

## TASK 1

① ( $\varepsilon_1 = 0,2$ ;  $\varepsilon_2 = 0,7$ ;  $T_1 = 800\text{K}$ ;  $T_2 = 500\text{K}$ )

$$\dot{Q}_{12}^{\text{no shield}} = \frac{A \sigma (T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

$$\dot{Q}_{12}^{\text{n shields}} = \frac{1}{n+1} \cdot \dot{Q}_{12}^{\text{no shields}}$$

$$\begin{aligned} &= \frac{1}{100} \dot{Q}_{12}^{\text{no shields}} \\ &\uparrow \\ &\text{WE SET THIS EQUATION} \end{aligned}$$

$$\frac{1}{n+1} \cdot \cancel{\dot{Q}_{12}^{\text{no shields}}} = \frac{1}{100} \cdot \cancel{\dot{Q}_{12}^{\text{no shields}}}$$

$$\cancel{100} \cdot \frac{1}{n+1} = \frac{1}{100} \cdot \cancel{100}$$

$$\cancel{100} \cdot \frac{1}{n+1} = 1 \rightarrow 100 = n+1 \rightarrow n = 99$$

NUMBER OF SHIELDS NEEDED TO HAVE A HEAT TRANSFER WHICH EQUALS TO 1% OF THE HEAT TRANSFER WITHOUT SHIELDS

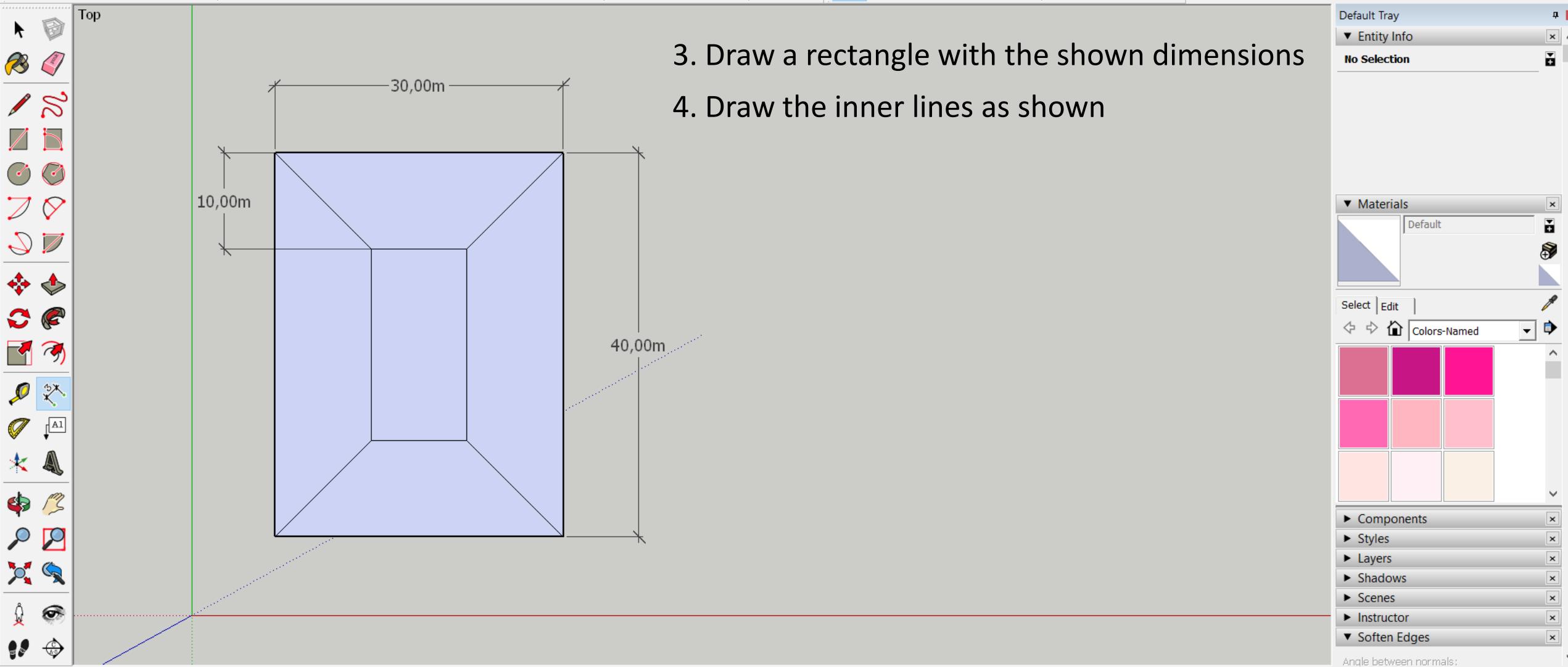
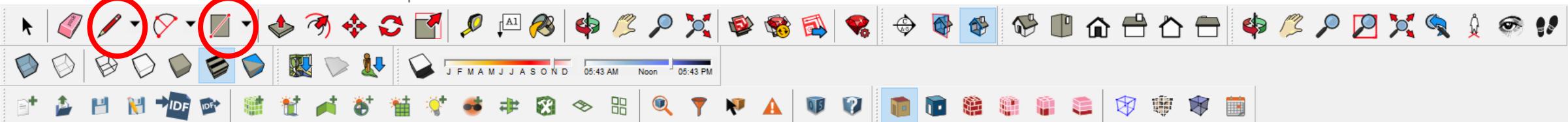
# TASK 2



+



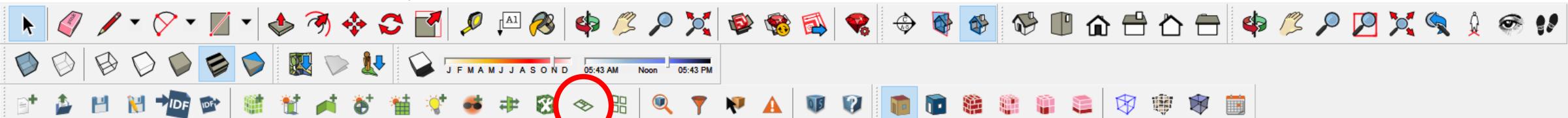
1. Open SketchUp with OpenStudio plug-in already installed
2. Follow the steps explained in the following slides



3. Draw a rectangle with the shown dimensions
4. Draw the inner lines as shown

Select an edge, curve, or two points to dimension, or drag one to move.

Measurements 18:26  
12/11/2019



5. Select everything and click on the command «create spaces from diagram»

6. Tipe «3» as number of floors, and then OK.

The screenshot shows a 3D model of a building's floor plan in the SketchUp workspace. A callout arrow points from the text "5. Select everything and click on the command «create spaces from diagram»" to the "Create Spaces From Diagram" icon in the toolbar, which is circled in red. Another callout arrow points from the text "6. Tipe «3» as number of floors, and then OK." to the "Number of Floors" input field in a dialog box titled "Create Spaces From 2d Floor Plan". The dialog box also shows a "Floor Height (SketchUp Units)" of "10'".

Default Tray

Entity Info

17 Entities

Layer: Layer0

Materials

Select Edit Colors-Named

Components

Styles

Layers

Shadows

Scenes

Instructor

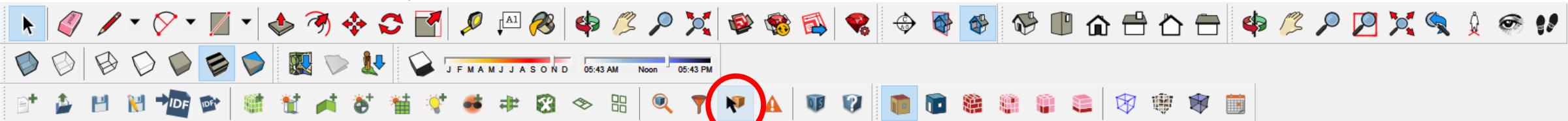
Soften Edges

Angle between normals:

The right side of the interface features several panels. The "Entity Info" panel lists 17 entities. The "Materials" panel shows a color palette with various named materials. Other panels like Components, Styles, Layers, Shadows, Scenes, Instructor, and Soften Edges are also visible.

Select objects. Shift to extend select. Drag mouse to select multiple.

Measurements



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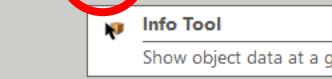
O

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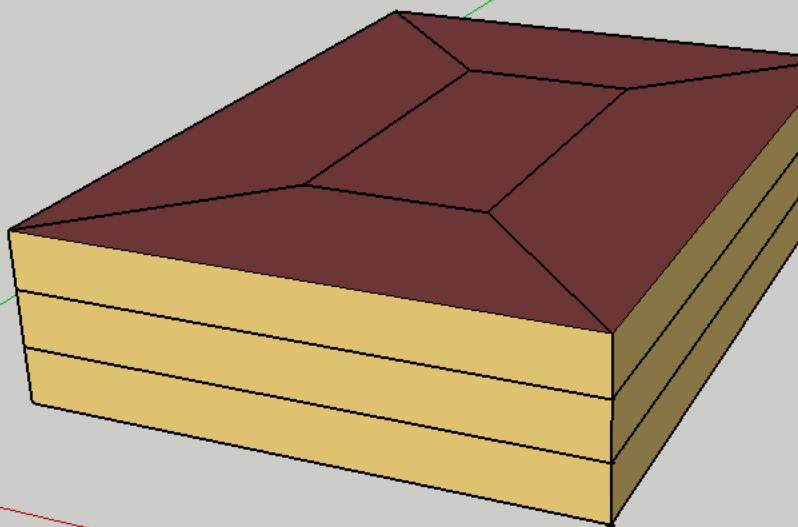
05:43 AM

Noon

05:43 PM



7. By using the «info tool» you can always drag the mouse onto a surface of any 3D object, like the one that you just created, and check all the info about it.



