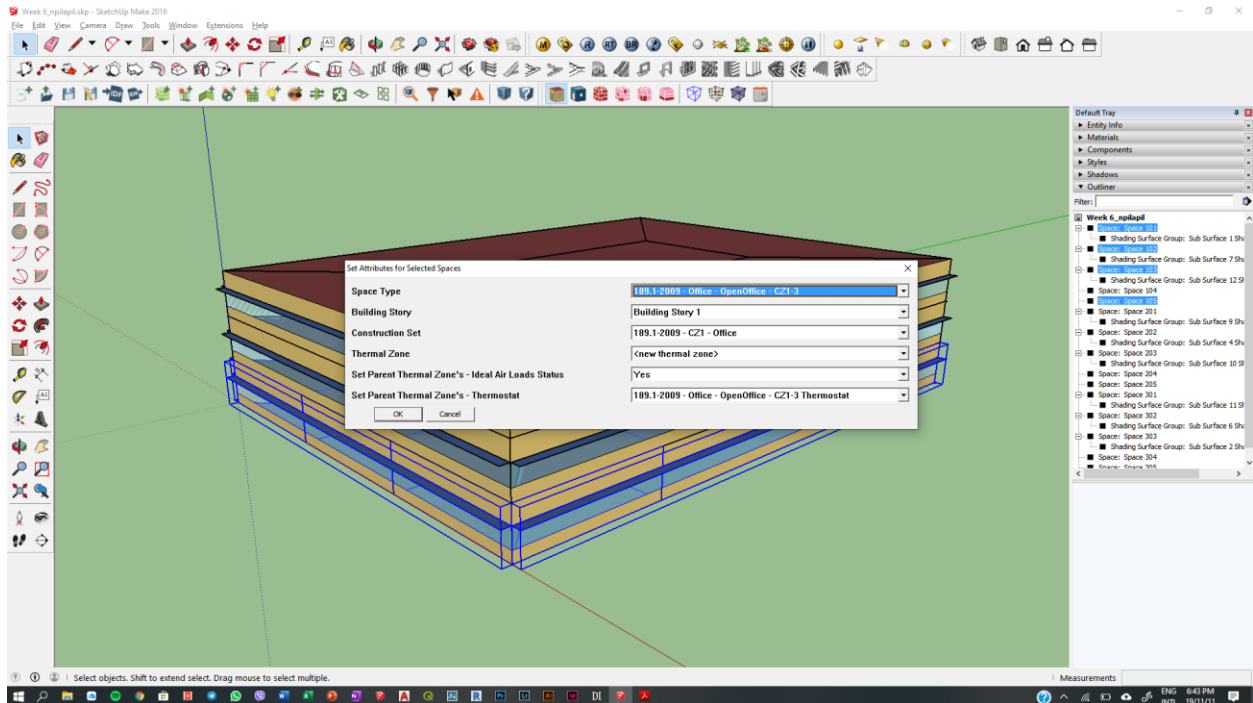
## 6. Add overhang (external shading) by going to Extensions > OpenStudio User Scripts > Alter or Add Model Elements > Add Overhangs by Projection Factor.



