

# **WUFI® Passive 3.0**

## Manual



### Authors:

Florian Antretter

Marcus Fink

Matthias Pazold

Jan Radon

Matthias Winkler

## Preamble

This manual describes the installation and the main features of WUFI® Passive.

Using a theoretical building as an example, this manual will show how to create a 3D visualization of the building, how to set boundary and initial conditions and finally how to calculate and assess this example. Some hints will be given at each step. It is advised that you follow this example when working with WUFI® Passive for the first time.

For detailed information please refer to our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)).

Throughout this manual, four recurring design elements can be found which will help in finding important information:

### Controls box

#### **Controls box**

These grey boxes show information about the menus of WUFI® Passive.



Green Information Boxes like this one give hints for further information about the current topic.



Orange Attention Boxes like this one include important information about calculation settings.



Blue Difference Boxes like this one remind the user of different inputs depending on the selected Passive House verification criteria. All differences are summed up in chapter 4.2.1.

# Contents

<b>1</b>	<b>Introduction</b>	<b>7</b>
<b>2</b>	<b>Installation</b>	<b>9</b>
2.1	System Requirements	9
2.2	Installation & Update	9
<b>3</b>	<b>Menus</b>	<b>16</b>
3.1	Main Window	16
3.2	Menu Bar	17
3.2.1	File	18
3.2.2	Input	18
3.2.3	Options	19
3.2.4	Database	20
3.2.5	Help	21
3.3	Tool Bar	23
3.4	Visualization Box	24
3.4.1	Inserting Windows and Openings	26
3.4.2	Creating and Modifying the Building Geometry	30
3.5	Status & Results Box	32
<b>4</b>	<b>Project Tree</b>	<b>34</b>
4.1	Project Information	37
4.2	Case Menu	38
4.2.1	Differences between “Default” and “PHIUS+ 2015” Certification Modes	38
4.3	Localization & Climate	40
4.3.1	Climate Data	41
4.3.2	Primary Energy/ CO <sub>2</sub> -Factors	43
4.4	Building Menu	44
4.4.1	Creating a Building	45
4.4.2	PH Case	47
4.4.3	Simulated Zones	51
4.4.4	Visualized Components	53
4.4.5	Not Visualized Components	54
4.4.6	Attached Zones	55
4.4.7	Internal Loads & Occupancy	56
4.4.8	Ventilation/ Rooms	65
4.4.9	Thermal Bridges	71
4.4.10	Remaining Elements	72
4.5	HVAC-Systems Menu	73
4.5.1	Ideal User-Defined Systems	75

4.5.2	Detailed Predefined Systems	77
4.5.3	Distribution	78
<b>5</b>	<b>Components</b>	<b>83</b>
5.1	Opaque Components	83
5.1.1	General Settings	84
5.1.2	Assembly – Selection	85
5.1.3	Assembly – Editing	86
5.1.4	Surface	88
5.1.5	Exterior Door	89
5.2	Transparent Components	90
5.2.1	General Settings	91
5.2.2	Window Parameters	92
5.2.3	Solar Protection	94
<b>6</b>	<b>HVAC-Devices</b>	<b>97</b>
6.1	Mechanical Ventilation	97
6.2	Electric Heating/ DHW	98
6.3	Boiler	98
6.4	Combined Heat and Power (CHP)	99
6.5	District Heating	99
6.6	Heat Pump	100
6.7	Solar Collector	102
6.8	Water Storage	104
6.9	Photovoltaics	105
6.10	User-Defined	105
6.11	Creating Database Entries for HVAC Devices	106
<b>7</b>	<b>Importing geometry data</b>	<b>109</b>
7.1	SketchUp Plugin	109
7.2	gbXML-Import	112
<b>8</b>	<b>Passive House Verification</b>	<b>115</b>
8.1	General Reports	115
8.2	Passive House Verification Report	118
<b>9</b>	<b>Hygrothermal building simulation</b>	<b>119</b>
9.1	Data-transfer between the Calculation Modes	119
<b>10</b>	<b>DIN 4108-2 Thermal Protection/ Building Simulation</b>	<b>121</b>
<b>11</b>	<b>Example Case</b>	<b>123</b>
11.1	Step 01: Creating a new project	125