Default Tray

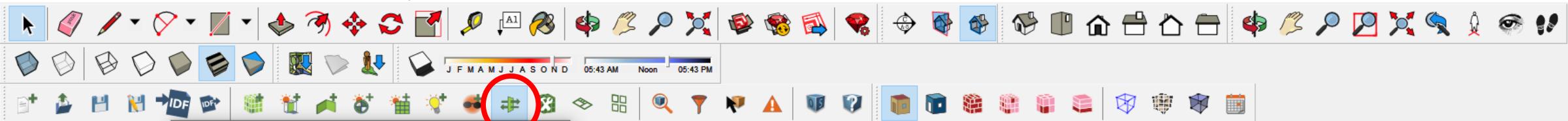
Entity Info

No Selection

Materials

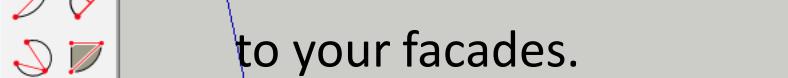
Default		
Colors-Named	Colors-Named	Colors-Named
Colors-Named	Colors-Named	Colors-Named
Components	Components	Components
Styles	Styles	Styles
Layers	Layers	Layers
Shadows	Shadows	Shadows
Scenes	Scenes	Scenes
Instructor	Instructor	Instructor
Soften Edges	Soften Edges	Soften Edges

Angle between normals:



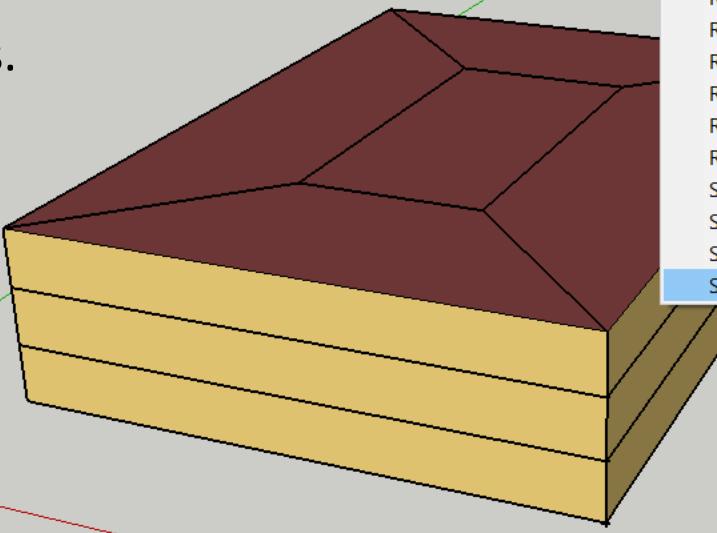
8. Select the whole 3D object and click on «surface matching», then click on «match in entire model».

The image shows a 3D model of a building with a dark brown roof and yellow walls. The entire model is selected, indicated by a blue selection frame. A green line points from the text above to the 'Match in Entire Model' button in the Surface Matching dialog box. The dialog box also contains 'Intersect in Entire Model' and 'Intersect in Selection' buttons. The SketchUp interface includes a left toolbar with various tools, a right panel with Entity Info, Materials, and Components, and a bottom status bar with measurement and selection information.

OpenStudio  
OpenStudio User ScriptsAlter or Add Model Elements  
Building Component Library  
Create Standard Building Shapes  
On Demand Template Generators  
Reports  
VisualizationAdd New Thermal Zone For Spaces With No Thermal Zone  
Add Overhangs by Projection Factor  
Add Photovoltaics  
Add Shading Controls  
Assign Building Stories  
Change Shading Type  
Cleanup Origins  
Export Selected Spaces to a new External Model  
Merge Spaces From External File  
Intersect Space Geometry  
Make Selected Surfaces Adiabatic and Assign a Construction  
Move Selected Surfaces to New Space  
Remove Hard Assigned Constructions  
Remove Loads Directly Assigned to Spaces  
Remove Orphan Photovoltaics  
Remove Orphan SubSurfaces  
Remove Photovoltaics  
Remove Unused ThermalZones  
Rename Thermal Zones Based On Space Names  
Set Interior Partition Height Above Floor  
Set Shading Controls  
Set Window Property Frame and Divider  
Set Window to Wall Ratio

9. Now use the command «set window to wall ratio» by the shown procedure.

This command will provide the openings to your facades.



Default Tray

Entity Info

No Selection

Materials

Default		
Colors-Named	Colors-Named	
Pink	Magenta	Pink
Pink	Red	Yellow
Light Pink	Light Red	Light Yellow

Components

Styles

Layers

Shadows

Scenes

Instructor

Soften Edges

Angle between normals:

Measurements



10. Click on «ok» leaving the existent parameters.

User input.

Window to Wall Ratio (Fraction)

Offset (meters)

Application Type

OK Cancel

A wireframe model of a building with a grid pattern is visible in the background.

Default Tray Entity Info 15 Solid Groups

Layer: OpenStudio::Mc Instance: Type: Type: <undefined>

Materials Default

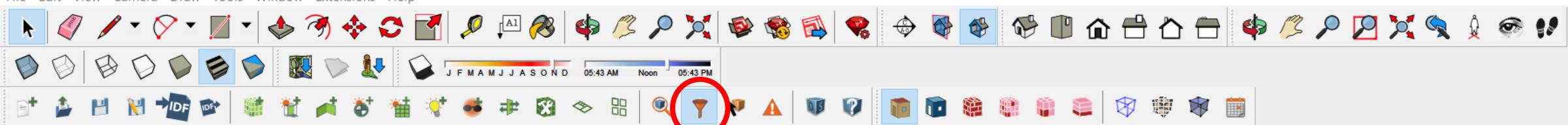
Select Edit Colors-Named

Components Styles Layers Shadows Scenes Instructor Soften Edges

Angle between normals:

Select objects. Shift to extend select. Drag mouse to select multiple.

Measurements



11. Now use the command «search surfaces»

12. To select only 3 of the four perimetral walls  
(you have to exclude the Northern facade)  
type from «90» to «270».

The image shows a 3D model of a building with a complex roof and multiple walls. A green line highlights the northern facade, which is the wall that needs to be excluded from the selection. The SketchUp interface includes a 'Surface Search' dialog box with settings for orientation (from 90 to 270 degrees) and surface types (excluding horizontal surfaces). The right side of the screen displays the Entity Info panel showing 48 faces and a Materials panel with color swatches.

Select objects. Shift to extend select. Drag mouse to select multiple.

Measurements

File Edit View Camera Draw Tools Window Extensions Help

OpenStudio >  
OpenStudio User Scripts >

Load User Scripts  
Alter or Add Model Elements >  
Building Component Library  
Create Standard Building Shapes  
On Demand Template Generators  
Reports  
Visualization

Add New Thermal Zone For Spaces With No Thermal Zone  
Add Overhangs by Projection Factor  
Add Photovoltaics  
Add Shading Controls  
Assign Building Stories  
Change Shading Type  
Cleanup Origins  
Export Selected Spaces to a new External Model  
Merge Spaces From External File  
Intersect Space Geometry  
Make Selected Surfaces Adiabatic and Assign a Construction  
Move Selected Surfaces to New Space  
Remove Hard Assigned Constructions  
Remove Loads Directly Assigned to Spaces  
Remove Orphan Photovoltaics  
Remove Orphan SubSurfaces  
Remove Photovoltaics  
Remove Unused ThermalZones  
Rename Thermal Zones Based On Space Names  
Set Interior Partition Height Above Floor  
Set Shading Controls  
Set Window Property Frame and Divider  
Set Window to Wall Ratio

Default Tray  
Entity Info  
48 Faces  
Layer: Layer0  
Area: 2437,5 m<sup>2</sup>

Materials  
Select Edit Colors-Named

Components  
Styles  
Layers  
Shadows  
Scenes  
Instructor  
Soften Edges

Angle between normals:

Measurements

13. Through the shown passages, select «add overhangs by projection factor». This command will provide sun shades to the 3 selected facades.