## 7. Using the Outliner and Set Attributes for Selected Spaces, we can set different thermal zones.

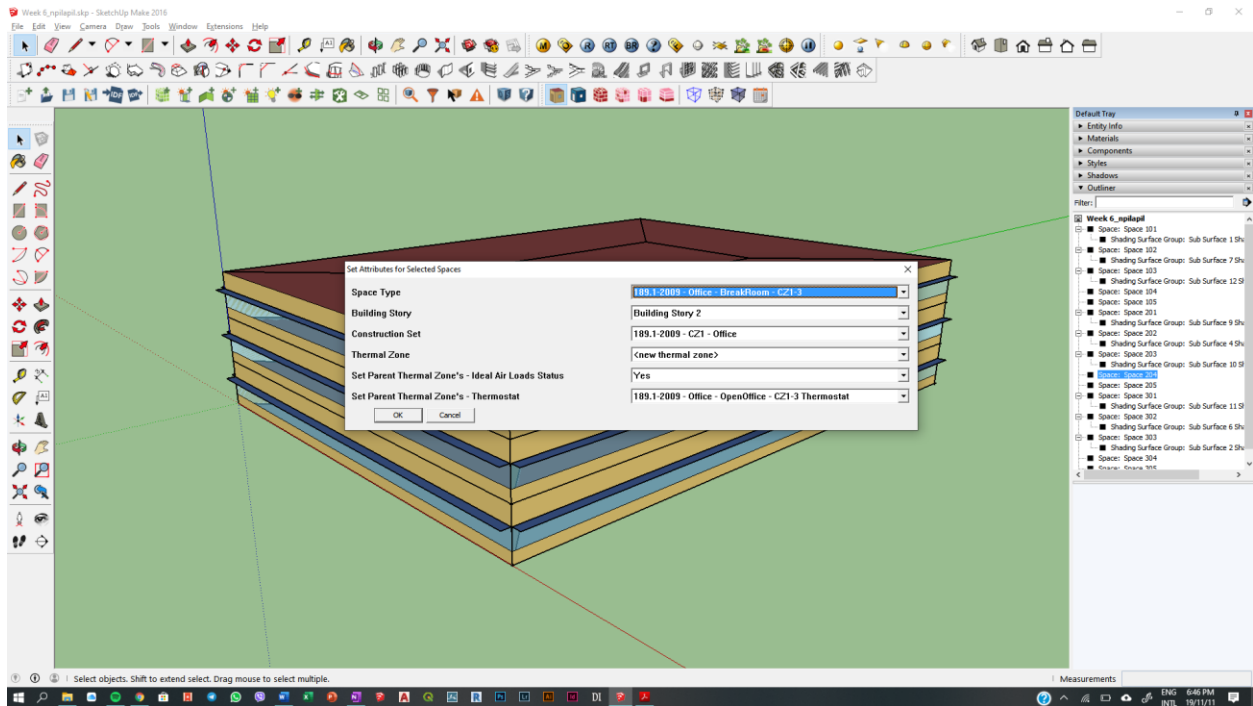
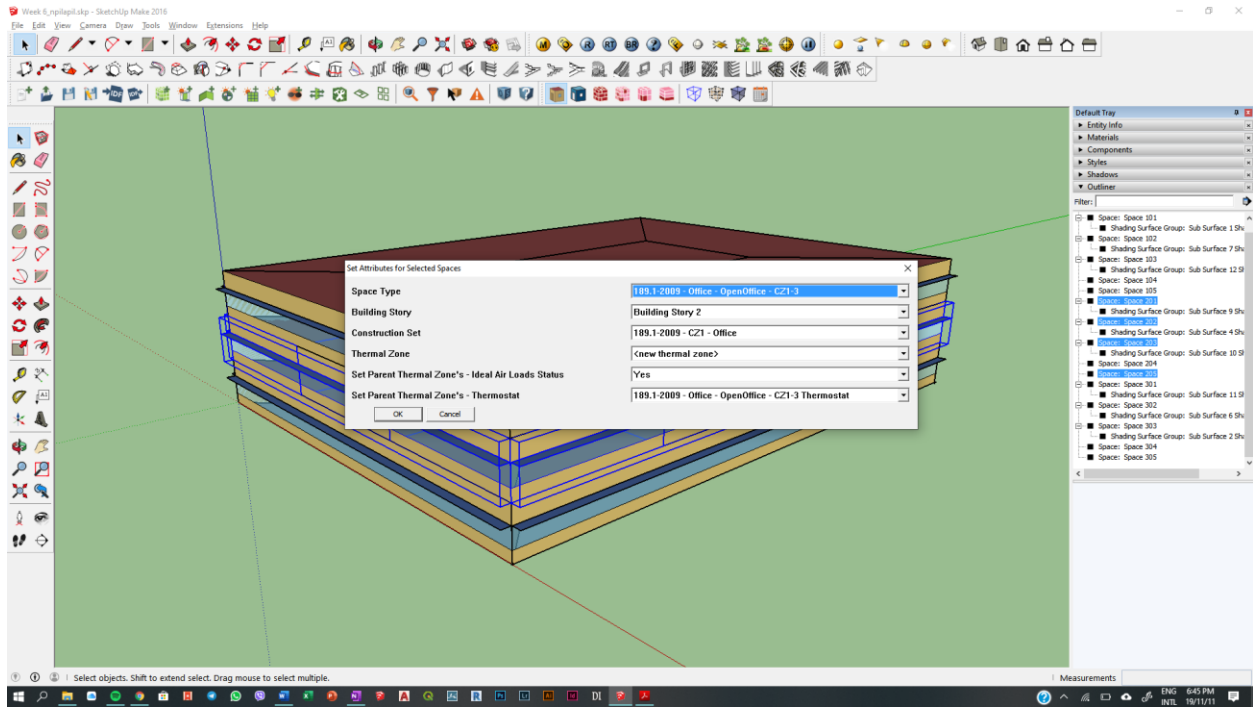
All X01, X02, X03, and X05 are set as Open Offices and X04 is set as a Break Room in all floors. Set each attribute as a different thermal zone. At the end of this step, there will be a total of 6 thermal zones in the building, 2 per floor.

