



Guidelines for using SketchUp with WUFI® Passive

1. WUFI Passive

1.1 Introduction

Thank you for your interest in learning WUFI Passive. WUFI Passive software is a building energy software offering profound contributions to passive building energy tools, broadening the scope of modeling methods through the capability of implementing static and dynamic modeling procedures. WUFI Passive is a result of a collaboration between Fraunhofer-Institute for Building Physics (IBP) and the Passive House Institute US (PHIUS) to suit the North American market. This guidebook should be used as a framework for building 3-D geometry, plug-in to WUFI Passive, and navigating WUFI Passive Software.

1.2 Accepted Software

As indicated in the [PHIUS+ Certification Guidebook V2.1 Section 6.1.1 Accepted Modeling Software](#) all projects to be considered for PHIUS+ 2018 Certification must be modeled in the respective software's:

WUFI Passive: 3_2_0_1 or later*

WUFI Passive Free: 3_2_0_1 or later*

A free version of WUFI Passive is available for [download](#). Additionally, instructions for download may be found [here](#).

For full modeling capabilities, including dynamic WUFI modeling, license for the full featured software are required, and are available in one, three, and ten-year periods. Licensure includes featured automatic updates through the duration of the license. Respective software packages may be purchased from the [web shop](#). A summary of features included in the paid versus free version is outlined [here](#).

Individuals completing the PHIUS CPHC Training receive an eight-week license of WUFI Passive as part of the certification process.

1.3 Computer Display Settings

WUFI® Plus and WUFI® Passive

Recommended:

Operating System: Current Windows OS

CPU: 1.6 GHz or higher

RAM: 4 GB better more

Video Adapter: 128 MB and better, OpenGL 2.0 capable

Hard Disk: 300 MB free space

Additional hard disk space needed for project files:

Plus: average project: 1-2 GB

Passive: average project: 1-2 GB

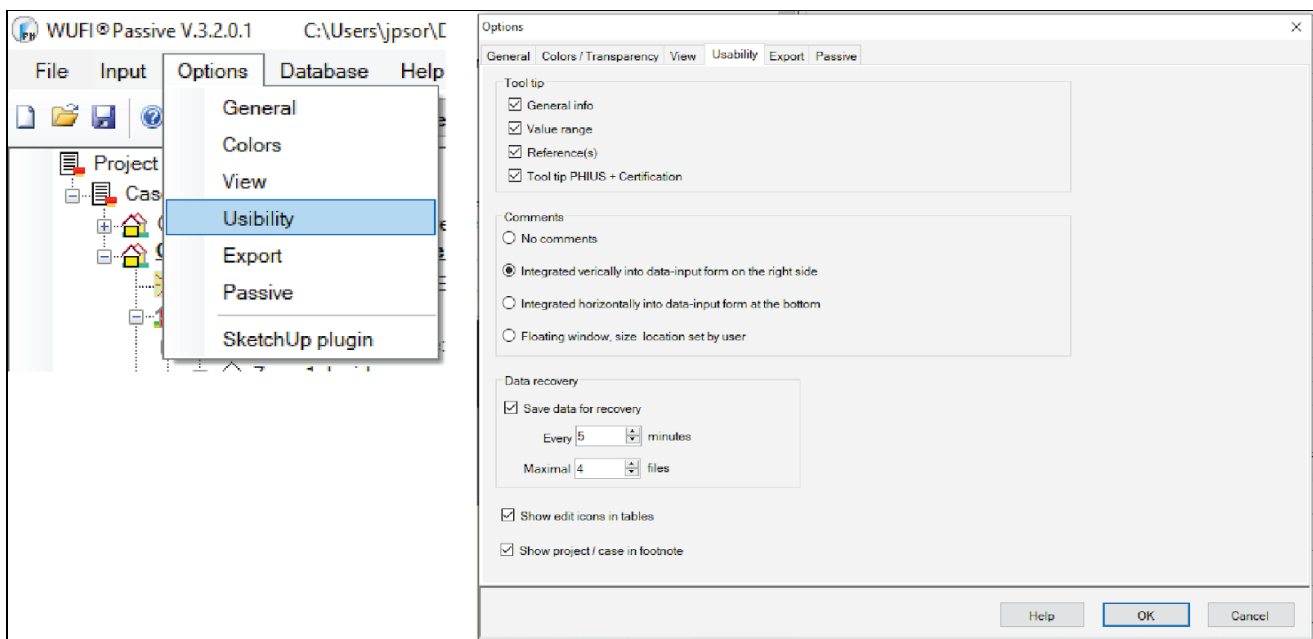
Take from:

<https://wufi.de/en/software/product-overview/system-requirements/>

1.3.1 WUFI Passive Usability Settings

PHIUS recommends the setup shown in the screenshot below. To update the ‘Usability’ settings, go to Options > Usability from the main toolbar in WUFI Passive. This will bring up options for the settings noted below.

- Tool Tip: Checking each of these boxes brings up ‘hover-over’ hints which can be helpful for modeling.
- Comments: This selection allows a side window to appear in WUFI Passive which allows for users to type in notes or comments on specific tabs directly in the software.
- Data recovery: Automatically saves copies of the current WUFI Passive file being worked on.
- Show edit icons in table: Any input in WUFI Passive that has an associated built-in calculation or additional table available to input data will automatically show a grey square with a ‘...’ inside of it.



2. CREATING 3-D GEOMETRY

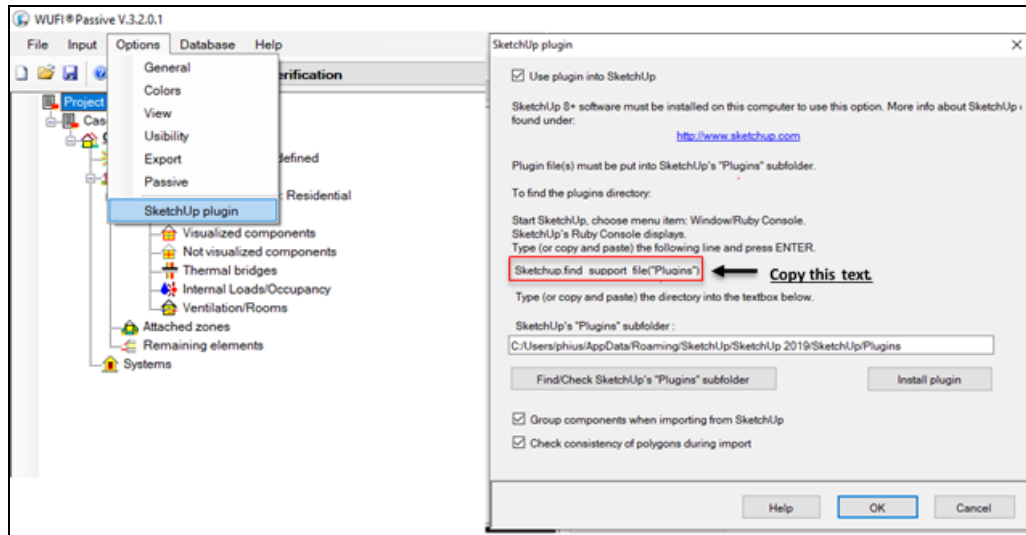
2.1 Design Software Set Up

WUFI Passive software requires imported 3-D geometry of the respective building, and currently offers imports from SketchUp, through a direct SketchUp plugin, with allowance of defining zones and properties of building components within the software to be directly transferred into WUFI Passive. Currently the SketchUp plugin is the recommended import method.

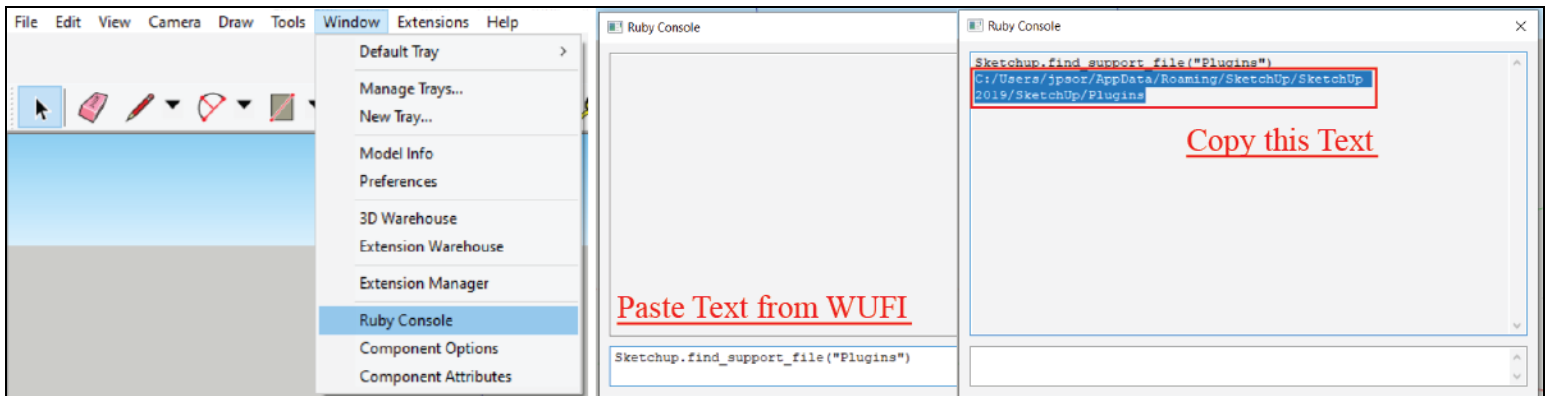
Instructions to download the WUFI Passive Plugin in SketchUp are as follows:

1. Right click on the WUFI Passive Icon and select ‘Run as Administrator’ to open WUFI Passive

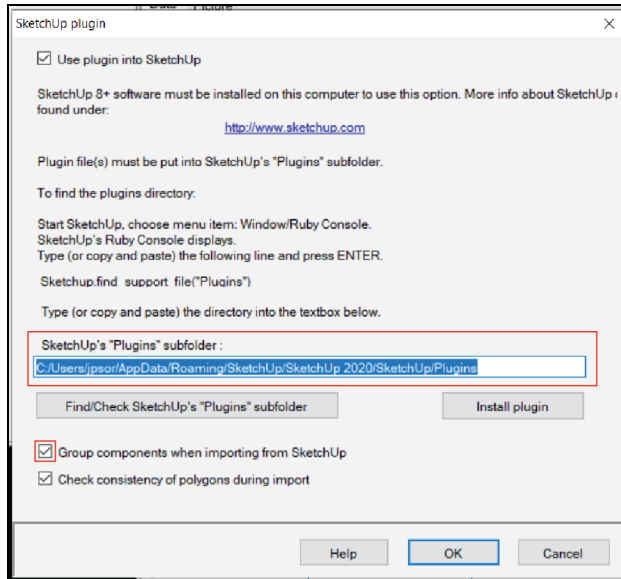
2. Open SketchUp
3. In WUFI Passive go to options > SketchUp Plugin, the respective window will appear.