11.2	Step 02: Defining climatic conditions	126
11.3	Step 03: Creating the building geometry	128
11.4	Step 04: Adding windows and an external door	130
11.4.1	Windows	130
11.4.2	Exterior door	132
11.5	Step 05: General Passive House settings	134
11.6	Step 06: Zonal settings	137
11.7	Step 07: Defining the visualized components	138
11.7.1	Floor Slab	138
11.7.2	Ceiling	142
11.7.3	Exterior Walls	143
11.7.4	Windows	148
11.7.5	Exterior Door	150
11.8	Step 08: Setting internal loads and occupancy schedule	151
11.9	Step 09: Ventilation settings	152
11.10	Step 10: Thermal bridges	156
11.11	Step 11: Connection with attached zone	157
11.12	Step 12: Including HVAC	158
11.12.1	Creating a HVAC system and its devices	158
11.12.2	Distribution	160
11.12.3	Heat Pump	162
11.12.4	Mechanical Ventilation	163
11.13	Step 13: Viewing the results and adjusting the building	164
11.14	Step 14: Passive House Verification Report	165
11.15	Step 15: Switching to dynamic hygrothermal simulations	166

# 1 Introduction

WUFI® Passive allows a double assessment of buildings based on the same building model:

- A monthly energy balance method following EN 13790 is used for the design and verification of buildings meeting the Passive House criteria.
- The dynamic building simulation of WUFI® Plus is used for the detailed dynamic assessment of the hygrothermal behavior of buildings meeting the passive house criteria, as well as individual components. This feature can be used as soon as the building meets the certification criteria.

Combining the monthly energy balance and the dynamic method allows designers to optimize passive buildings for local climate conditions while maintaining indoor comfort.

Passive buildings are characterized by extremely low energy consumption. Dynamic hygrothermal models are necessary to accurately model the hygrothermal behavior of buildings in dynamically changing climates or climates where cooling and dehumidification of the indoor air play an important role. Thermal and hygric inertia can be considered in detail to further reduce energy demand and to eliminate limitations on indoor comfort (e.g. overheating).

In many climate zones, the use of highly insulated components presents risks – such as moisture issues to designers and construction professionals. Managing this risk requires a dynamic hygrothermal assessment under real climatic conditions.

To meet this need, the Fraunhofer-Institute for Building Physics (IBP) and the Passive House Institute US (PHIUS) developed WUFI® Passive. WUFI® Passive combines the WUFI® Plus building simulation tool with the PHIUS+ verification criteria.

WUFI® Passive allows the user to switch through different calculation scopes at any time. Building data that is applicable to multiple scopes is carried over from one scope to another, avoiding double entry. WUFI® Passive comes with the following scopes:

- Passive House Verification: This scope offers the complete passive house design and verification method, as described in this manual.
- WUFI® Plus: This scope provides access to the dynamic building simulation of WUFI® Plus. As long as the building doesn't fulfill the certification criteria only thermal simulations are possible. As soon as the building meets the certification criteria the full hygrothermal building simulation capabilities of WUFI® Plus are available. Please refer to chapter 9 and the WUFI® Plus manual for further information.

- DIN 4108-2 Thermal Protection / Building Simulation: The German thermal protection standard DIN 4108-2 describes verification methods to reduce overheating during summer. One of these methods is thermal building simulation with boundary conditions defined by the standard. This scope of WUFI® Passive can be used to perform calculations according to the standard. After the simulation is finished a report with all results and a classification according to the standard can be exported for every zone. Please refer to chapter 10 for further information.

## 2 Installation

### 2.1 System Requirements

IBM compatible computer, CPU at least 1.6 GHZ

RAM (Memory): 4 GB or better

Hard Drive: At least 8 GB free space

Graphic Card: At least 128 MB, OpenGL support

Operating System: Windows XP Service Pack 2 or higher; Windows 7; Windows 8

.NET Framework: 3.5 with Service Pack 1

### 2.2 Installation & Update



This installation procedure must be executed for a new installation of WUFI® Passive and for updates. When an update is performed, the existing settings and database-entries will be transferred to the new version of WUFI® Passive automatically. User-defined database-entries will be transferred, too.

After the download of WUFI® Passive is complete, unzip the downloaded file into a new folder. It's crucial to unzip the file or, the WUFI® Database won't be installed and WUFI® Passive cannot be started. This folder can be deleted after the installation has completed successfully.

Start the WUFI® Passive setup by double-clicking the Setup-File. The setup-dialog will open. Click "Next" to continue with the installation and "Cancel" to end it:



Figure 1:  
Installation: Start the setup.

Please read the License Agreement. You must accept the terms of this agreement before continuing with the installation.