### 1<sup>st</sup> Floor Thermal Zones

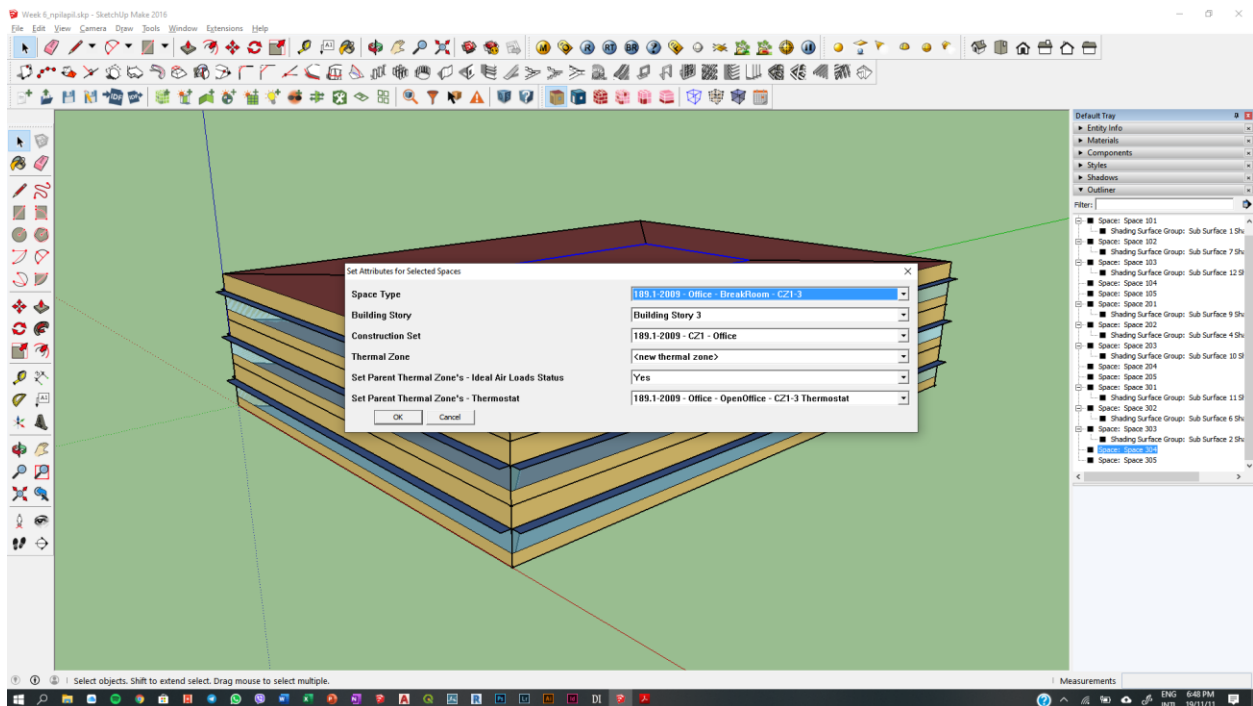
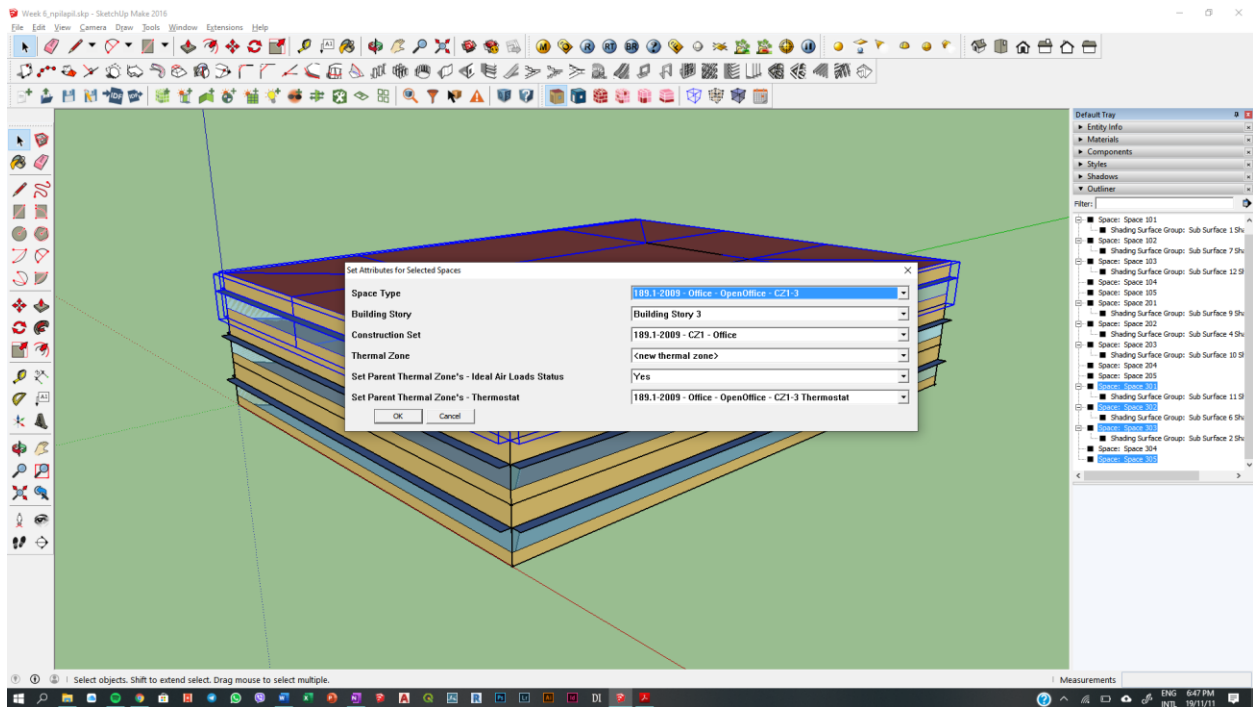