4. Go to SketchUp and open Window > Ruby Console. Copy the text from the WUFI Passive Screen (**Sketchup.find_support_file("Plugins")**). Hit enter, and the file extension will appear in the ruby console window. Copy the entirety of the text populated in the window.



5. Go back to WUFI Passive and paste the extension from the Ruby console into the “SketchUp ‘Plugins’ subfolder:” and click “install Plugin”
 - 5a. Note that there is a check-box to select ‘Group components when importing from SketchUp’.



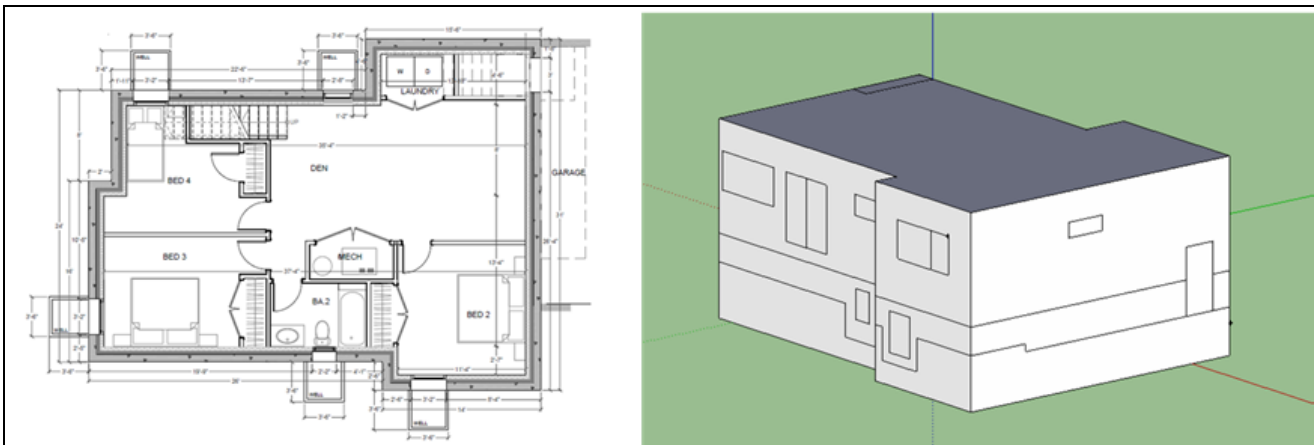
6. You should see a window indicating the Plugin was installed correctly.

**WUFI Passive does support gbXML files corresponding to CAD-programs such as REVIT, but there are known challenges with this method of import and it is not currently recommended.*

2.2 Preparing the 3-D Model

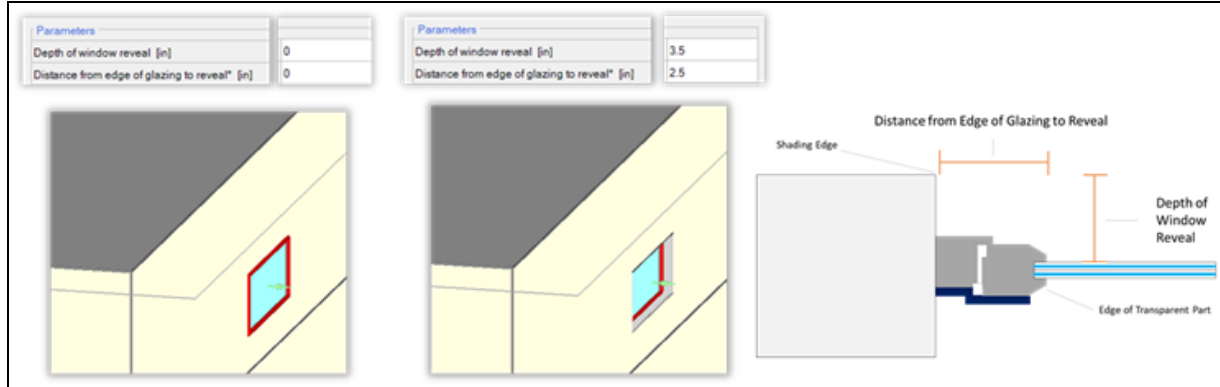
2.2.1 Building

To prepare the SketchUp Model for WUFI Passive, the model should reflect only the building geometry; the building components/elements should have no thickness, be modeled as a singular plane to the exterior of the thermal envelope.

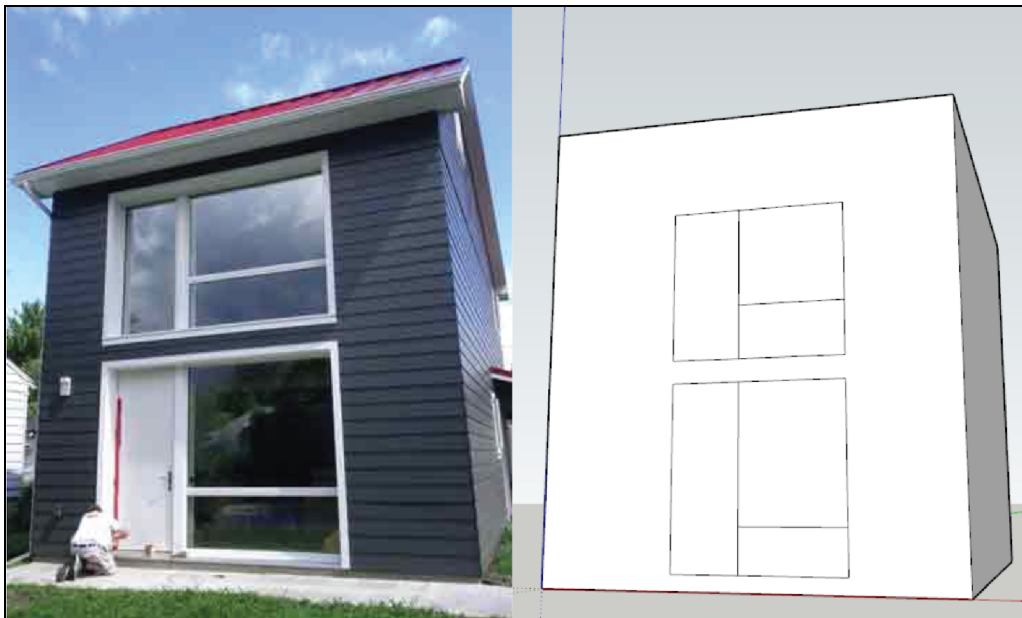


This should include extrusions such as the elevator pit, penthouses, etc. Within the model each component should be its own clickable unit. If ‘groups’ are created in SketchUp, they may need to be ‘exploded’ before importing into WUFI depending on which version of the SketchUp plugin is installed.

It is best practice to begin in SketchUp by modeling the building mass, followed by components such as windows and doors which can be drawn directly on each surface. For simplicity, windows and doors should be drawn in the same plane as the wall. Details such as reveal depth can be assigned in WUFI Passive.



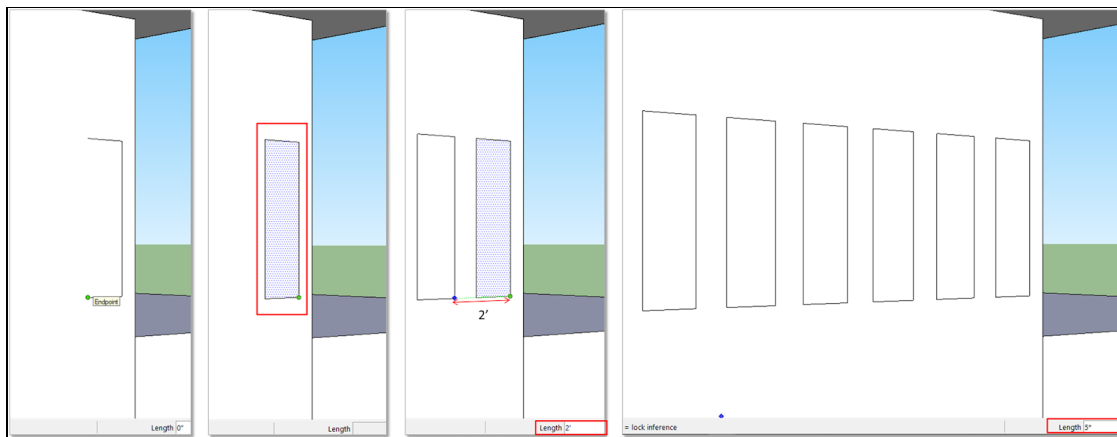
The windows are entered into the building energy model in their actual size and configuration (every lite), as a single polygon to represent both glass and frame. (Do not use rough openings).



WINDOW AND EXTERIOR DOOR SCHEDULE									
ID	FRONT VIEW	UNIT SIZE		R.O. SIZE		ROUGH SILL HEIGHT	OPERATION TYPE	TOTAL UNIT U-FACTOR	SHGC
		WIDTH	HEIGHT	WIDTH	HEIGHT				
01		2'	3'	2'-2"	3'-2"	3'-1 1/2"	W1 Casement 18		

If a commercial building with repetitive windows is being modeled this can be further simplified:

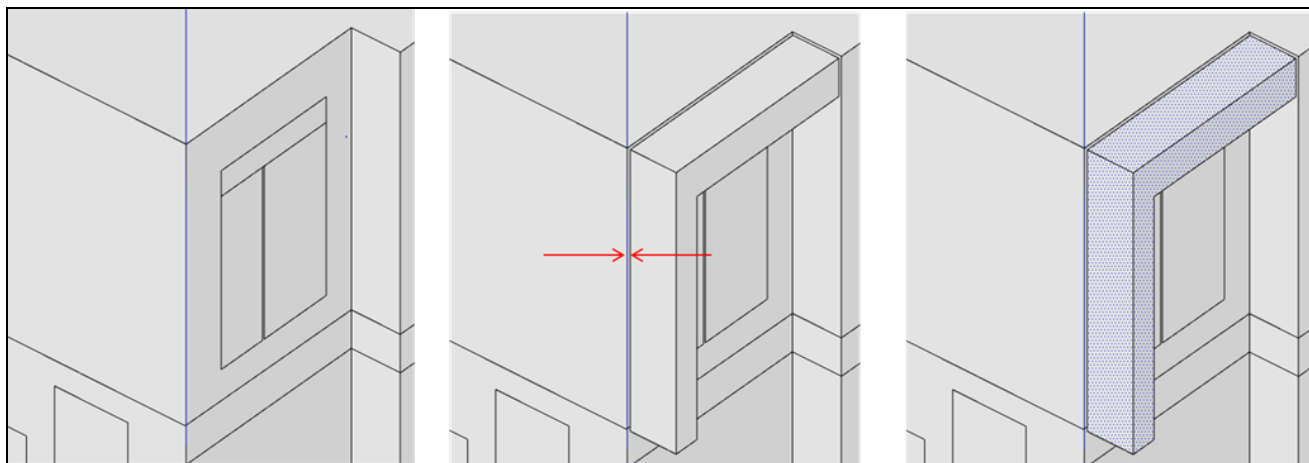
Draw the geometry of one window > group line segments > click the move tool and pressing the CTRL key > enter the distance between windows > press enter to create the first copy > type the number of repetitions followed by an asterisk (5 (5 for five windows)) to create an array of equally spaced groups.*