14. Leave the shown parameters and click «ok».

**User input.**

Projection Factor (Fraction)   
Offset (Fraction)   
Remove Existing Space Shading Groups

OK Cancel

**Surface Search**

Type:   
Construction:   
Outside Boundary Condition:   
Sun Exposure:

to 270 (Clockwise) - North is 0  
Horizontal Surfaces  
Non-Convex Surfaces  
Surfaces With More Than 4

Search Entire Model Search Selection Unhide All Last Report Cancel

**Default Tray**

**Entity Info**

48 Faces  
Layer: Layer0 Area: 2437,5 m<sup>2</sup>

**Materials**

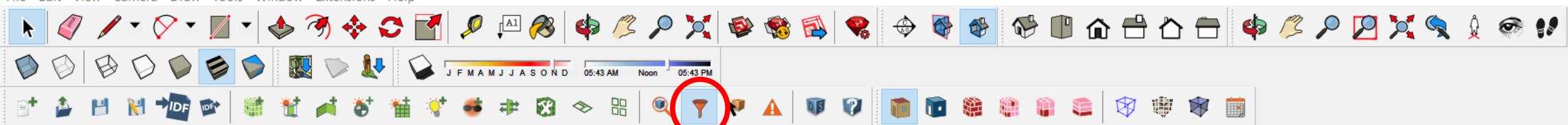
Select Edit Colors-Named

Components Styles Layers Shadows Scenes Instructor Soften Edges

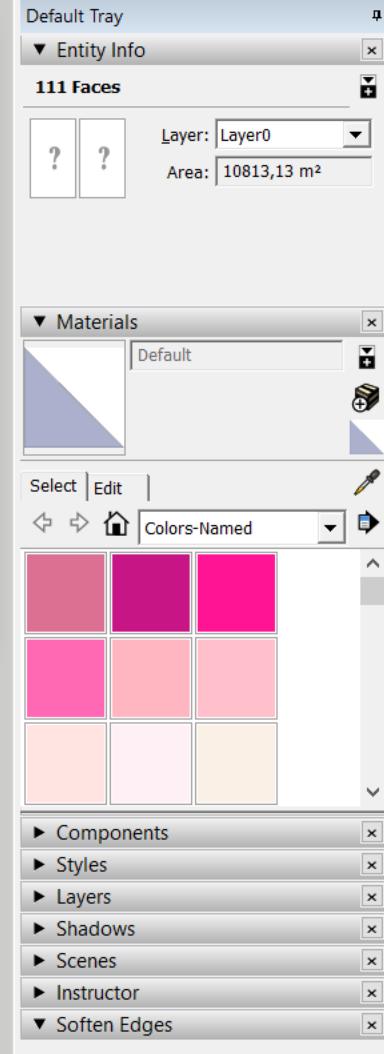
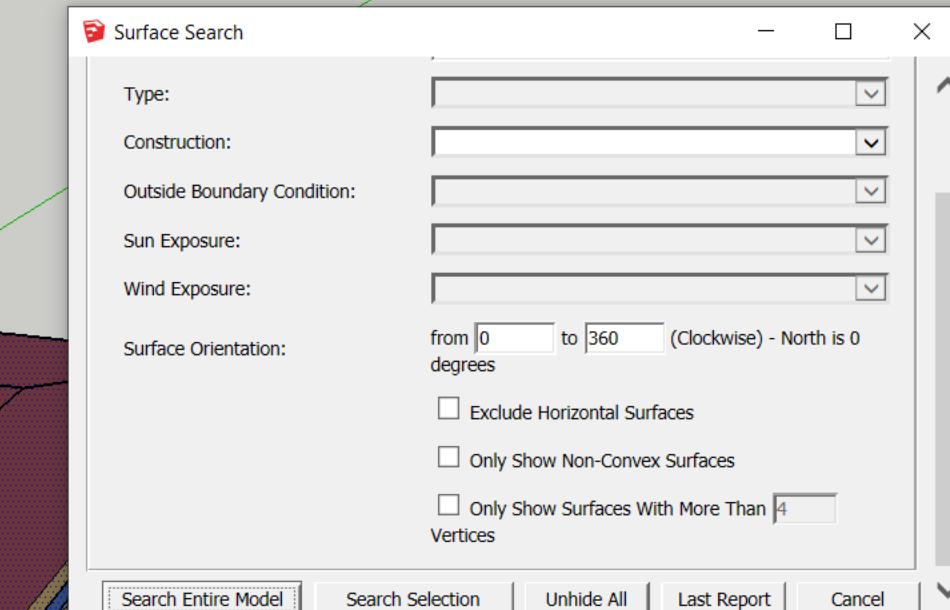
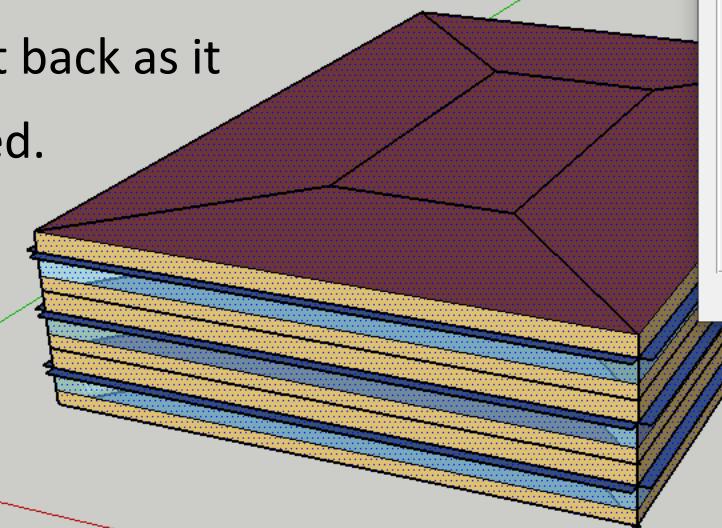
Angle between normals:

Select objects. Shift to extend select. Drag mouse to select multiple.

Measurements

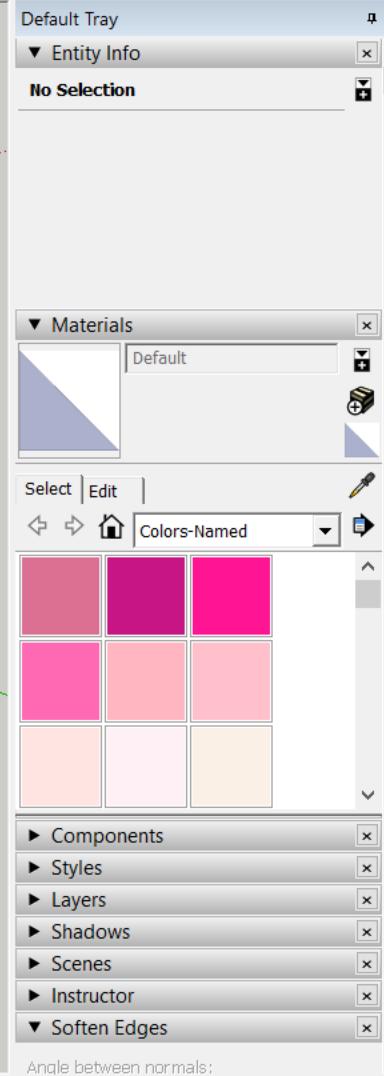
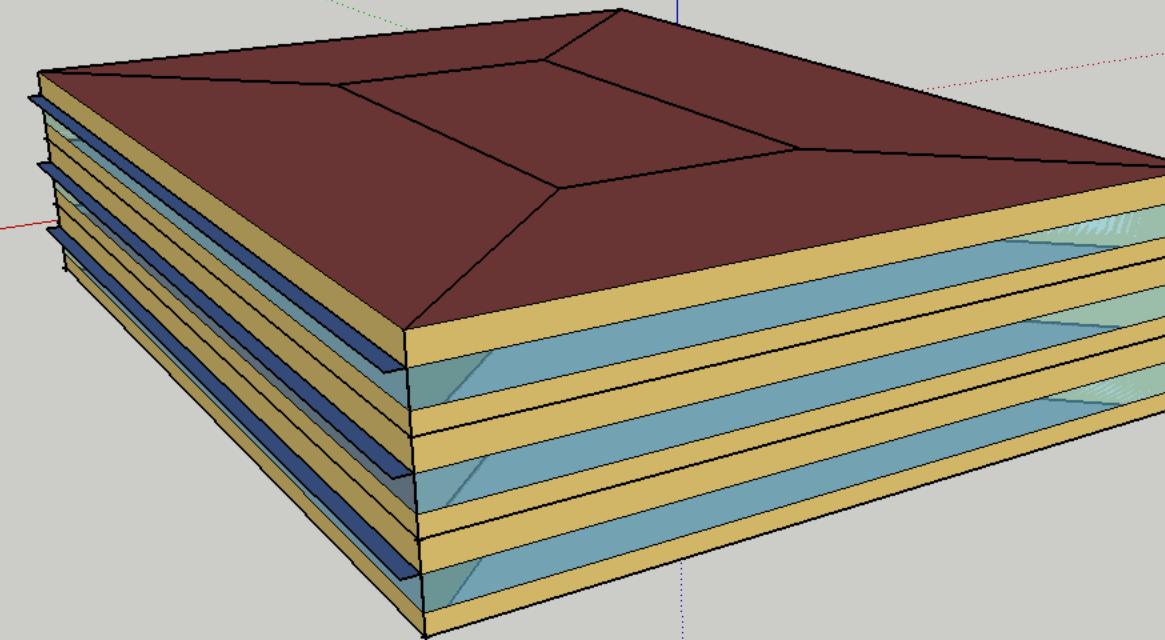