Figure 2:  
Installation: Terms of use.

Please make sure that your computer meets the system requirements:

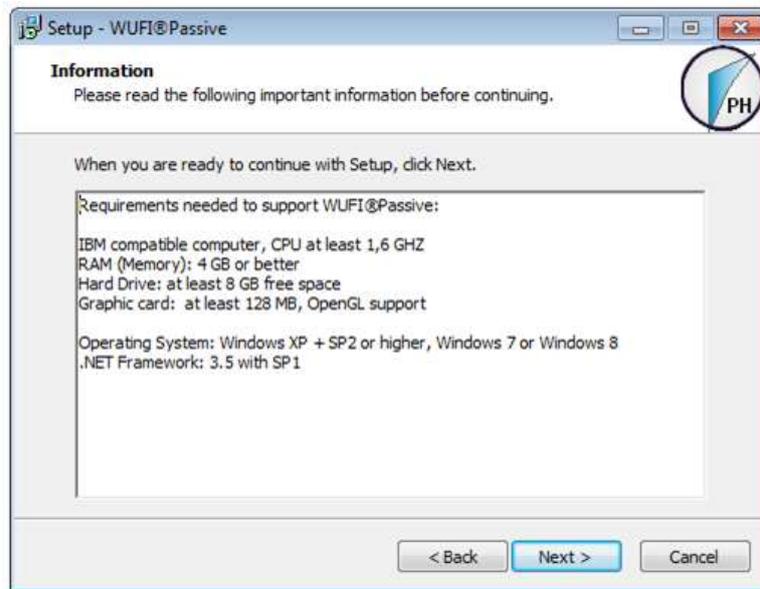


Figure 3:  
Installation: System requirements.

Input your license information from the Purchase-Email. Please note, that the license key from the Purchase-Email must be entered in the "Serial Number" field. It is recommended to copy the license information directly from our Purchase-Email to avoid input errors:

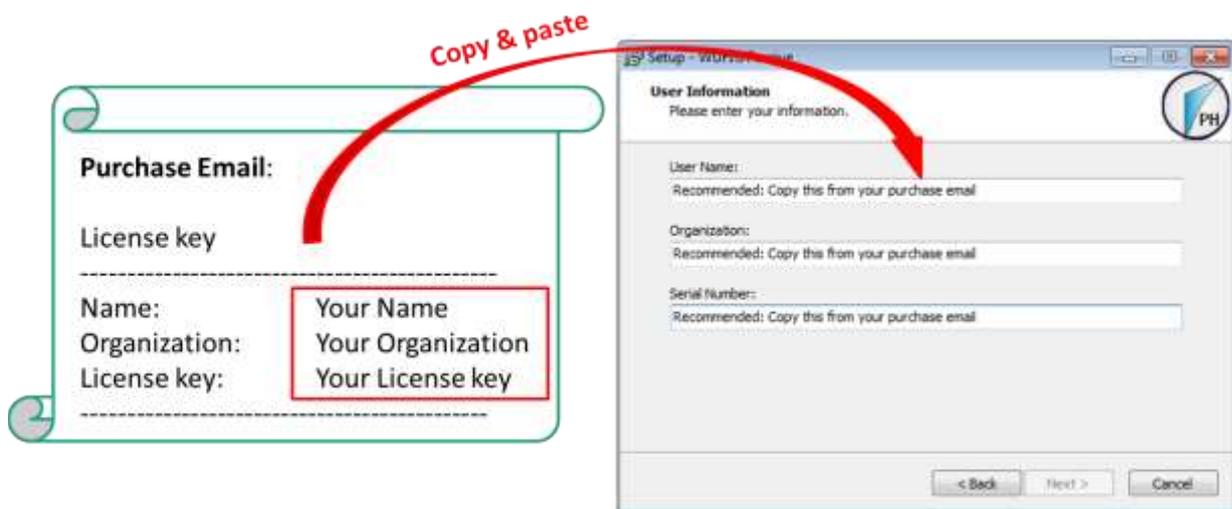


Figure 4:  
Installation: Enter your license data.