2.2.2 Site Shading/Context

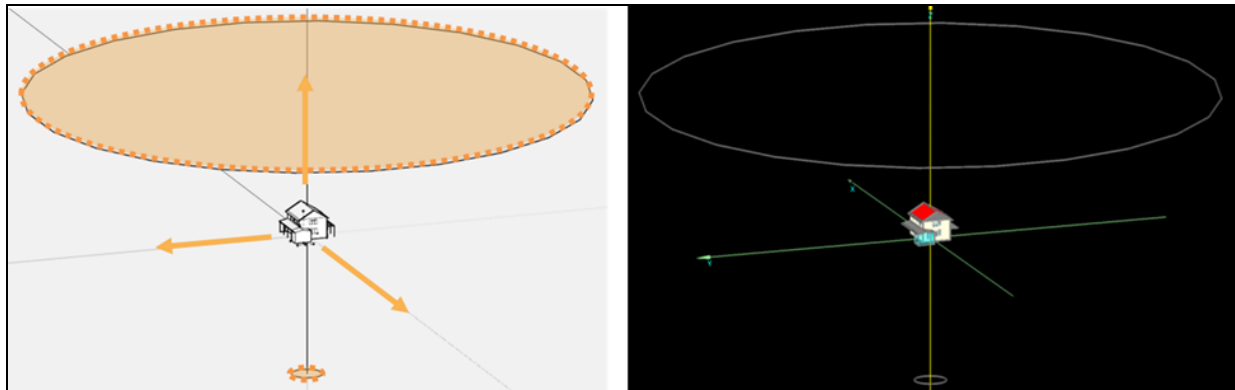
The geometry should include areas that create shading as a site-shading calculator is a new feature in WUFI Passive version 3.2. This reduces the time and complexity to calculate the numerical inputs that were once required to account for horizontal/landscape obstructions entries, overhang, and related shading components. However, if these components have not been decided upon, numerical values may still be used for feasibility.

Usually, shading elements such as balconies or overhangs are modeled in contact with wall components in SketchUp. Once these geometries are imported into WUFI, these may generate interference errors between wall components, causing failure to import. Therefore, it is better to separate the 'shading element' by a few inches from the wall component plane in SketchUp.



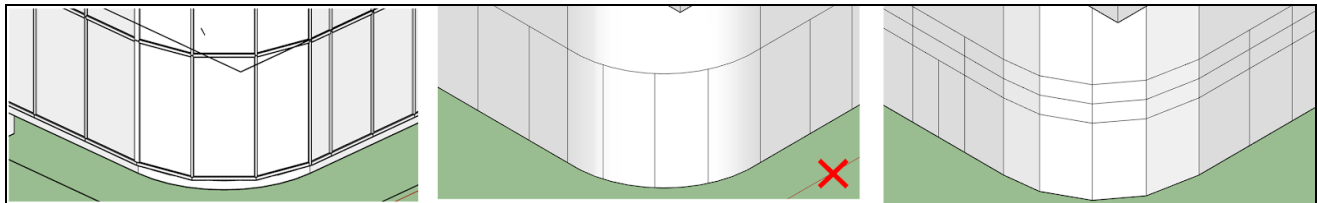
It is recommended to create 'two' additional circular components in SketchUp that will allow the project's geometry to be centered in WUFI. These are 'opening' components with 'outer air' assigned to the interior and the exterior surfaces. The idea is that the midpoint between these two components

coincides with the 'ground level' of the project in SketchUp. When the geometry is imported into WUFI, these components will not shade or otherwise affect the project, but PHIUS recommends deleting them.



2.2.3 Non-linear geometry

WUFI divides curved elements (circular walls or windows) that were modeled in SketchUp as a single component into multiple flat planes/segments. In the case of transparent components, there is potential for the segments to be broken into components that are too small to appropriately reflect the frame conditions. To solve this issue, curved window elements in SketchUp should be modeled as flat components for at least the width of each individual frame.



2.2.4 Troubleshooting Import

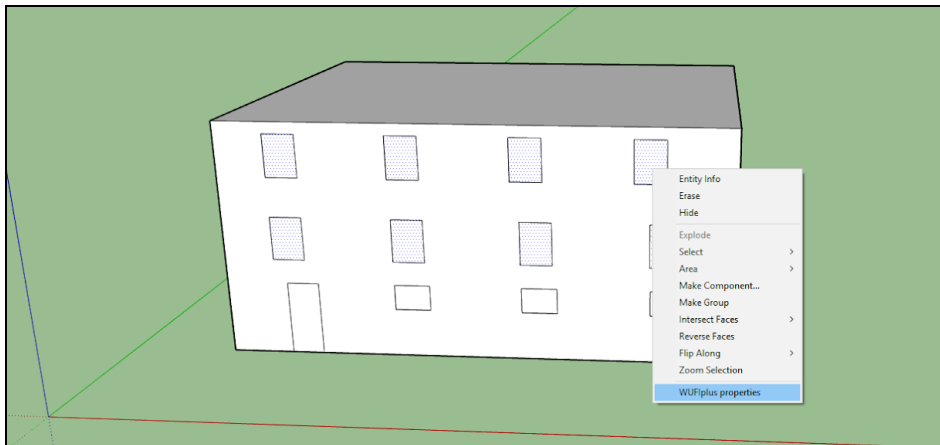
It is not uncommon for there to be loose geometry, line segments, and object intersection within the model. If this occurs WUFI Passive will notify you and the geometry may be fixed within WUFI Passive or SketchUp. If fixes are made within SketchUp, the file must be re-imported in WUFI Passive. If the fix is made in WUFI Passive, there is no way to connect the changes back to the previously imported WPS file from SketchUp.

Building geometry from scratch in SketchUp has been the most tried and true method for importing geometry into WUFI Passive. Importing a geometry from other softwares such as Rhino, Revit, ArchiCAD or AutoCAD into SketchUp can be done, but special attention needs to be given to cleaning these files up to avoid convergence errors.

2.3 Assign Properties

Upon completing the geometry, WUFI Passive properties may be assigned to the components of the model within SketchUp. This is done by right clicking on the component and navigating to the WUFIplus properties tab. To speed up this process you can *hold the Shift key or Ctrl key* and select multiple components of the same type at once to assign respective WUFI properties.

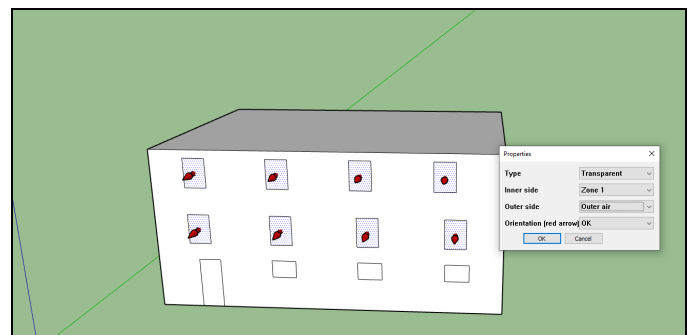
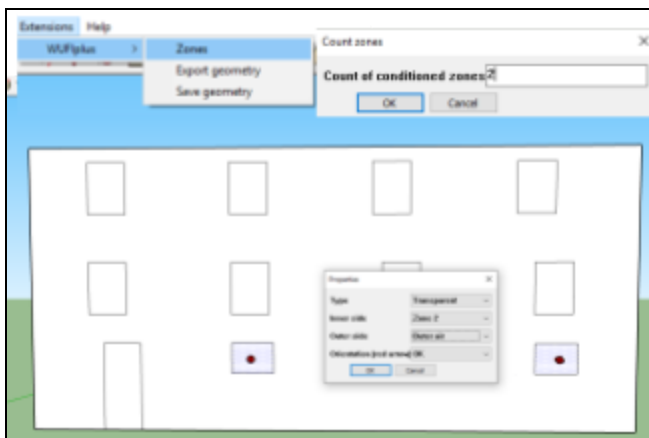
A method of ensuring that all components have been assigned with WUFI Passive properties is after assigning properties, to right click and ‘hide’ that component. This method will ensure that no components are missed or unintentionally assigned incorrect properties.



For larger projects, PHIUS recommends assigning components with larger surface areas, such as walls, roofs and floor slabs first and then ‘hiding’ them. You can then click and drag over all of the windows remaining to select them all at once. This allows multiple windows to be selected simultaneously, and WUFI properties assigned in bulk, rather than window by window.

Components with the same WUFI properties assigned (and same orientation from horizontal) will be grouped together when imported into WUFI Passive. When modeling in WUFI Passive, windows typically need to be grouped by different types; fixed, operable, glazed doors etc... Rather than ‘ungrouping’ and then ‘grouping’ the correct windows together by manually clicking in WUFI Passive, these groups can be assigned much more easily in SketchUp.

To make grouping in WUFI Passive easier, there is a workaround using ‘Zones’ in SketchUp. Multiple zones can be created in the SketchUp file to create groups of components that will import together. These zones will predetermine groups in WUFI Passive. The windows will import into WUFI Passive in separate Zones (Zone 1, 2, 3 etc.). Once in WUFI Passive, you can revise the ‘Inner side’ of each group of windows back to the appropriate conditioned zone (typically Zone 1) and delete the remaining zones that will no longer have visualized components. The additional zones may then be easily deleted in WUFI Passive. This is beneficial when buildings have multiple window types. (fixed, operable, storefront, glazed doors, sliding glass doors etc..)



WUFI Property assignments include component type, inner side option, outer side option, and orientation options.

SKETCHUP ASSIGNMENT PROPERTIES	
Component Types	Transparent
	Opaque
	Not Relevant (will not import into WUFI)
	Ground
	Opening (not used for PHIUS Certification, only WUFIplus)
Inner Side	Respective zone/zones created,
	Outer air
	Ground
Outer Side	Respective zone/zones created,
	Outer air
	Ground
	Adiabate (Space with same inner conditions)
Orientation Options	Ok
	Reverse by export.

Additional notes:

Component types: *Transparent* and *opaque* are the most commonly used. *Not relevant* is the default setting and will result in the component not being imported into WUFI Passive. *Opening* is only used for the WUFIplus (dynamic side) airflow model.