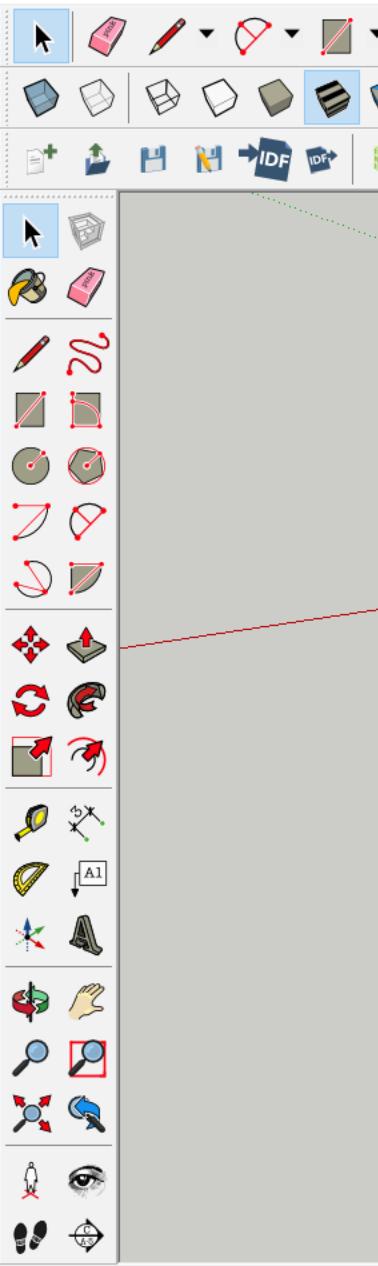
15. After having selected the whole object, choose again «surface search» and type from «0» to «360» to have the whole object back as it was visualized.



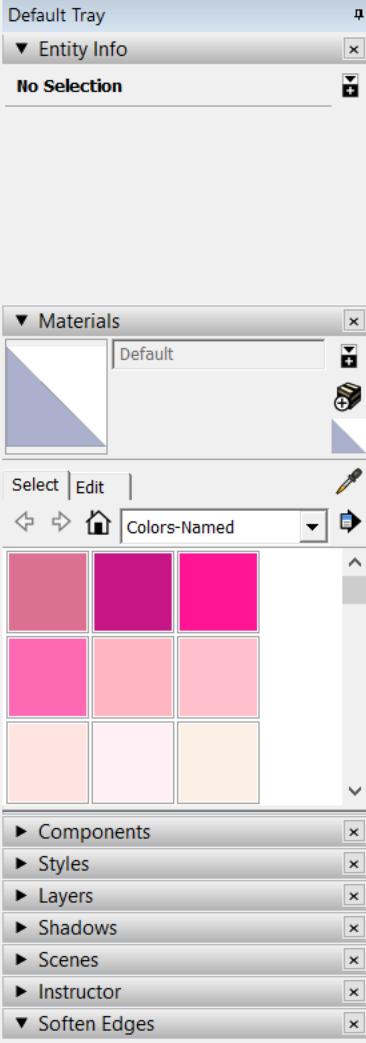


16. Now the building has sun shades on the facades (except for the one facing North)

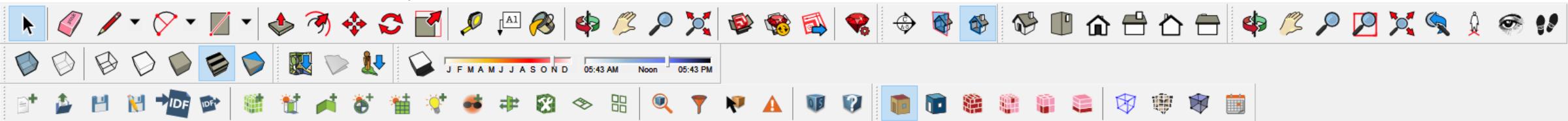




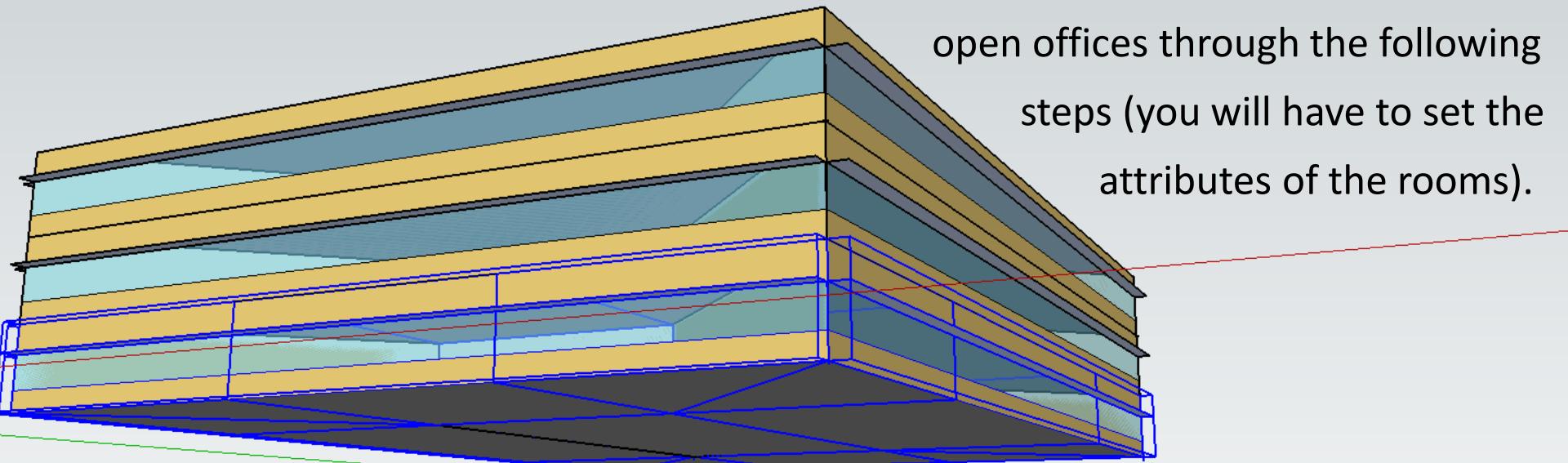
17. Following the shown steps, activate (V) the «Outliner» tray.



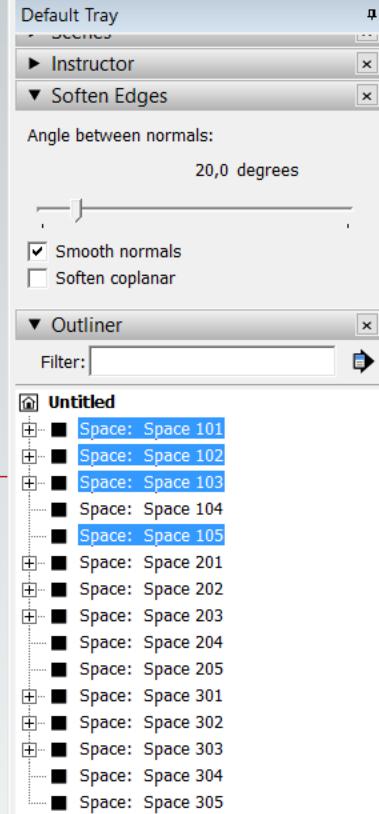
Angle between normals:

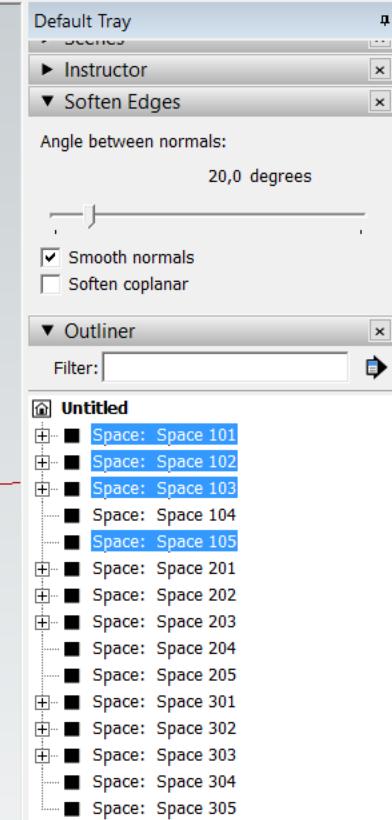
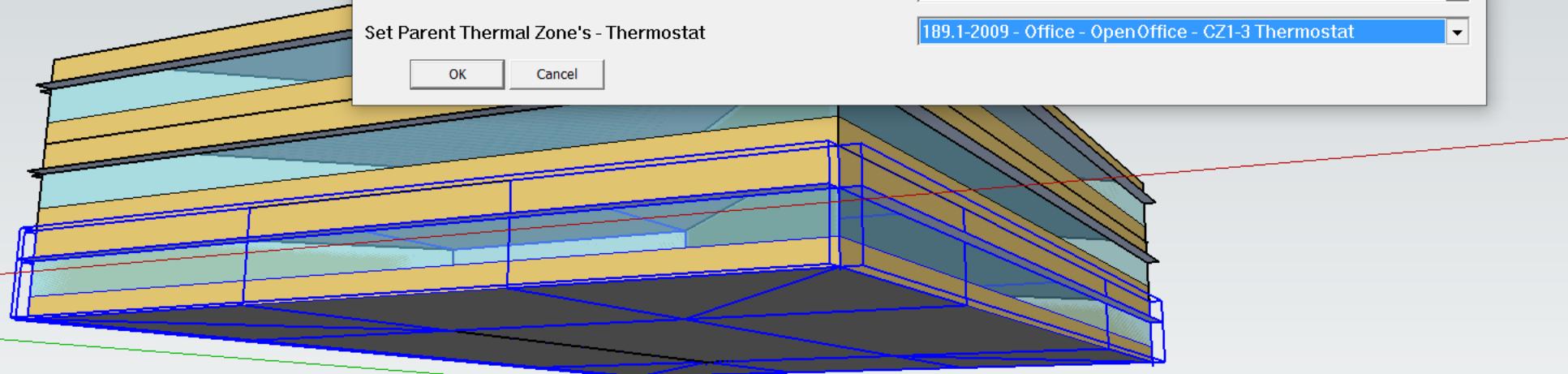
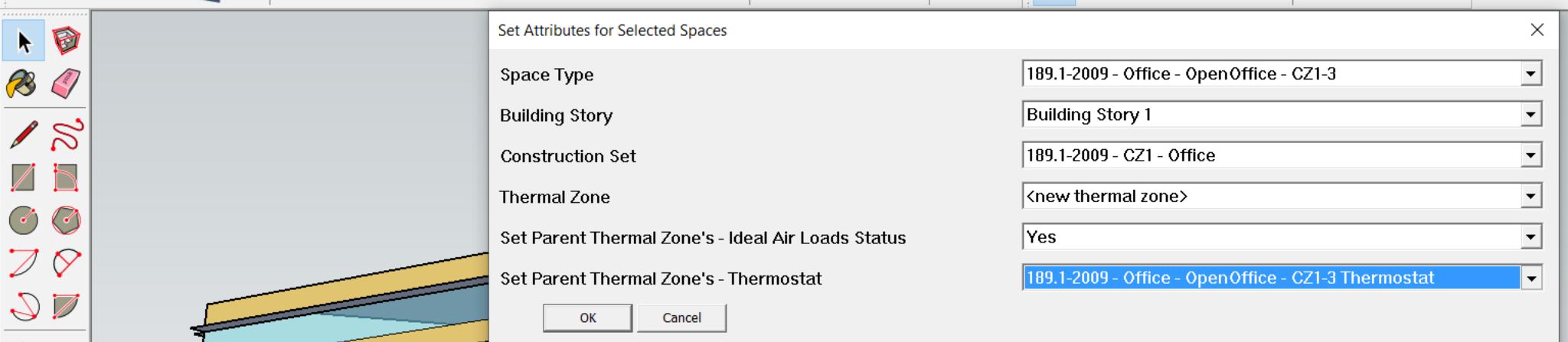


18. Select the four spaces along the borders of building (shown below): they will be listed as open offices through the following steps (you will have to set the attributes of the rooms).



The central space will be then set as break room.  
The procedure will be repeated for each floor.





19. Select all the shown attributes for the chosen spaces, to be set as «open offices».



## Set Attributes for Selected Spaces

Space Type

189.1-2009 - Office - BreakRoom - CZ1-3

Building Story

Building Story 1

Construction Set

189.1-2009 - CZ1 - Office

Thermal Zone

&lt;new thermal zone&gt;

Set Parent Thermal Zone's - Ideal Air Loads Status

Yes

Set Parent Thermal Zone's - Thermostat

189.1-2009 - Office - OpenOffice - CZ1-3 Thermostat

OK

Cancel

## Default Tray

► Scenes

► Instructor

▼ Soften Edges

Angle between normals:

20,0 degrees

 Smooth normals Soften coplanar

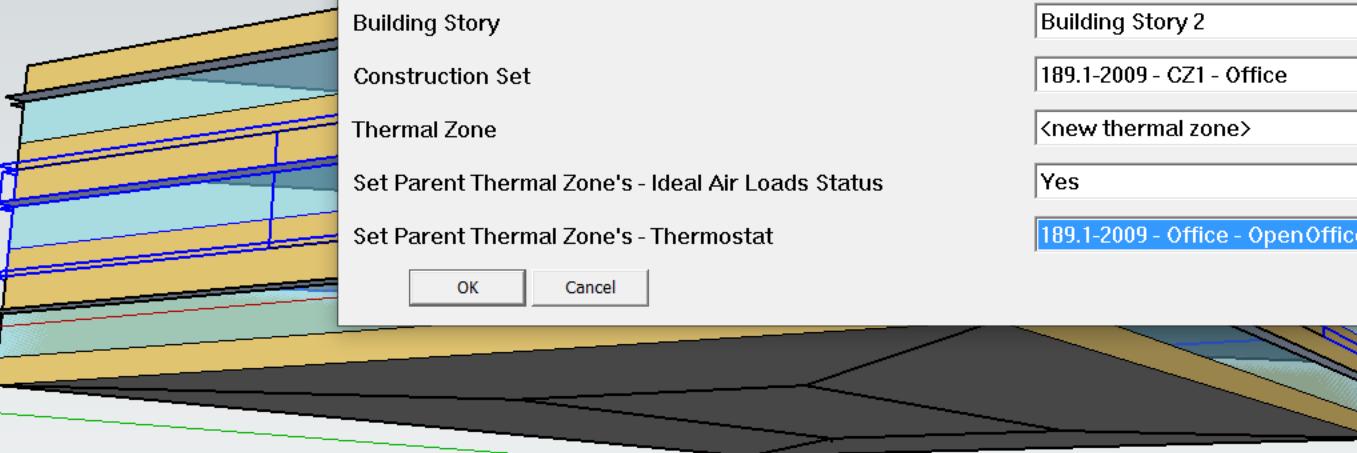
## Outliner

Filter:

## Untitled

- Space: Space 101
- Space: Space 102
- Space: Space 103
- Space: Space 104
- Space: Space 105
- Space: Space 201
- Space: Space 202
- Space: Space 203
- Space: Space 204
- Space: Space 205
- Space: Space 301
- Space: Space 302
- Space: Space 303
- Space: Space 304
- Space: Space 305

20. Select all the shown attributes for the chosen space, to be set as «break room».



Set Attributes for Selected Spaces

Space Type

189.1-2009 - Office - OpenOffice - CZ1-3

Building Story

Building Story 2

Construction Set

189.1-2009 - CZ1 - Office

Thermal Zone

&lt;new thermal zone&gt;

Set Parent Thermal Zone's - Ideal Air Loads Status

Yes

Set Parent Thermal Zone's - Thermostat

189.1-2009 - Office - OpenOffice - CZ1-3 Thermostat

OK

Cancel

## Default Tray

► Scenes

► Instructor

▼ Soften Edges

Angle between normals:

20,0 degrees

 Smooth normals Soften coplanar

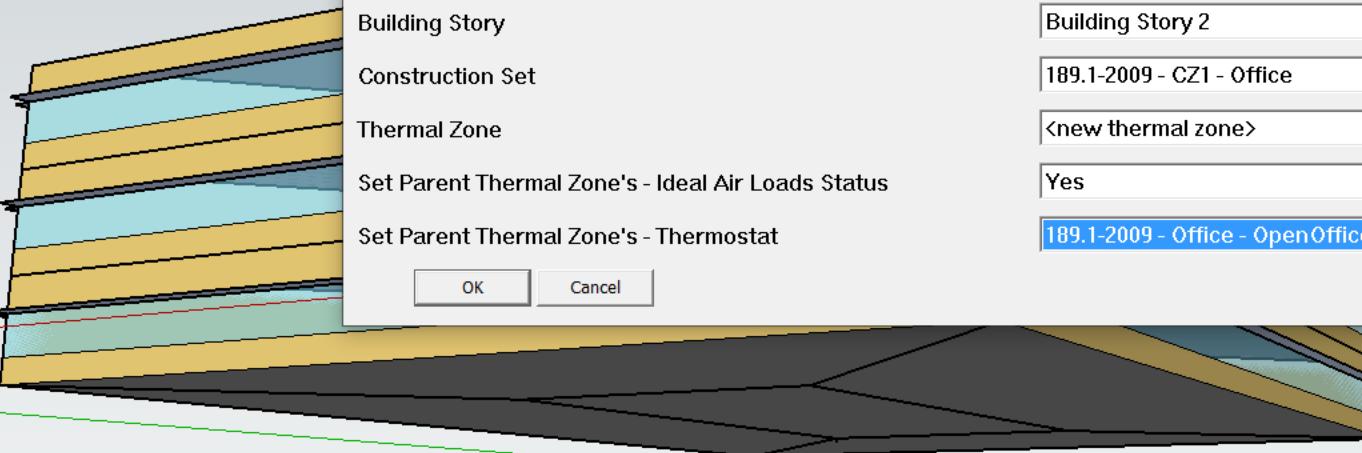
## Outliner

Filter:

## Untitled

- Space: Space 101
- Space: Space 102
- Space: Space 103
- Space: Space 104
- Space: Space 105
- Space: Space 201
- Space: Space 202
- Space: Space 203
- Space: Space 204
- Space: Space 205
- Space: Space 301
- Space: Space 302
- Space: Space 303
- Space: Space 304
- Space: Space 305

21. Select all the shown attributes for the chosen spaces, to be set as «open offices» (floor 2°).



Set Attributes for Selected Spaces

Space Type

189.1-2009 - Office - BreakRoom - CZ1-3

Building Story

Building Story 2

Construction Set

189.1-2009 - CZ1 - Office

Thermal Zone

&lt;new thermal zone&gt;

Set Parent Thermal Zone's - Ideal Air Loads Status

Yes

Set Parent Thermal Zone's - Thermostat

189.1-2009 - Office - OpenOffice - CZ1-3 Thermostat

OK

Cancel

## Default Tray

► Scenes

► Instructor

▼ Soften Edges

Angle between normals:

20,0 degrees

 Smooth normals Soften coplanar

## ▼ Outliner

Filter:

## Untitled

- Space: Space 101
- Space: Space 102
- Space: Space 103
- Space: Space 104
- Space: Space 105
- Space: Space 201
- Space: Space 202
- Space: Space 203
- Space: Space 204
- Space: Space 205
- Space: Space 301
- Space: Space 302
- Space: Space 303
- Space: Space 304
- Space: Space 305

22. Select all the shown attributes for the chosen space, to be set as «break room» (floor 2°).



## Set Attributes for Selected Spaces

Space Type

189.1-2009 - Office - OpenOffice - CZ1-3

Building Story

Building Story 3

Construction Set

189.1-2009 - CZ1 - Office

Thermal Zone

&lt;new thermal zone&gt;

Set Parent Thermal Zone's - Ideal Air Loads Status

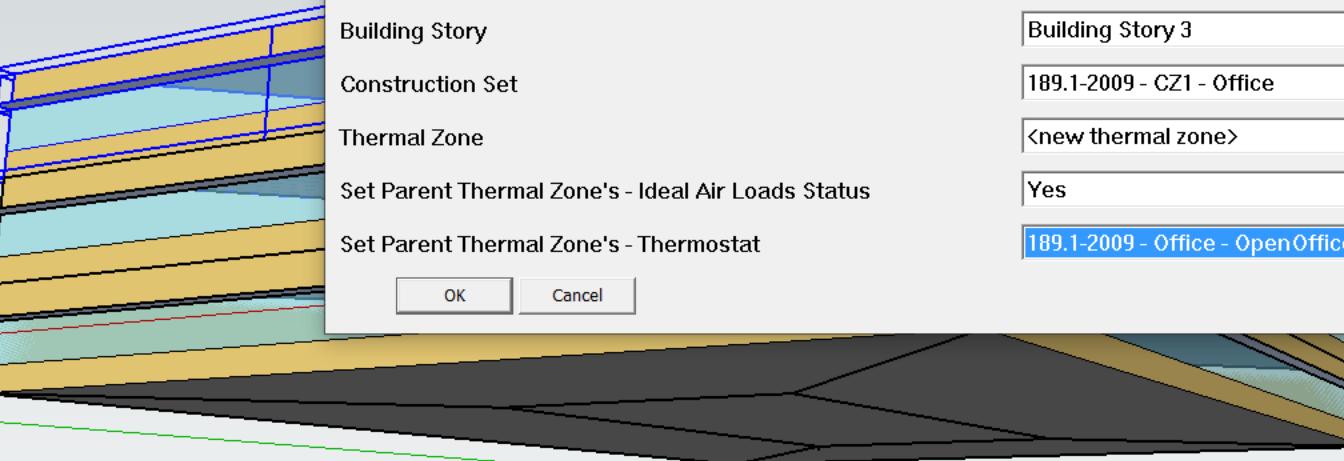
Yes

Set Parent Thermal Zone's - Thermostat

189.1-2009 - Office - OpenOffice - CZ1-3 Thermostat

OK

Cancel



## Default Tray

► Scenes

► Instructor

▼ Soften Edges

Angle between normals:

20,0 degrees

 Smooth normals Soften coplanar

## Outliner

Filter:

## Untitled

- Space: Space 101
- Space: Space 102
- Space: Space 103
- Space: Space 104
- Space: Space 105
- Space: Space 201
- Space: Space 202
- Space: Space 203
- Space: Space 204
- Space: Space 205
- Space: Space 301
- Space: Space 302
- Space: Space 303
- Space: Space 304
- Space: Space 305

23. Select all the shown attributes for the chosen spaces, to be set as «open offices» (floor 3°).



## Set Attributes for Selected Spaces

Space Type

189.1-2009 - Office - BreakRoom - CZ1-3

Building Story

Building Story 3

Construction Set

189.1-2009 - CZ1 - Office

Thermal Zone

&lt;new thermal zone&gt;

Set Parent Thermal Zone's - Ideal Air Loads Status

Yes

Set Parent Thermal Zone's - Thermostat

189.1-2009 - Office - OpenOffice - CZ1-3 Thermostat

OK

Cancel

## Default Tray

► Scenes

Instructor

## ▼ Soften Edges

Angle between normals:

20,0 degrees

 Smooth normals Soften coplanar

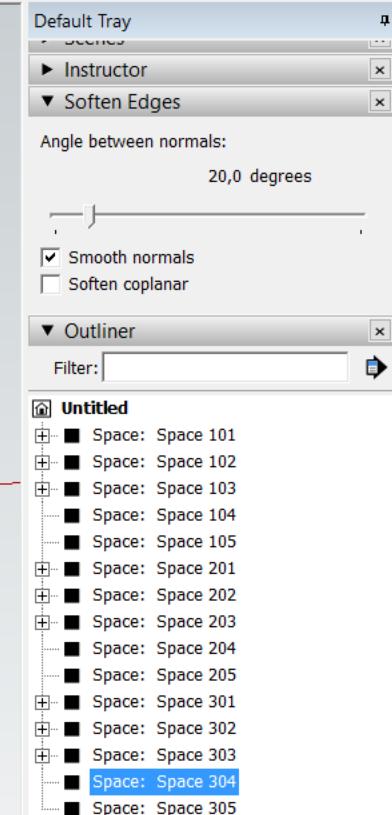
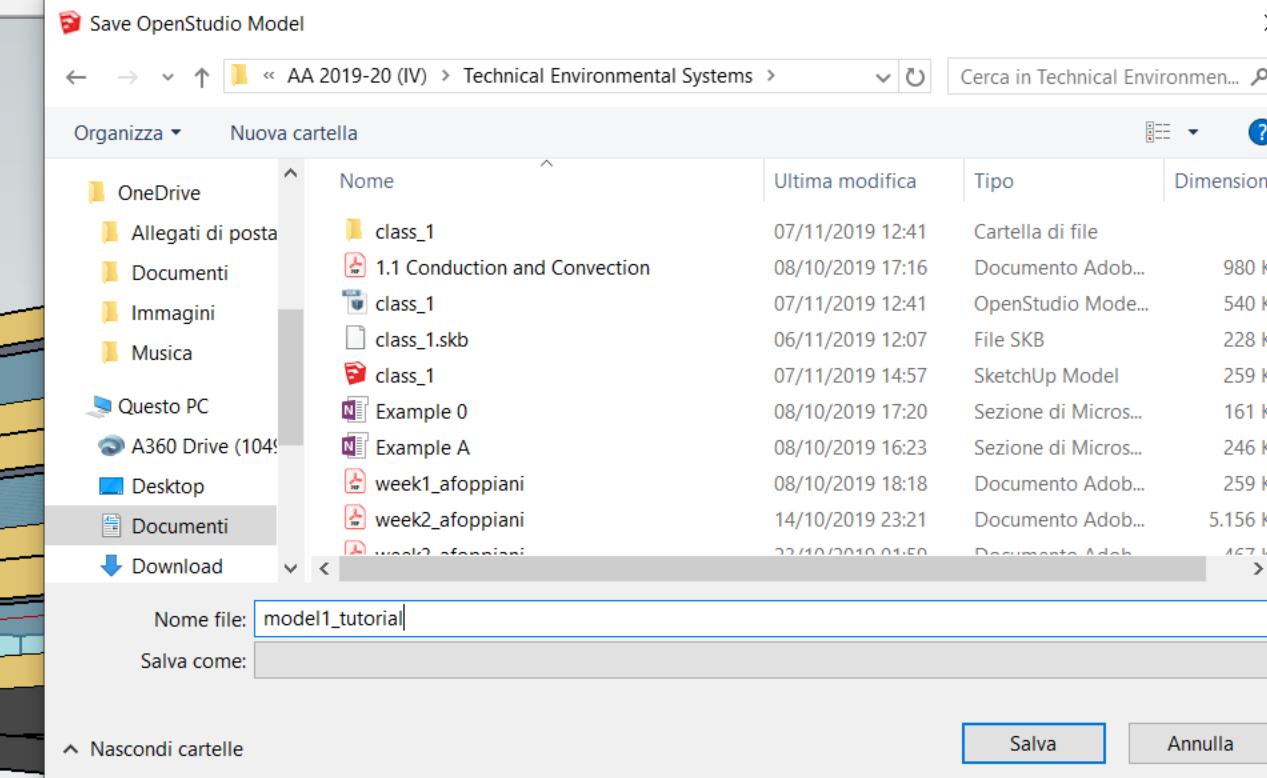
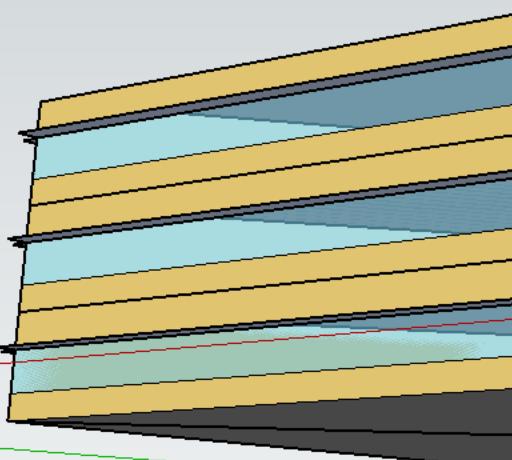
## ▼ Outliner