If the license information was entered correctly, the "Next"-button can be selected and the installation folder can be chosen. WUFI® Passive setup will create

an entry in the Windows Start Menu. Its name can be entered in the next dialog:

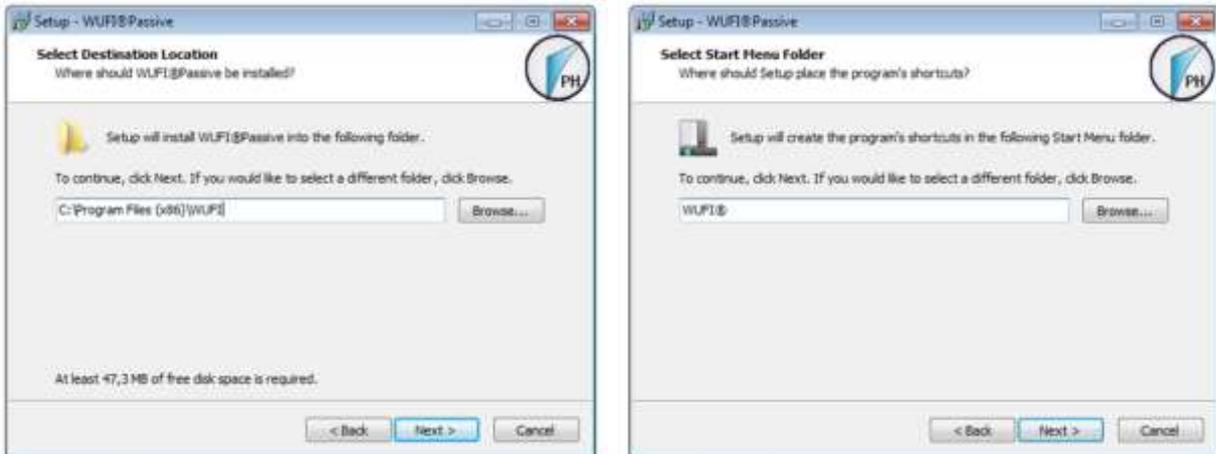


Figure 5:  
Installation: Select the installation folder and create an entry in the Windows Start Menu.

There is also an option to create a desktop icon:

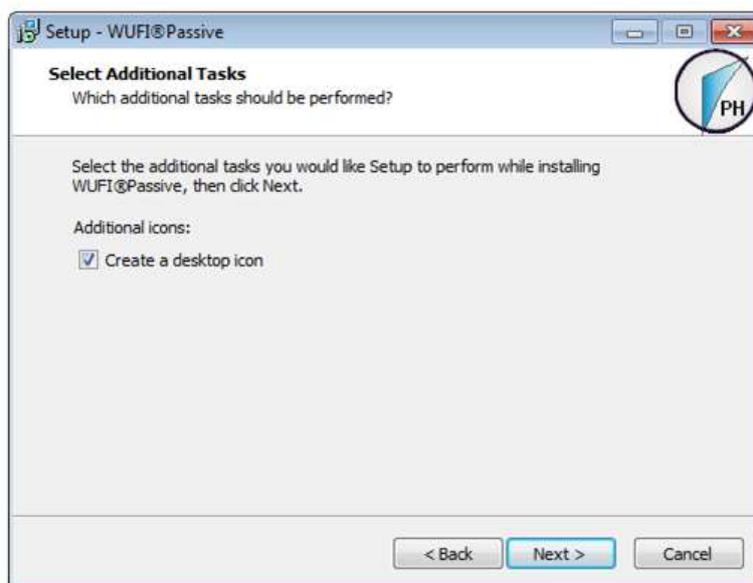


Figure 6:  
Installation: Create a desktop icon.

An info-screen sums up all settings for the installation-process. Please check these settings and use the "Back"-button to change any part of the installation. After all settings are entered correctly, click "Install" to continue with the installation.

After the installation of WUFI® Passive has finished successfully, a second setup-dialog for the WUFI® Database opens:



Figure 7:  
Installation: Start the installation of the WUFI® Database.

Select the installation folder for the WUFI® Database:

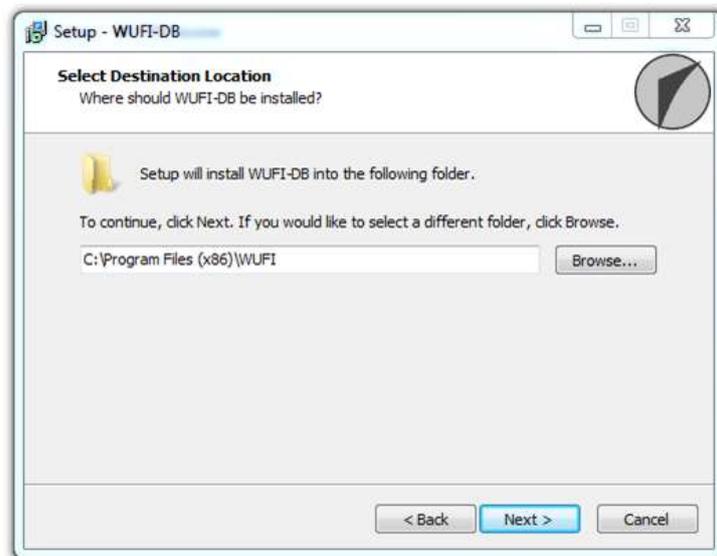


Figure 8:  
Installation: Select the folder for the installation of the WUFI® Database.