Inner Side and Outer Side: If you have conditioned areas divided into multiple zones, the respective zones may be created as shown above and assigned in SketchUp. PHIUS recommends to only use one conditioned zone for simplicity, when possible. If multiple zones are required due to differences in usage or set points, a separate model should be created as set points and usage type are not editable for individual zones. The *Adiabate* property (called Space with same inner conditions in WUFI-Passive) should be assigned to components that have the same properties on both sides, resulting in the absence of heat transfer through the respective component. Use this setting for the outer-side of a component that is attached to a conditioned space that is not part of the certified portion of the building. For example, a multifamily building that has a first floor commercial space outside of the certified space would assign the boundary of the commercial space to *Adiabate*.

When to use ‘Attached Zones’ vs ‘Space with same inner conditions’. For more information see Section 2.4 Unique WUFI Component Properties

Applicable components	Inner Side	Outer Side	Used for
Components in contact with unconditioned, but sheltered spaces	Zone 1	‘Attached Zone’	Unconditioned, but sheltered spaces such as attics, attached garages etc..
Components in contact with other certified spaces	Zone 1	Zone 1	Mixed-use projects where multiple models are needed to model varying building usage.
Components in contact with other conditioned, but not certified spaces	Zone 1	‘Space with same inner conditions’	Conditioned spaces outside of the passive building enclosure.

Orientation Options: When you click on a component in WUFI Passive, there is a red arrow that appears to show which side is the ‘Outer’ side. The red arrow always starts from the ‘Inner’ side and points to the ‘Outer’ side. If the red arrow is pointing outward, choose ok. If the arrow is not pointing to the outer side of the component, it is cleaner and quicker to flip the orientation of that component directly in SketchUp by selecting the component, right clicking and choosing ‘Reverse Faces’. This will ensure the SketchUp model is correct for future use.

Common property assignments include,

Component Type	Property	Inner Side	Outer Side	Orientation Setting
Windows	Transparent	Zone 1	Outer Air	Red Arrow points outward
Walls / Roof	Opaque	Zone 1	Outer Air	
Slab / Floor	Opaque	Zone 1	Ground	
Shading Elements	Opaque	Outer Air	Outer Air	Does Not Matter

If you mislabel or misassign a component, or need to make changes, this is not an issue as properties can be changed and assigned in WUFI Passive. It is recommended to also fix the SketchUp file at the same time for future use.

Save the respective file as a .WPS extension to further import into WUFI Passive. To do this, go to Sketchup toolbar, Extensions > WUFI Passive > Save Geometry.

Alternatively, ‘Export Geometry’ can be used which will import the geometry into any open WUFI Passive file for spot-checking if all elements will import before saving the WPS file. (Warning: If you

have other WUFI Passive project files open, it will import geometry into that project file). Once any issues are resolved, save as a .WPS file.

Once the SketchUp file has been saved as a .WPS it is best practice to open the file within the WUFI Passive software. Note that saving a .WPS file is **not** the same as saving the Sketchup File. They are two separate files. Saving a SketchUp file is done by going to File>Save in Sketchup, while saving a WPS file is done by going to Extensions>WUFI Passive>Save Geometry. You cannot open a WPS file in SketchUp, you must open a SketchUp file if you want to revise your WPS file.

2.4 Unique WUFI Component Properties

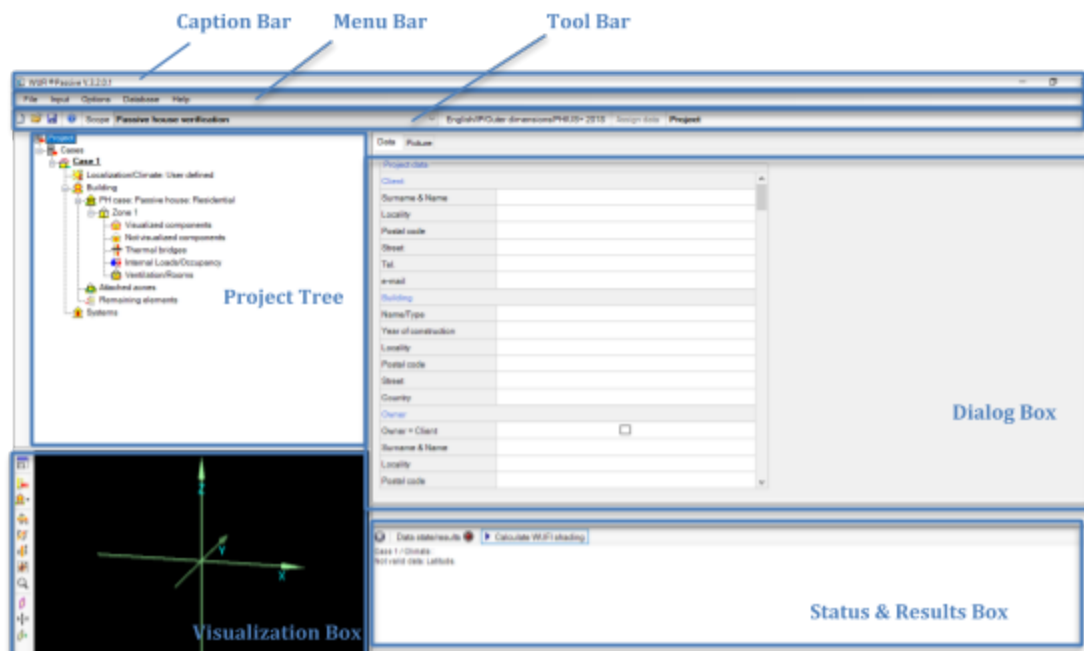
Components assigned to ‘Space with same inner condition’ (SIC), will count the area of the component towards the surface area of the project for the airtightness testing criteria, but the surface area will not be included when calculating the envelope to floor area ratios used to determine the space conditioning targets. This means, these components are subject to the same airtightness criteria, but transmission losses are assumed to be negligible. SIC should be assigned to any component that is in contact with a conditioned space outside of the passive building thermal envelope.

Spaces assigned to ‘Attached Zones’ will count the area of the components towards the surface area for the airtightness testing criteria and for calculating the envelope to floor area ratio used to determine the space conditioning targets. ‘Attached Zones’ should only be used for unconditioned (or semi-conditioned) spaces that are sheltered from true exterior conditions. The default for PHIUS certification is to use a slight reduction factor (0.95) which buffers the exterior climate by 5% for components assigned to attached zones.

3. Navigating WUFI Passive

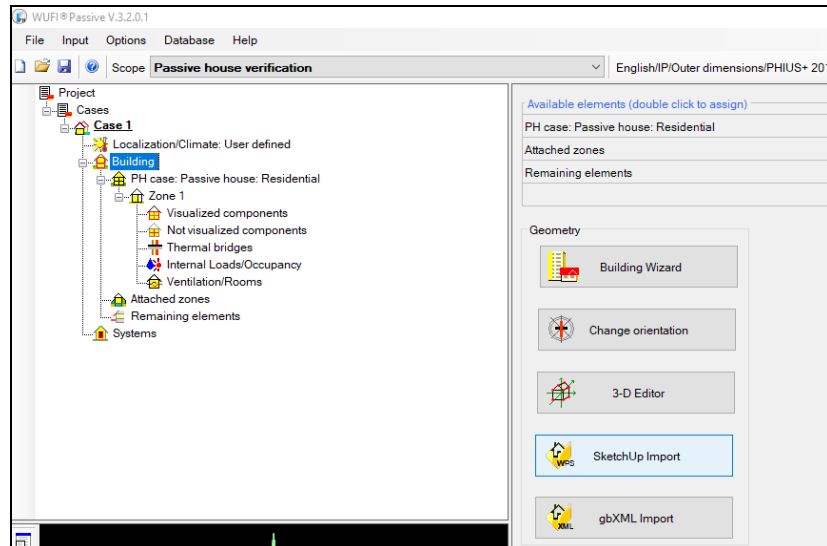
3.1 Opening WUFI Passive

Open a blank/new WUFI Passive file, dialogs and menus will appear as shown below.



4.1 Importing Geometry

To open .WPS geometry in WUFI Passive go to the Project Tree and click on the *Building* tab and then select the SketchUp import tab. The gbXML is available for use of REVIT files, but this import option is not recommended or covered in this guide.



4.2 Verifying Geometry Import

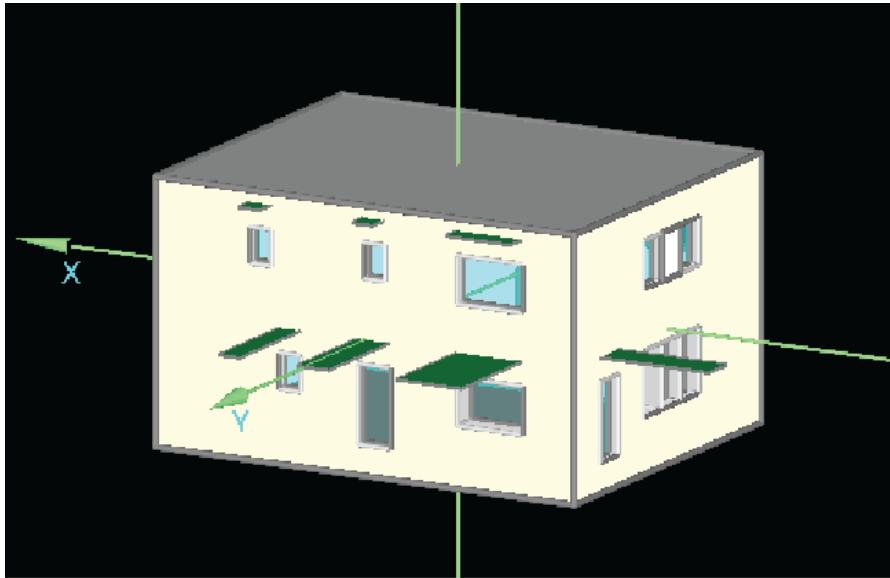
Upon importing geometry into WUFI Passive it is not uncommon for there to be loose geometry, line segments, and object intersection within the model. If this occurs WUFI Passive will notify you and the geometry may be fixed within WUFI Passive utilizing vertices from within the visualization box, instructions for this are in section 4.4 *Editing Geometry in WUFI Passive*. Geometry may also be edited in SketchUp and re-uploaded into WUFI Passive. If some components in the geometry do not import, it is best practice to check that each component was assigned a property in the SketchUp model and did not default to the *not relevant* setting.