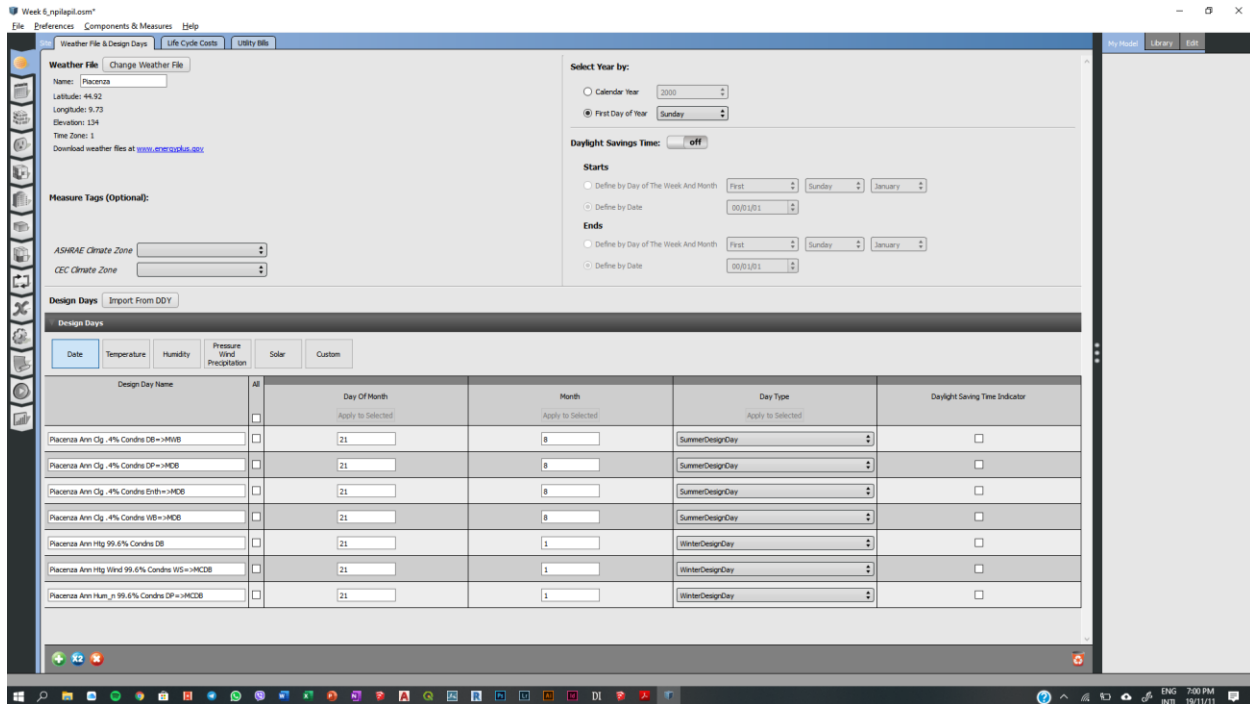
## 2<sup>nd</sup> Floor Thermal Zones



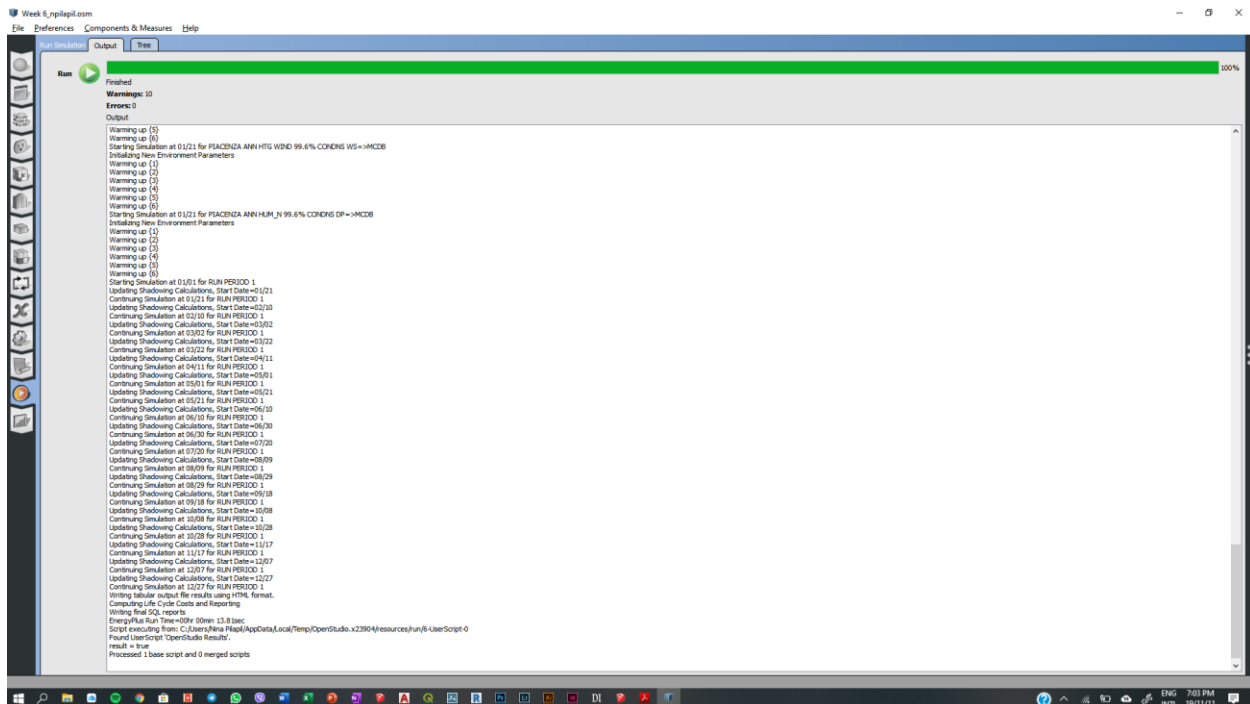
### 3<sup>rd</sup> Floor Thermal Zones



**8. Open the OpenStudio file. Choose Discard when asked if you want to save the modifications. Import the weather data provided for Piacenza.**



## 9. Run the model.





## 10. Review the results.

### OpenStudio Results:

The screenshot shows the OpenStudio Results application window. The left sidebar contains a list of reports, with 'Model Summary' selected. The main content area displays the 'OpenStudio Results' title and the 'Model Summary' report. The 'Building Summary' tab is active, showing a table of building information.

Information	Value	Units
Building Name	Building 1	building_name
Net Site Energy	2,248,886	kBtu
Total Building Area	38,750	ft²
EUI (Based on Net Site Energy and Total Building Area)	58.04	kBtu/ft²
OpenStudio Standards Building Type		

Below the Building Summary, the 'Weather Summary' tab is visible, showing a table of weather data.

	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	