An info-screen sums up all settings for the installation-process. Please check these settings and use the "Back"-button to change any part of the installation. After all settings are entered correctly, click "Install" to continue with the installation.

After both installations are finished, click the "Finish"-button to complete the setup-process.



Figure 9:  
Finish the installation of WUFI® Passive and the WUFI® Database.

WUFI® Passive can now be started from the Windows Start Menu or from the desktop icon (if created).

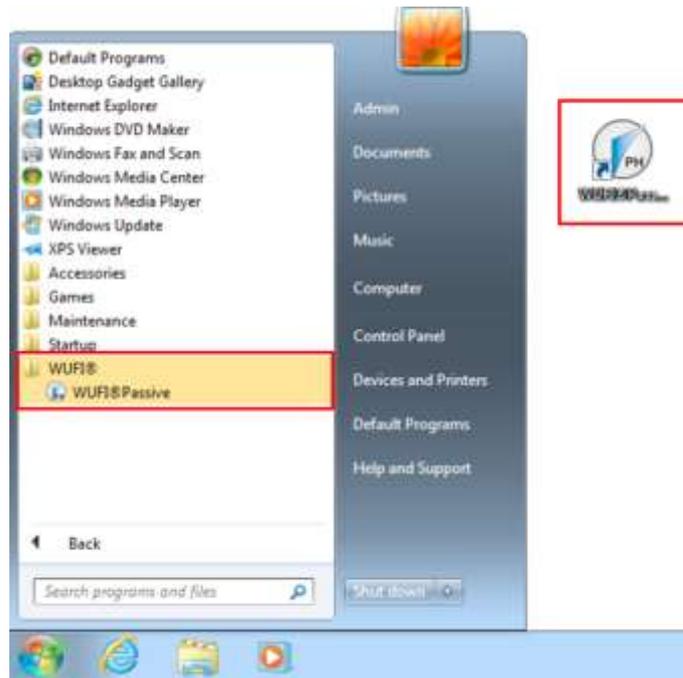


Figure 10:  
Starting WUFI® Passive either from the Windows Start Menu or the desktop shortcut.

### 3 Menus

This chapter gives a short overview of WUFI® Passive and its menu structure.

#### 3.1 Main Window

After starting WUFI® Passive, the main window will appear, as shown below. This window provides access to all dialogs and menus. A short description of each element follows.