4.2.1 Individual Component Orientation

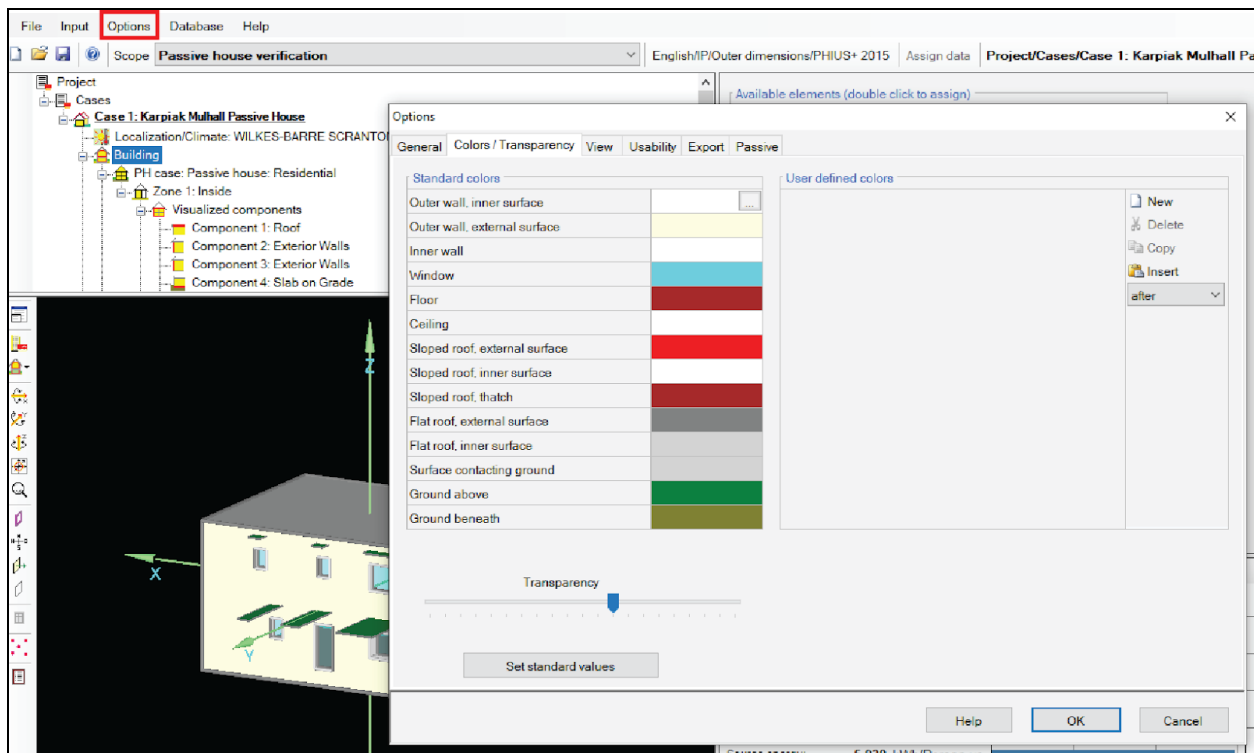
When the geometry is successfully imported into WUFI Passive, check the component orientation. The red component arrow in SketchUp will become a green vector arrow in WUFI. Vector arrows should be pointing in the “outer” direction, the vector starts at the inner side and points to the outer side of the components. This is very important when WUFI Passive calculates criteria such as solar gain for windows, and inner and outer orientation of wall components. If the direction of a vector arrow needs to be changed, click the component > select change orientation > inner <-> outer. Be careful when making this change, as grouped elements will not necessarily have the same vector orientation. If grouped components have different vector orientations, you should first *ungroup* these components before changing the vector orientation. (If changes are made in the WUFI Passive geometry, it is recommended to make the same adjustment in the SketchUp model).

Additionally, you may change the settings for the inner walls to a more obvious color difference. This visually allows you to indicate that WUFI is reading inner and outer wall components correctly. The default setting paints the exterior side of walls a cream color and the interior side of walls white.

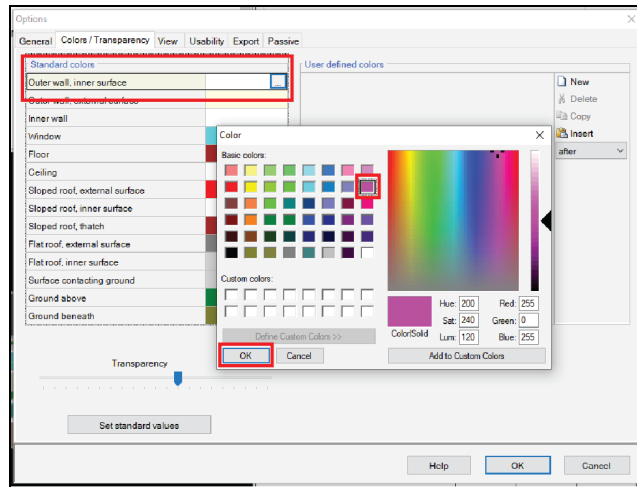
At first glance, the model below appears to have imported well.



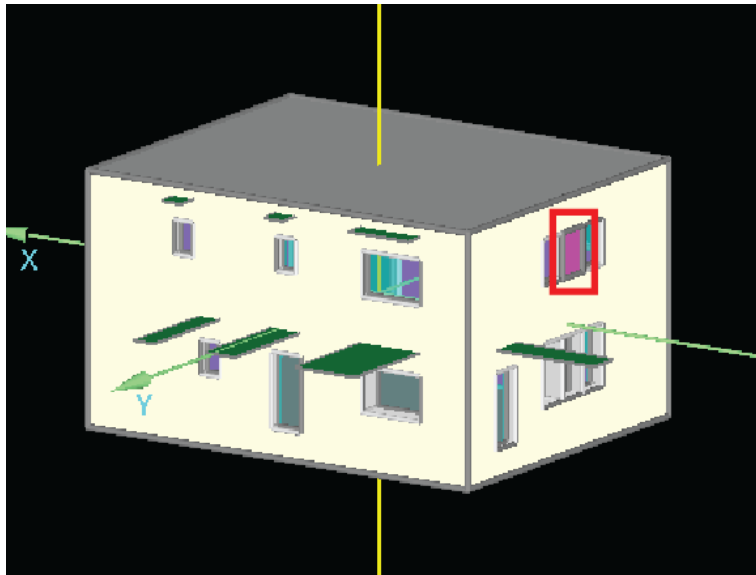
Going under 'Options' and then 'Color/Transparency' will allow you to change the color settings of typically assigned components.



As outlined above, we will change the 'Inner surface' color of our exterior walls to confirm all components are oriented correctly. From the typical white, we've changed the color to magenta.

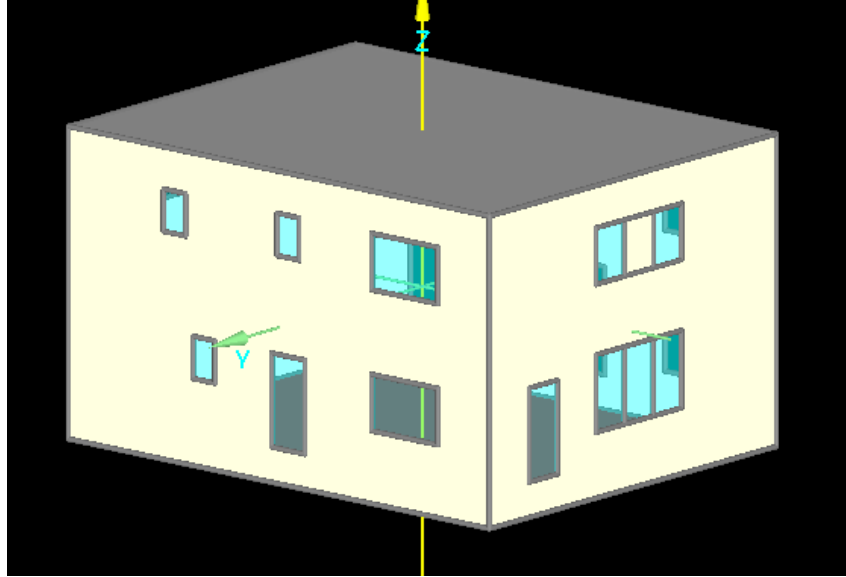


With the new color assigned, it becomes clear very quickly that the wall outlined in red is not oriented correctly and the newly assigned magenta inner side is facing outwards.



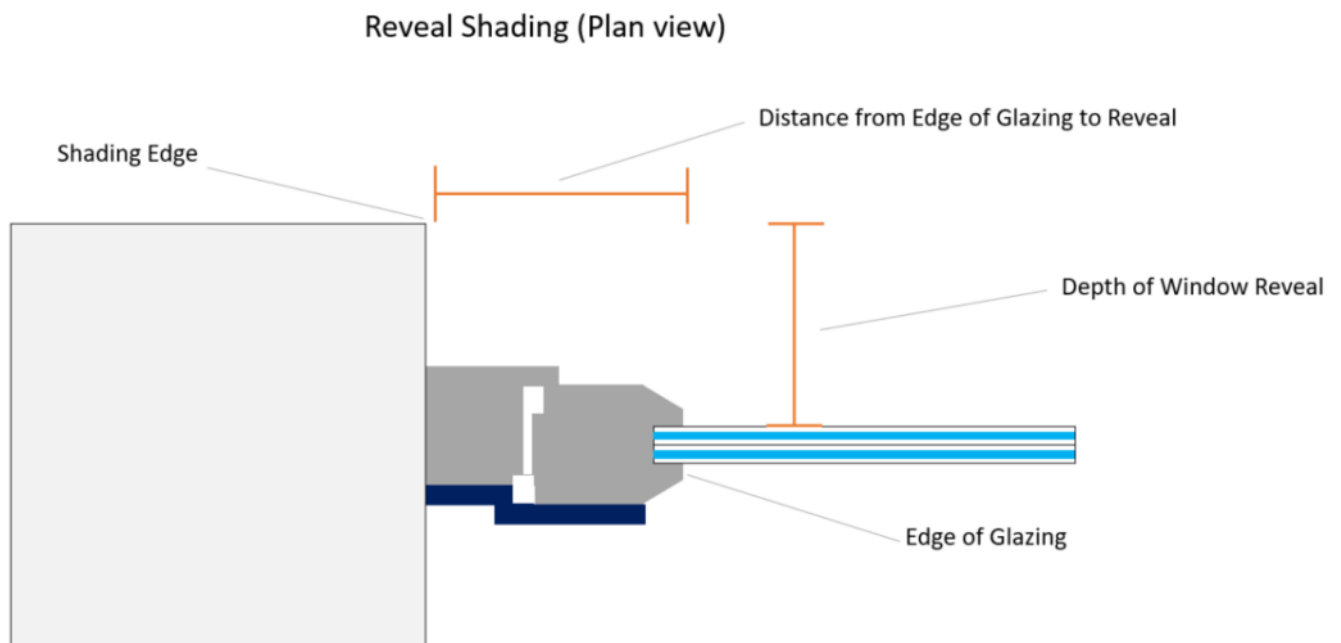
The most common components to be oriented incorrectly are windows. Windows are transparent and are assigned the same color on both the interior and exterior side, so it can be tricky to confirm the windows are oriented properly at first glance.