### EnergyPlus Results:

The screenshot shows the EnergyPlus Results application window. The left sidebar contains a list of reports, with 'EnergyPlus Results' selected. The main content area displays the 'EnergyPlus Results' title and the 'Annual Building Utility Performance Summary' report. The 'Building: Building 1' tab is active, showing a table of energy performance data.

Program Version: EnergyPlus, Version 8.5.0-c87e61b44b, YMD=2019.11.11 19:01  
Tabular Output Report in Format: HTML  
Environment: RUN PERIOD 1 \*\* Piacenza - ITA IGDG WMO#160840  
Simulation Timestamp: 2019-11-11 19:01:44

Report: Annual Building Utility Performance Summary  
For: Entire Facility  
Timestamp: 2019-11-11 19:01:44  
Values gathered over 8760.00 hours

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m²]	Energy Per Conditioned Building Area [MJ/m²]
Total Site Energy	2372.70	659.08	659.08
Net Site Energy	2372.70	659.08	659.08
Total Source Energy	6126.52	1701.81	1701.81
Net Source Energy	6126.52	1701.81	1701.81

Site to Source Energy Conversion Factors

	Site to Source Conversion Factor
Electricity	3.167
Natural Gas	1.084
District Cooling	1.056
District Heating	3.613
Steam	0.300
Gasoline	1.050