Filter:

## Untitled

- Space: Space 101
- Space: Space 102
- Space: Space 103
- Space: Space 104
- Space: Space 105
- Space: Space 201
- Space: Space 202
- Space: Space 203
- Space: Space 204
- Space: Space 205
- Space: Space 301
- Space: Space 302
- Space: Space 303
- Space: Space 304
- Space: Space 305

24. Select all the shown attributes for the chosen spaces, to be set as «break room» (floor 3°).



25. To save the project, remember to always save through the shown command.

model1Tutorial.osm\*

File Preferences Components & Measures Help

Site Weather File & Design Days Life Cycle Costs Utility Bills

My Model Library Edit

**Weather File** Set Weather File

Name:

Latitude:

Longitude:

Elevation:

Time Zone:

Download weather files at [www.energyplus.net/weather](http://www.energyplus.net/weather)

**Measure Tags (Optional):**

ASHRAE Climate Zone

CEC Climate Zone

**Select Year by:**

Calendar Year 2000

First Day of Year UseWeatherFile

**Daylight Savings Time:**

**Starts**

Define by Day of The Week And Month First Sunday January

Define by Date 01/04/2009

**Ends**

Define by Day of The Week And Month First Sunday January

Define by Date 01/10/2009

**Design Days** Import From DDY

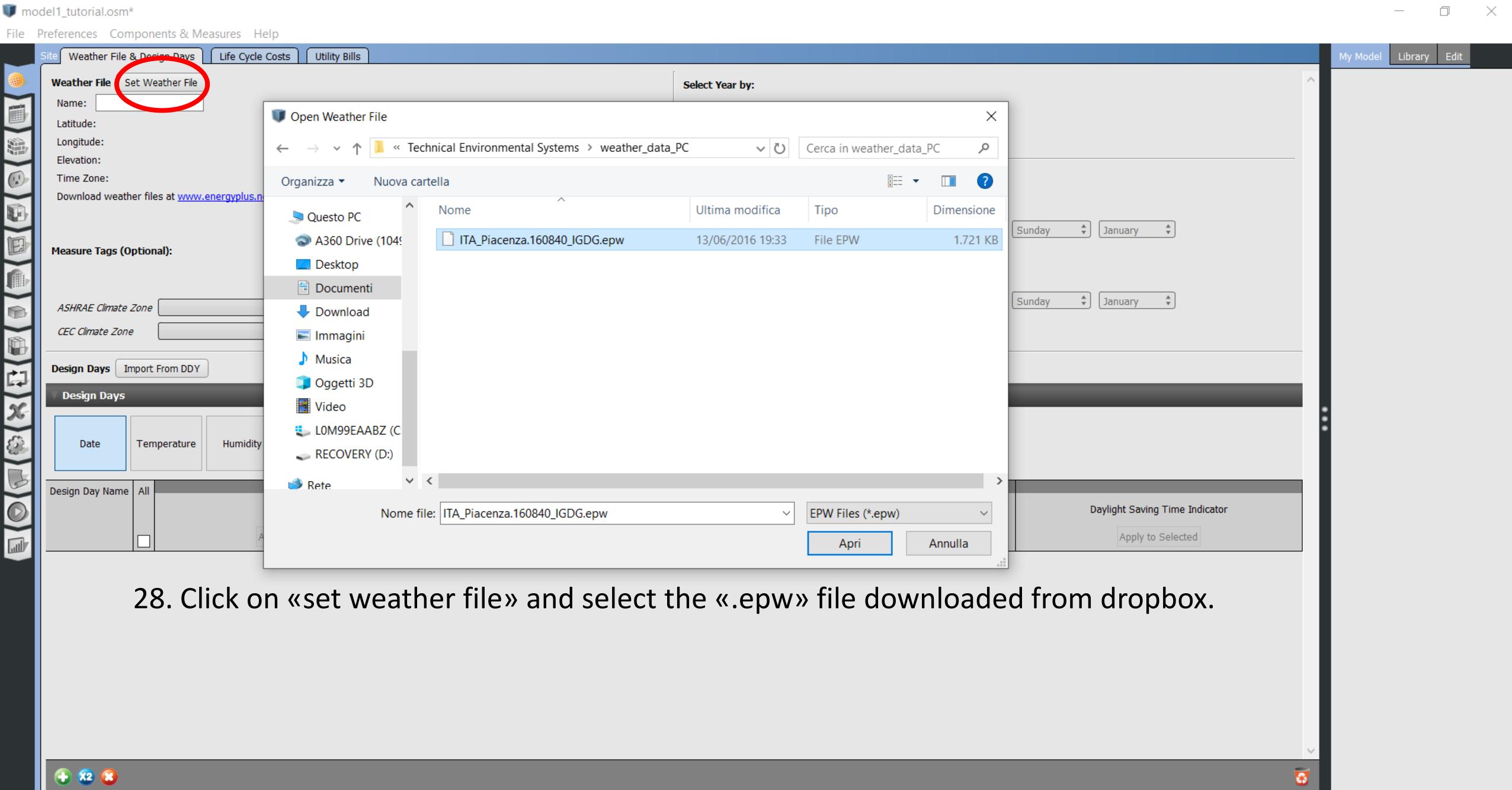
**Design Days**

Date Temperature Humidity Pressure Wind Precipitation Solar Custom

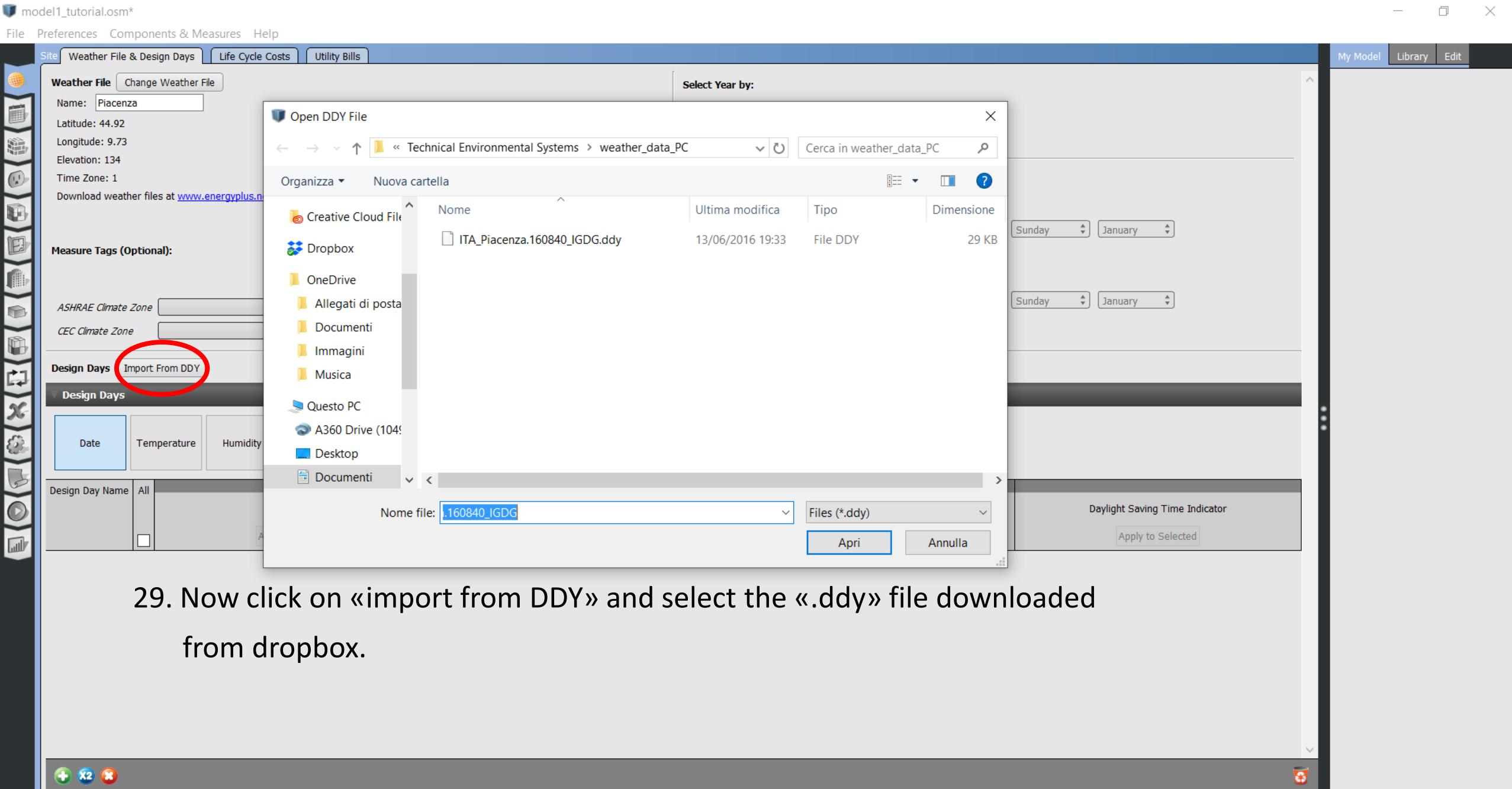
Design Day Name	All	Day Of Month	Month	Day Type	Daylight Saving Time Indicator
	<input type="checkbox"/>	<input type="button" value="Apply to Selected"/>			