A visual inspection is the only reliable way to confirm if the windows are oriented correctly. The first step in this visual inspection should involve assigning reveal depths to all windows. Before reveals are assigned, the windows will appear flush with the exterior walls as shown below.



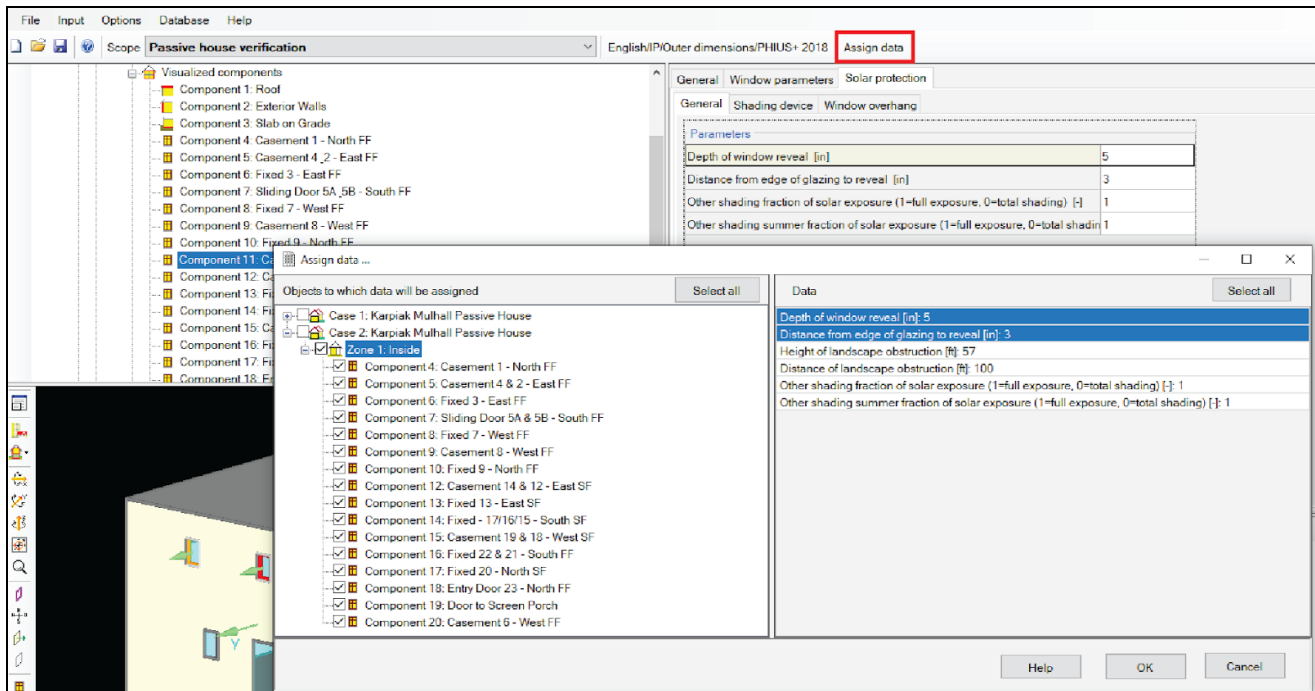
To assign reveals, select a single window and assign the correct reveal inputs under the Solar Protection>General tab. Definitions for the two reveal entries are noted below.

- Depth of window reveal: Measured from the outside of the leading shading edge to the glazing.
- Distance from edge of glazing to reveal: Measured from the edge of glazing to the shading edge.

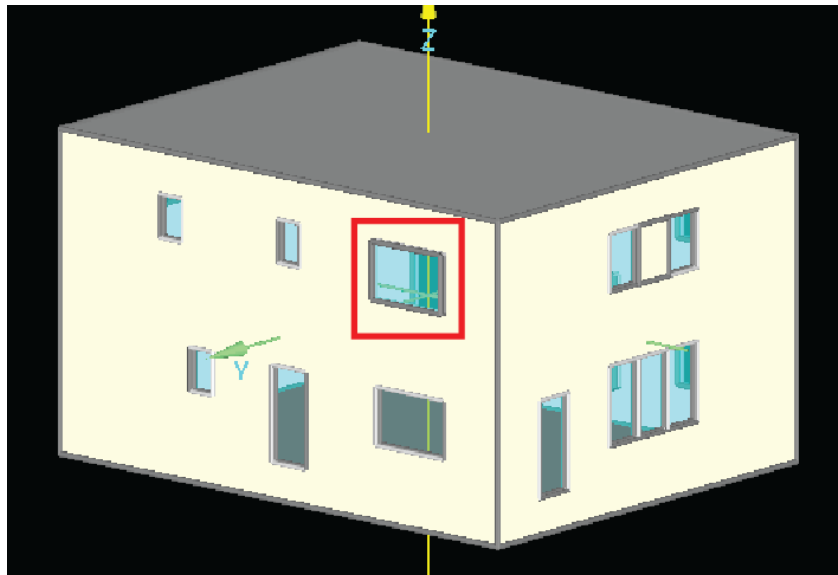


After entering the reveals for a single window, you can assign reveals in bulk to all windows by clicking the 'Assign data' button. This button allows you to choose which data you'd like to assign

and check the boxes for which windows you'd like to assign that data to. Hold 'Ctrl' to select more than one of the 'Data' entries on the right side of the screen. Selected entries will be highlighted in blue. For this example, we've assigned the same reveal to all windows.

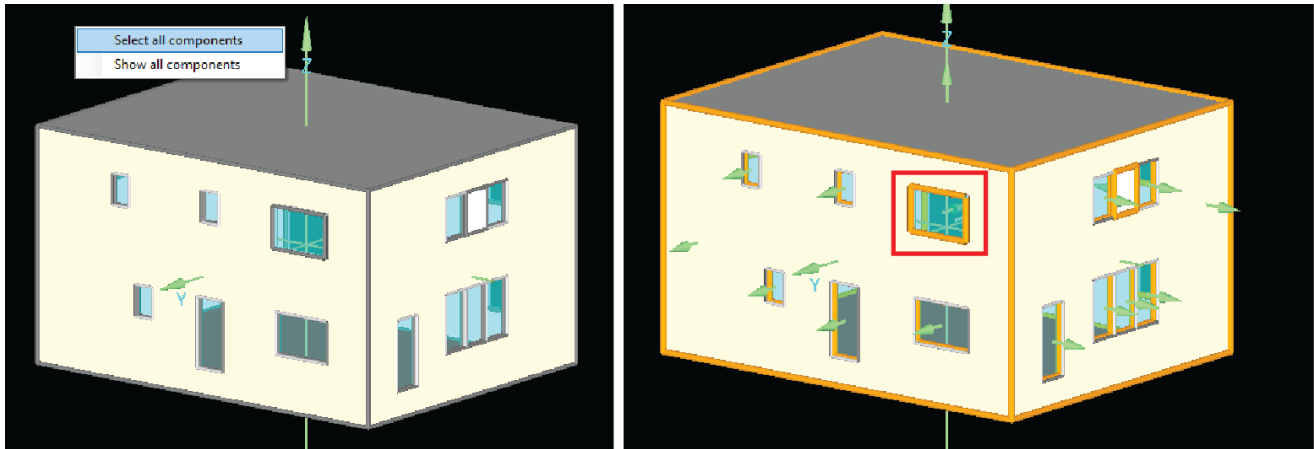


After the reveals have been assigned, the 3D visualized geometry is updated to show the windows pushed back from the facade. If you look closely, the window circled in red below does not have quite the same reveal look as the rest of the windows in the building.



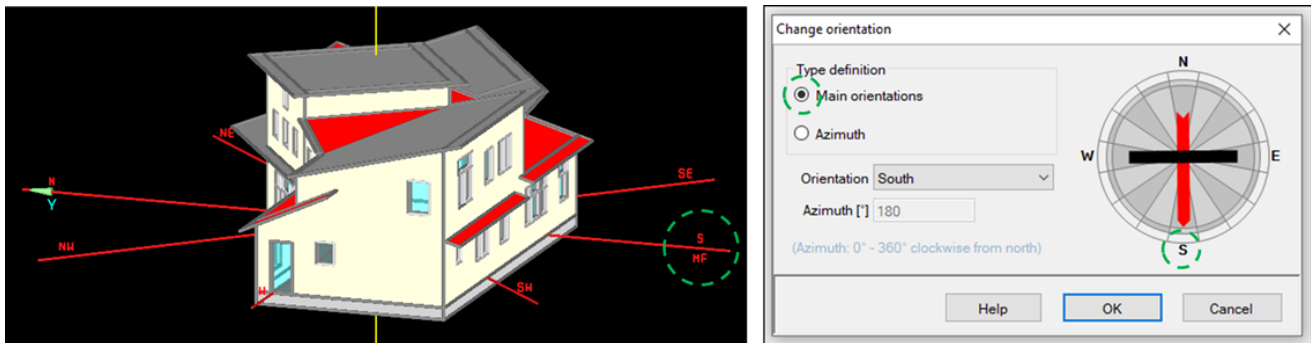
To confirm that this is indeed an incorrectly oriented window, right click in the black space of the model and choose 'Select all components'. This will activate the green vector arrows for all

components and you see the window circled in red does not have an outward pointing green vector arrow like the rest of the windows, walls and roof.



4.2.2 Building Orientation

Verify that the orientation of the building matches the orientation that is found in the architectural drawings. You may check the orientation by expanding the visualization box and clicking the orientation icon. Note that one of the facades will display ‘MF’ (main facade). This will be the facade you are defining the orientation to. If the orientation needs to be changed, right click the icon and a respective box will appear.