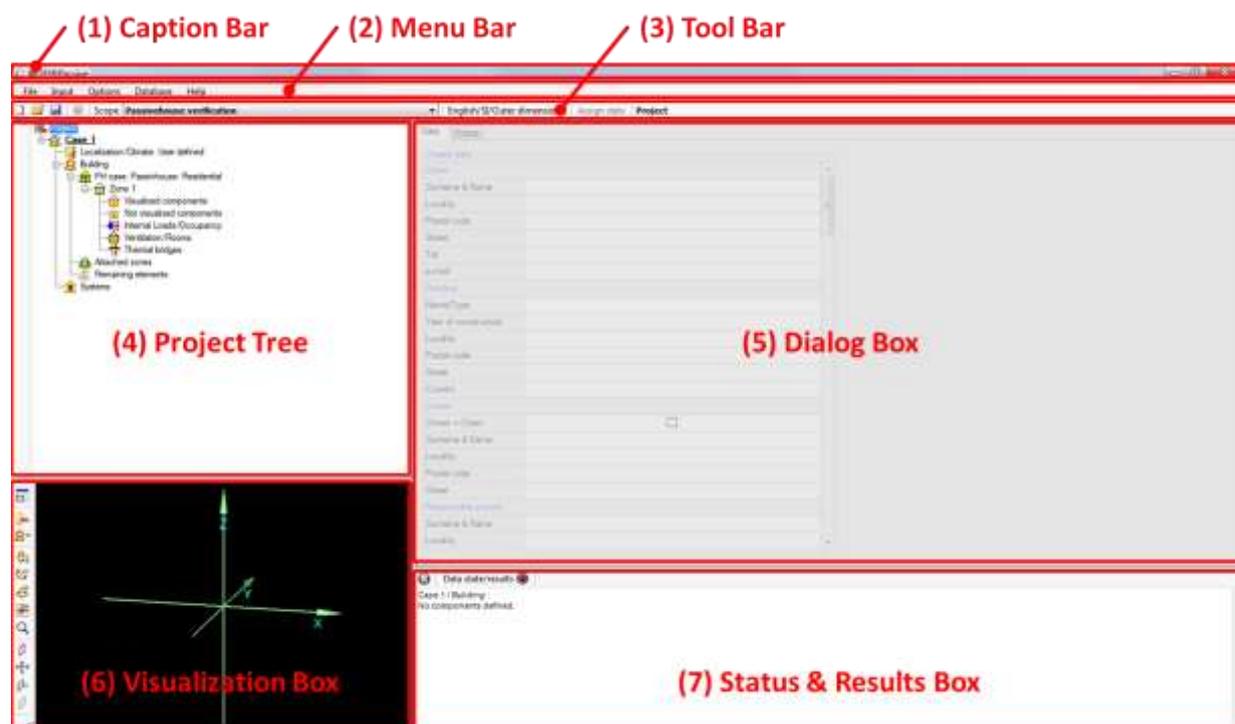


Figure 11:  
Main Window of WUFI® Passive.

#### Elements of the Main Window

##### (1) Caption Bar

The product name (WUFI® Passive) and its version number are shown here together with the name of the current project.

##### (2) Menu Bar

The menu bar contains different main menus. To see individual menu items and submenus, please open the main menus.

##### (3) Tool Bar

Very basic and frequently used commands can be quickly reached using the tool bar. It also allows switching through the different calculation scopes of WUFI® Passive.

<b>(4) Project Tree</b>	As an alternative to the <i>"Input"</i> menu in the tool bar, the project tree offers easy and quick access to different panels. It is advised to follow the project tree structure while working on a project to ensure that no important information is left out.
<b>(5) Dialog Box</b>	Dependent of the selections in the <i>"Project Tree"</i> or <i>"Input"</i> menu, all user inputs or simulation results will be shown in this box. Chapter 4 and its subsections will explain them in detail.
<b>(6) Visualization Box</b>	The geometry of the building is visualized here. The 3D Editor menu is located along the left side of this box. Its functions are described in chapter 3.4.
<b>(7) Status &amp; Results Box</b>	Missing user inputs or errors in the simulation are displayed here. After all necessary data is input, the output of main calculation results are shown.

### 3.2 Menu Bar

Five different drop down menus are available in the Menu Bar: *"File"*, *"Input"*, *"Options"*, *"Database"* and *"Help"*.

### 3.2.1 File

#### Controls

<b>New Project</b>	The memory will be reset and a new empty project will be created.
<b>Open</b>	The standard Windows dialog for opening a project file will be shown.
<b>Reopen</b>	Enables quick access to the last ten projects.
<b>Save</b>	Saves the project input data and the calculated results if a simulation has already been completed. The project should be saved before periodically.
<b>Save as</b>	Saves the current project with a new name, while the original project will remain unchanged and with its original name.
<b>Exit</b>	Closes WUFI® Passive. If any input has been changed, a safety query will ensure that no data is lost.

### 3.2.2 Input

This menu allows for fast navigation. Clicking on one of the items makes the program jump to the corresponding entry in the "Project Tree". For further information refer to chapter 4.

### 3.2.3 Options

#### Options Categories

<b>General</b>	General settings which include Language, Unit system, user-information and the default project directory. This menu also has a very important option, which defines if the visualized geometry displays the outer or inner surfaces of the building.
<b>Colors</b>	Direct link to the color setting menu for the visualized geometry.
<b>View</b>	Direct link to the view properties menu for the visualized geometry.
<b>Edit data</b>	Settings concerning tool tips and result export.
<b>SketchUp Plugin</b>	Options for the WUFI® Plus SketchUp plugin, see chapter 7.1 for further information

### 3.2.4 Database

This menu directs the user to subsections of the WUFI® Passive database.