**26.** Now you should open the «.osm» file that you just saved in a folder on your pc, by double clicking on it.

**27.** The following steps will add the climatic data about the city of Piacenza.



28. Click on «set weather file» and select the «.epw» file downloaded from dropbox.



29. Now click on «import from DDY» and select the «.ddy» file downloaded from dropbox.

## Weather File Change Weather File

Name: Piacenza

Latitude: 44.92

Longitude: 9.73

Elevation: 134

Time Zone: 1

Download weather files at [www.energyplus.net/weather](http://www.energyplus.net/weather)

## Measure Tags (Optional):

ASHRAE Climate Zone

CEC Climate Zone

## Select Year by:

 Calendar Year 2000 First Day of Year Sunday

## Daylight Savings Time: off

## Starts

 Define by Day of The Week And Month First Sunday January Define by Date 01/04/2009

## Ends

 Define by Day of The Week And Month First Sunday January Define by Date 01/10/2009

## Design Days Import From DDY

## Design Days



30. This is what you should see.

Design Day Name	All	Day Of Month	Month	Day Type	Daylight Saving Time Indicator
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Piacenza Ann Clg .4% Condns DB=>MWB	<input type="checkbox"/>	21	8	SummerDesignDay	<input type="checkbox"/>
Piacenza Ann Clg .4% Condns DP=>MDB	<input type="checkbox"/>	21	8	SummerDesignDay	<input type="checkbox"/>
Piacenza Ann Clg .4% Condns Enth=>MDB	<input type="checkbox"/>	21	8	SummerDesignDay	<input type="checkbox"/>
Piacenza Ann Clg .4% Condns WB=>MDB	<input type="checkbox"/>	21	8	SummerDesignDay	<input type="checkbox"/>
Piacenza Ann Htg 99.6% Condns DB	<input type="checkbox"/>	21	1	WinterDesignDay	<input type="checkbox"/>
Piacenza Ann Htg Wind 99.6% Condns WS=>MCDB	<input type="checkbox"/>	21	1	WinterDesignDay	<input type="checkbox"/>
Piacenza Ann Hum n 99.6% Condns DP=>MCDB	<input type="checkbox"/>	21	1	WinterDesignDay	<input type="checkbox"/>



Run Simulation

Run



66%

Show Simulation

EnergyPlus Starting

EnergyPlus, Version 9.2.0-921312fa1d, YMD=2019.11.12 19:09

Initializing Response Factors

Calculating CTFs for "ASHRAE 189.1-2009 EXTROOF IEAD CLIMATEZONE 1", Construction # 1

Calculating CTFs for "ASHRAE 189.1-2009 EXTWALL MASS CLIMATEZONE 1", Construction # 5

Calculating CTFs for "EXTSLABCARPET 4IN CLIMATEZONE 1-8", Construction # 19

Calculating CTFs for "INTERIOR CEILING", Construction # 20

Calculating CTFs for "INTERIOR WALL", Construction # 24

Initializing Window Optical Properties

Initializing Solar Calculations

Allocate Solar Module Arrays

Initializing Zone and Enclosure Report Variables

Initializing Surface (Shading) Report Variables

Computing Interior Solar Absorption Factors

Determining Shadowing Combinations

Computing Window Shade Absorption Factors

Proceeding with Initializing Solar Calculations

Initializing Surfaces

Initializing Outdoor environment for Surfaces

Setting up Surface Reporting Variables

Initializing Temperature and Flux Histories

Initializing Window Shading

Computing Interior Absorption Factors

Computing Interior Diffuse Solar Absorption Factors

Computing Interior Diffuse Solar Exchange through Interzone Windows

Initializing Solar Heat Gains

Initializing Internal Heat Gains

Initializing Interior Solar Distribution

Initializing Interior Convection Coefficients

Gathering Information for Predefined Reporting

Completed Initializing Surface Heat Balance

Calculate Outside Surface Heat Balance

Calculate Inside Surface Heat Balance

Calculate Air Heat Balance

Initializing HVAC

Warming up

31. Select «run simulation» and then «play».



Run



100% Show Simulation

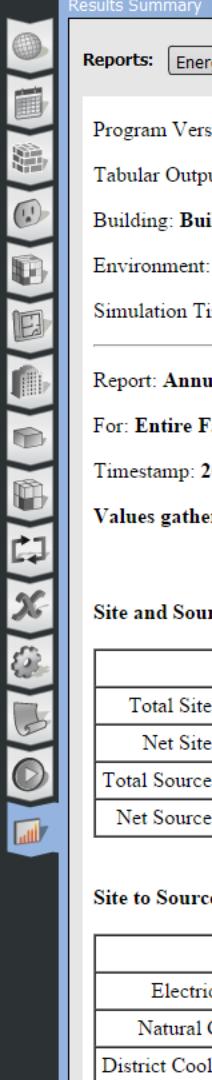
Updating Shadowing Calculations, Start Date=05/01/2006  
Continuing Simulation at 05/01/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=05/21/2006  
Continuing Simulation at 05/21/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=06/10/2006  
Continuing Simulation at 06/10/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=06/30/2006  
Continuing Simulation at 06/30/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=07/20/2006  
Continuing Simulation at 07/20/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=08/09/2006  
Continuing Simulation at 08/09/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=08/29/2006  
Continuing Simulation at 08/29/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=09/18/2006  
Continuing Simulation at 09/18/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=10/08/2006  
Continuing Simulation at 10/08/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=10/28/2006  
Continuing Simulation at 10/28/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=11/17/2006  
Continuing Simulation at 11/17/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=12/07/2006  
Continuing Simulation at 12/07/2006 for RUN PERIOD 1  
Updating Shadowing Calculations, Start Date=12/27/2006  
Continuing Simulation at 12/27/2006 for RUN PERIOD 1  
Writing tabular output file results using HTML format.  
Computing Life Cycle Costs and Reporting  
Writing final SQL reports  
EnergyPlus Run Time=00hr 00min 19.85sec  
EnergyPlus Completed Successfully.

**Processing Reporting Measures.**

**Gathering Reports.**

**Completed.**

32. This is the 100% completed process.



## Results Summary

Reports: EnergyPlus Results

Refresh

Open DView for  
Detailed Reports

Program Version: EnergyPlus, Version 9.2.0-921312fa1d, YMD=2019.11.12 19:09

[Table of Contents](#)

Tabular Output Report in Format: HTML

Building: Building 1

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

Simulation Timestamp: 2019-11-12 19:09:15

Report: Annual Building Utility Performance Summary

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For: Entire Facility

Timestamp: 2019-11-12 19:09:15

Values gathered over 8760.00 hours

33. Then you can check and go through the final results.

## Site and Source Energy

	Total Energy [GJ]	Energy Per Total Building Area [MJ/m <sup>2</sup> ]	Energy Per Conditioned Building Area [MJ/m <sup>2</sup> ]
Total Site Energy	2375.79	659.94	659.94
Net Site Energy	2375.79	659.94	659.94
Total Source Energy	6136.71	1704.64	1704.64
Net Source Energy	6136.71	1704.64	1704.64

## 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
...	...