4.3 Grouping Components

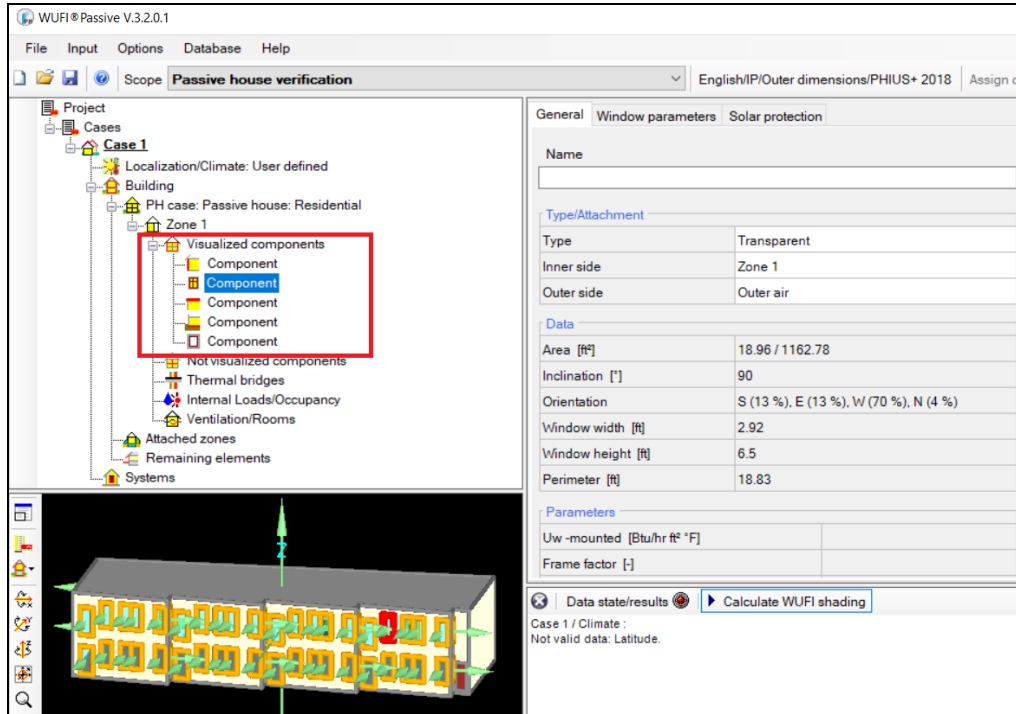
Grouping like-components should be a standard practice utilized in each individual energy model, for both ease of use, speed and consistency. Grouping becomes significant when assigning component assembly and surface details. For this reason, only components with the same properties and inclination may be grouped.

To group components, click the component > hold the “CTRL” key > select any like-components > right click > group.

Ungrouping components is also an option, to do this, right click on the component > Ungroup. Two options are available here, “ungroup main component”, which ungroups only the component selected, and “ungroup all selected components”, which ungroups everything.

As groups are created, they become available for viewing in the Project Tree, under *Visualized Components*.

WUFI Passive begins to identify the components of respective groups as shown in the photo below.

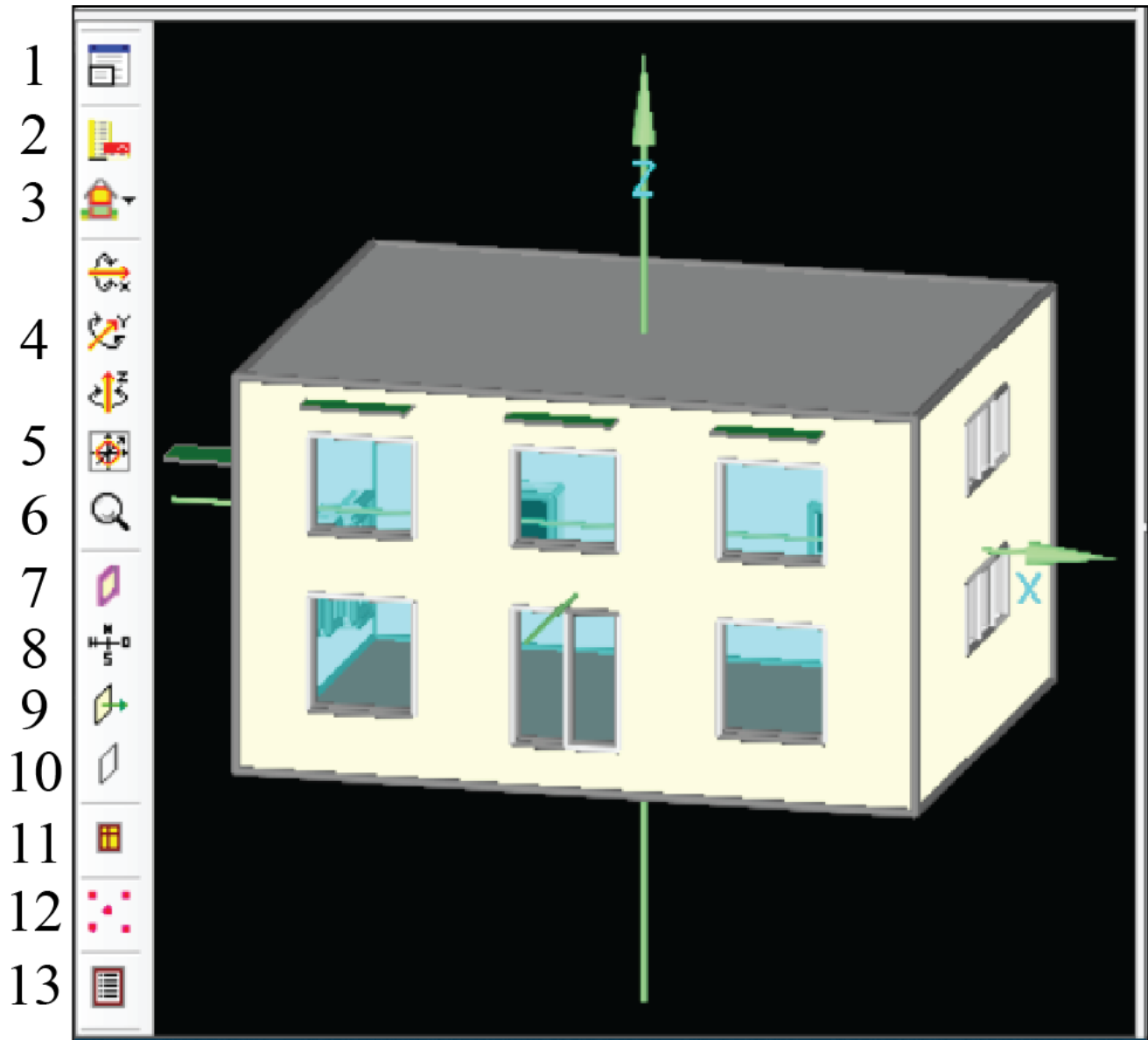


Naming conventions for each component should be identified and used for organization.











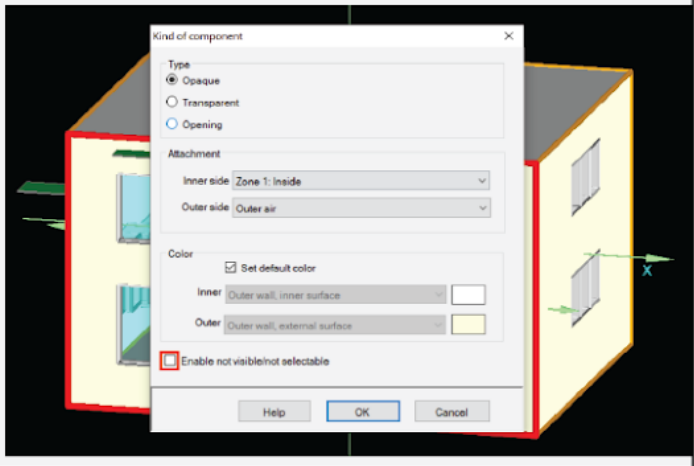



4.4 Editing Geometry in WUFI Passive

As noted in the sections above, editing geometry directly in WUFI Passive is not recommended except for small changes. Any changes made in WUFI, should be duplicated in the SketchUp file used for the original import. At this time, there is no way to export the geometry from WUFI Passive back to SketchUp.

The 3D Visualized Geometry window has multiple tools which are defined in the following figures.



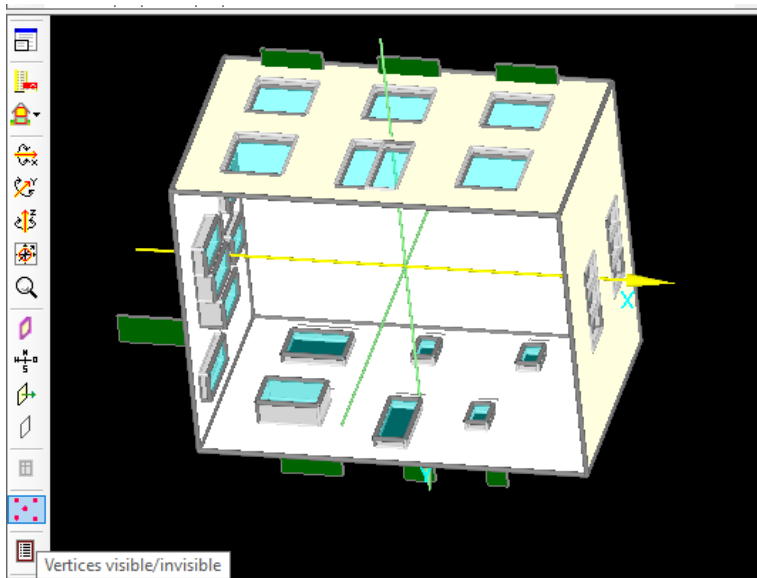
3D Preview of Building - WUFI-Passive Tools

Expands the 3D visualized geometry window.		1
Building Wizard: Overrides existing geometry.		2
Zones: 'Left click' and hold will hide/view elements assigned to different zones.		3
Axis Rotations: Rotate the 3D visualized geometry around the axis chosen. Example: 'Left click' the 'Z' axis button to rotate counter-clockwise. 'Right click' the 'Z' axis button to rotate clockwise. If an axis rotation option is selected, a mouse scroll wheel will rotate the building.		4
Center the Building: Re-centers the 3D visualized geometry window on the origin point.		5
'Left click' = zoom in. 'Right click' = zoom out. If selected, a mouse scroll wheel will zoom.		6
Toggles all components between opaque and transparent.		7
Toggles the compass rose on and off.		8
Toggles the green vector arrows on and off. PHIUS recommends keeping these vectors turned on.		9
Toggles components that have 'Enable not visible/not selectable' on and off. See notes below.		10
<p>Select a component with a 'Left Click'. While component is highlighted, 'Right Click' to open 'Kind of Component' properties. Check/Uncheck the box for 'Enable not visible/not selectable'.</p> <div style="text-align: center;">  </div>		
Select a component (wall or roof) with a 'Left Click'. Click the 'Component Openings' icon and a 2-D view of the component selected will appear. Windows and openings can be edited in this view.		11
Toggles vertices on/off. Useful when making small adjustments to building geometry in WUFI. When not making adjustments to vertices, PHIUS recommends toggling this option off.		12
Options dialogue box. Allows adjustments to be made to color/transparency of all component types, vertice sizes and other options for view in the 3D visualized geometry window.		13

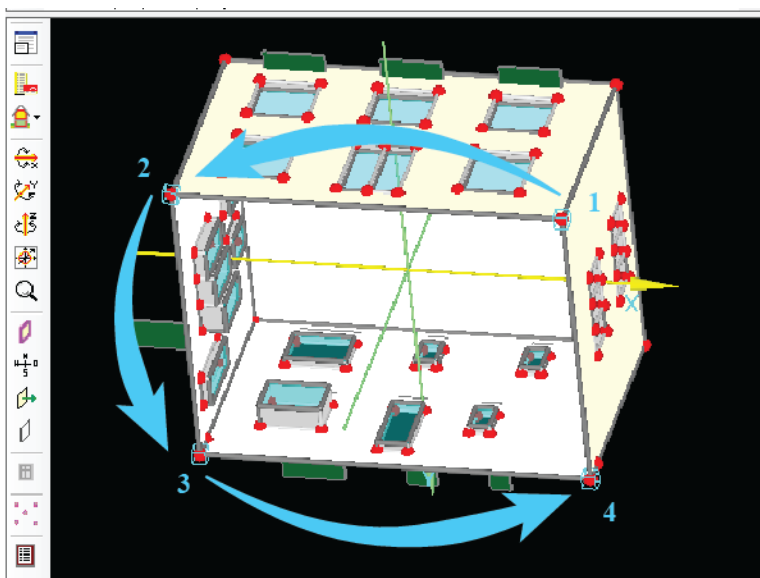
To edit geometry in WUFI Passive, it is recommended to use the *expand/shrink window* tab to make the geometry full screen. Once the geometry has been expanded to full screen, all options are visible on the toolbar.