#### Controls

<b>Materials</b>	List of predefined building materials and their physical properties. These materials can be used, and new materials can be created.
<b>Assemblies</b>	List of predefined combinations of the materials mentioned above. New assemblies can be created, as well.
<b>Windows</b>	List of predefined window data. New entries can be added.
<b>Emission sources</b>	List of possible sources of heat, moisture, or carbon dioxide emissions. New entries can be added.
<b>Day profiles</b>	List of predefined day profiles representing the usage of a zone. New entries can be added.
<b>HVAC device</b>	List of predefined HVAC devices. New entries can be added.
<b>Climates</b>	List of available climate files. New entries can be added.



Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about the database. Its usage is described on our Wiki-pages and a tutorial movie provides detail of how to work with the database.

### 3.2.5 Help

## Controls

<b>About</b>	Information about the current WUFI® Passive installation, including its program and database version.
<b>WUFI Wiki</b>	Link to the WUFI®-Wiki ( <a href="http://www.wufi-wiki.com">www.wufi-wiki.com</a> ) where additional information and tutorials can be found.
<b>WUFI Forum</b>	Link to the WUFI®-Forum ( <a href="http://www.wufi-forum.com">www.wufi-forum.com</a> ), which can be used to discuss and exchange information about the WUFI®-family with other users.



WUFI® Passive offers tool tips for many input parameters. These tool tips explain the current input and give hints to recommended values or further sources of data. The tool tips will appear if the mouse is held for one second over an input field:

Indoor temperature [°C]	20	<p>The mean indoor temperature during the heating period.</p> <p>Recommended values: 20°C for residential and office buildings</p> <p>References: For non residential buildings with intermittent heating, this value can be calculated according to EN 13790</p>
Internal gains setting	Default	
Internal heat gains [W/m²]	2.1	
Occupancy setting method	Verification	
Number of occupants	2.5	
Number of units [:]	1	

WUFI® Passive categorizes the user input:



- All inputs that are inside an “*Additional Data*” box further specify the currently selected element. Usually, they must be entered and WUFI® Passive will show an error message in the “*Status & Results Box*” (chapter 3.5), if the data is missing.
- All inputs inside an “*Optional data*” box don’t have to be entered by the user. WUFI® Passive assumes default values or calculates them from necessary inputs. However, the calculation accuracy will be improved when the optional data is entered by the user.

Additional parameters	
Position of the perimeter insulation	Not defined
Perimeter insulation width/depth [m]	1
Thickness of perimeter insulation [m]	0,05
Conductivity perimeter insulation [W/mK]	0,1
Optional data (if not defined default value will be calculated)	
Phase shift months [months]	
Harmonic fraction [W/K]	

### 3.3 Tool Bar

The Tool Bar provides access to some often used functions:

Controls	
	<b>New</b> The memory will be reset and a new empty project will be created.
	<b>Open</b> The standard Windows dialog for opening a project file will be shown.
	<b>Save</b> Saves the project input data and the calculated results.
	<b>Help</b> Open the WUFI® Help. Currently not active.
	<b>Scope</b> This dropdown-menu allows users to switch through the different scopes of WUFI® Passive: <ul style="list-style-type: none"><li>▪ WUFI® Plus</li><li>▪ Passive House verification</li><li>▪ DIN 4108-2 Thermal protection / Building simulation</li></ul> <p>Please refer to chapter 1 for information about these scopes.</p>
	<b>Current Settings</b> This dialog shows the current settings for the language, unit-system and if the visualization represents inner or outer dimensions. Clicking on this dialog opens the General Options, described in section 2.2.3.
	<b>Assign data</b> This option allows the application of settings or user-input to multiple elements in the project tree.
	<b>Navigation Info</b> The last dialog in the Tool Bar shows which section in the project tree is currently opened.

### 3.4 Visualization Box

The Visualization Box shows a 3D-visualization of the active case. Its important functions include displaying the geometry, establishing windows/ openings and creating and modifying the building-model. The view of the model can be changed with the command buttons along the left side. Also, the model can be moved by clicking and holding the left mouse-button and then moving the mouse.