4.5 Creating a New Component in WUFI Passive using Vertices

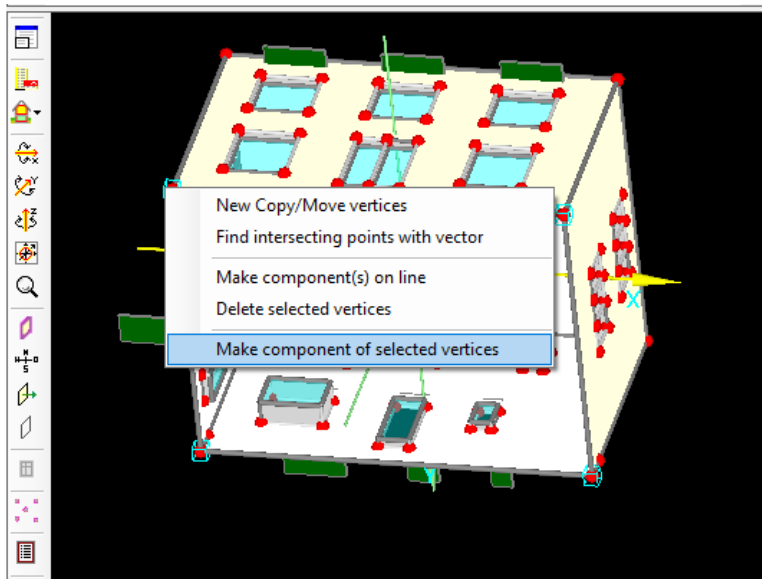
Click the *vertices visible/invisible* tab, to activate the vertices.



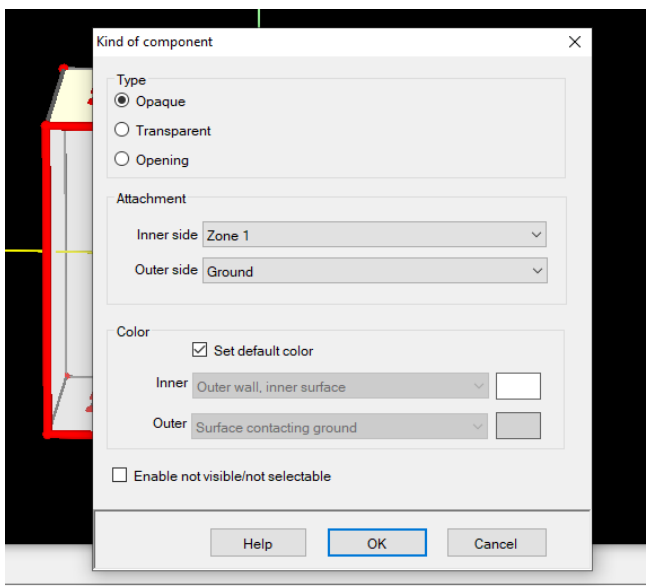
To create a component in WUFI Passive, in this case a floor, select the vertices in a counter-clockwise fashion, clicking each vertice while holding the CTRL key.



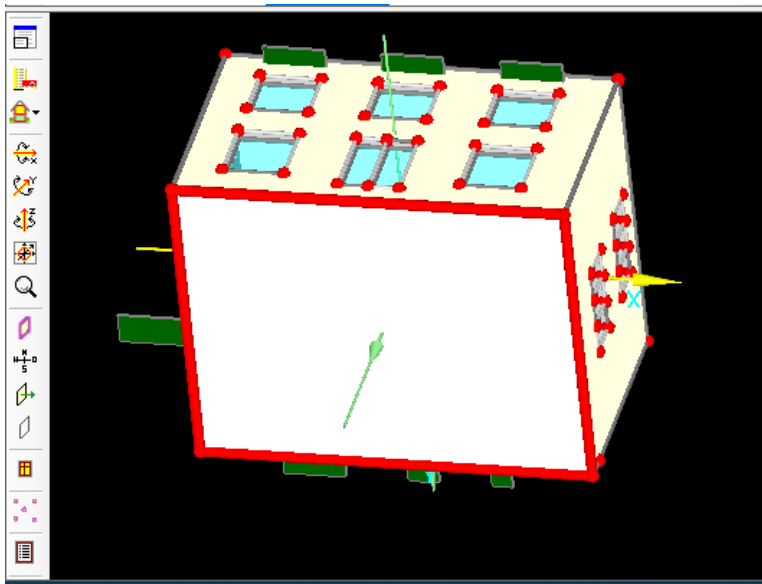
Once the vertices are selected right click to see additional options > *Make component of selected vertices*



A screen to assign WUFI Passive properties will further be displayed.



Once Properties are assigned, the geometry is created.

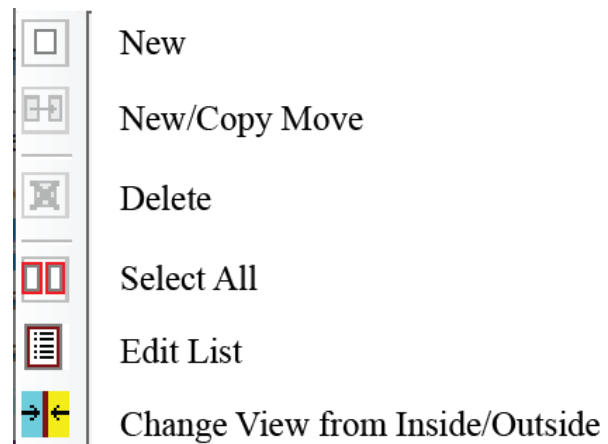
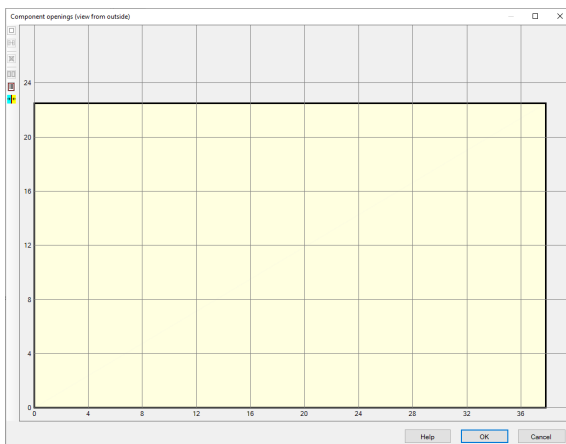


When two vertices are selected, the *2 points operation* becomes available, which may be beneficial in determining distances between vertices and creating additional lines or components. Copying and moving components may be available when vertices are selected. Vertices may be created by right clicking the expanded screen and selecting the new vertices tab, then inputting the x, y, z, coordinates of the desired vertices.

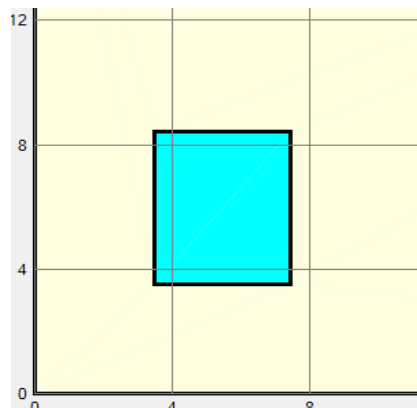
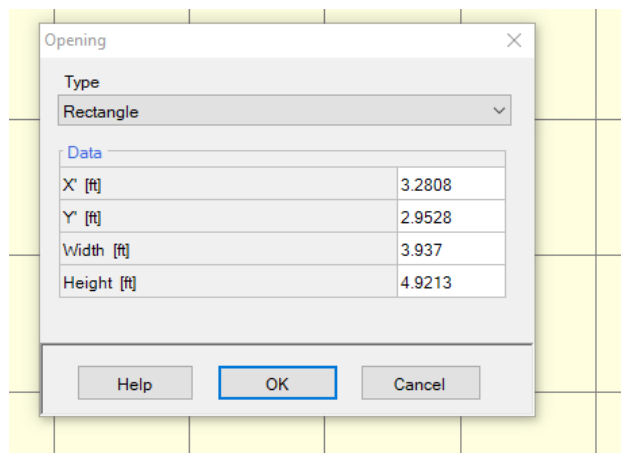
4.6 Editing Windows in WUFI Passive

In general, if significant changes are needed, PHIUS recommends making changes in the SketchUp model and re-importing the geometry. However, small revisions can be made within the software if needed.

Windows may be added in WUFI Passive by first selecting the wall/roof component (in the 3D visualization) that the window will be placed in, then clicking the *Windows/Openings* tab. The *Component openings* dialog box and toolbar will appear.



To create a new window or opening select the *New* tab. The shape, position, and measurements may further be input into the dialog box and the window will be created.



You can copy the newly created window by selecting it > right click> *copy and move*. You will be prompted to enter the X and Y coordinates along with the number count. After a window is created, you can also click and drag the window to the desired location in the dialog box. Windows that are preexisting may also be copied or moved using the same procedures. Once you close the dialog box the changes will be reflected on the building geometry.

4.7 Non-Visualized Components

Due to limitations with how non-visualized components interact with visualized components, PHIUS does not recommend using non-visualized components.

Exceptions: A non-visualized component may be used to represent small amounts of opaque envelope area such as an elevator pit or other extrusions that do not include windows.

4.8 Openings

A SketchUp import may automatically generate a component categorized as an 'Opening' when there is an extrusion from an opaque component, which creates a void at the plane of that opaque component. Otherwise, 'opening' components should not be used for PHIUS+ Certification models. This component type is reserved for air-flow modeling in WUFIplus.

For all other modeling related questions, refer to the most updated version of the PHIUS+ Certification Guidebook. You may contact certification@phius.org with further questions.