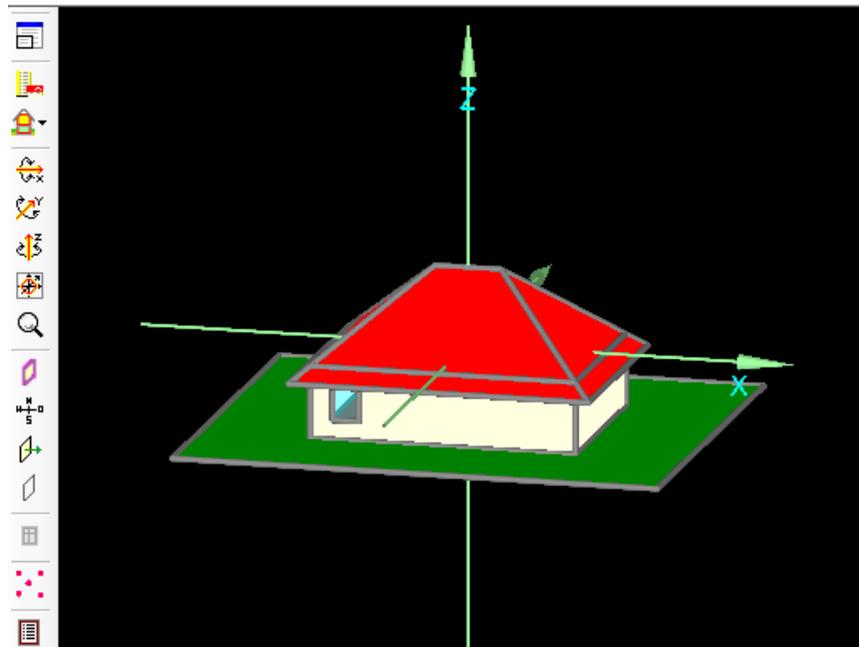


Figure 12:  
Visualization Box.

#### Controls

	<b>Expand/Shrink</b>	Allows expansion of the "Visualization Box". It is advised to use this option, as it facilitates using the "Visualization Box".
	<b>Building Wizard</b>	Clicking this button opens the "Building Wizard". See chapter 4.4.1 and the example case, chapter 11, for more information about this feature.
	<b>Zones</b>	By clicking this button, already existing zones can be re-named and new ones can be created. By holding the mouse on this button, individual zones can be selected with the effect that only the components belonging to the selected zone are shown in the "Visualization Box". For more information on zones see chapter 4.4.3.

	<b>Rotating</b>	<p>These Buttons allow rotating the building around all three axes (X,Y &amp; Z).  Clockwise and counterclockwise rotation is possible by clicking with the left or right mouse-button.  Also the building can be rotated around an axis by clicking on the axis and then using the scroll wheel of the mouse.</p>
	<b>Center</b>	<p>Centers the view of the "<i>Visualization Box</i>" to its original position.</p>
	<b>Zoom</b>	<p>This Button allows zooming in (left mouse button) and zooming out (right mouse button). The zoom function can also be used by clicking the button and scrolling with the mouse wheel.</p>
	<b>Transparency</b>	<p>With this button viewing of components can be changed from transparent to opaque.  Transparent mode allows users to look "through" components to see some otherwise hidden components.</p>
	<b>Orientation</b>	<p>The orientation of the building can be displayed by left clicking this button.  Right clicking opens the "<i>Change orientation</i>" window, where the orientation of the building can be altered.</p>
	<b>Normal vector</b>	<p>The normal vector of every component can be viewed as well. It is visualized as a green arrow on the selected component and points from the inner side of a component to its outer side. This is important for setting the attachments of every component, see chapter 3.4.2.</p>
	<b>Conditionally not visible/ selectable</b>	<p>This button allows the user to make a component conditionally not "<i>visible/ selectable</i>", for example to making hidden components accessible.  The difference of this button to the "<i>transparent/opaque</i>" button is, that after clicking on this button, the component is neither visible nor selectable, whereas it is still selectable if only the view is switched from opaque to transparent.  In order to use this button for a component, it is important to checkmark the Option "<i>conditionally not visible/ selectable</i>" in its properties, which can be accessed by right-clicking on the component in the "<i>Visualization Box</i>".</p>
	<b>Windows &amp; Openings</b>	<p>Creates new windows and openings. See chapter 3.4.1 for further information.</p>
	<b>Vertices</b>	<p>Shows or hides the vertices. Chapter 3.4.2 shows how vertices can be used to create or modify a building.</p>
	<b>Options</b>	<p>Settings for the "<i>Visualization Box</i>", as described in chapter 3.2.3.</p>

### 3.4.1 Inserting Windows and Openings

It is advisable to expand the "Visualization Box" before creating new windows and openings.

Before inserting windows or openings into a component, please select the component by left-clicking it in the visualization box. Then press the "Windows & Openings"-Button or right-click on the component and select "Windows/Openings" and the "Component Openings" dialog appears:

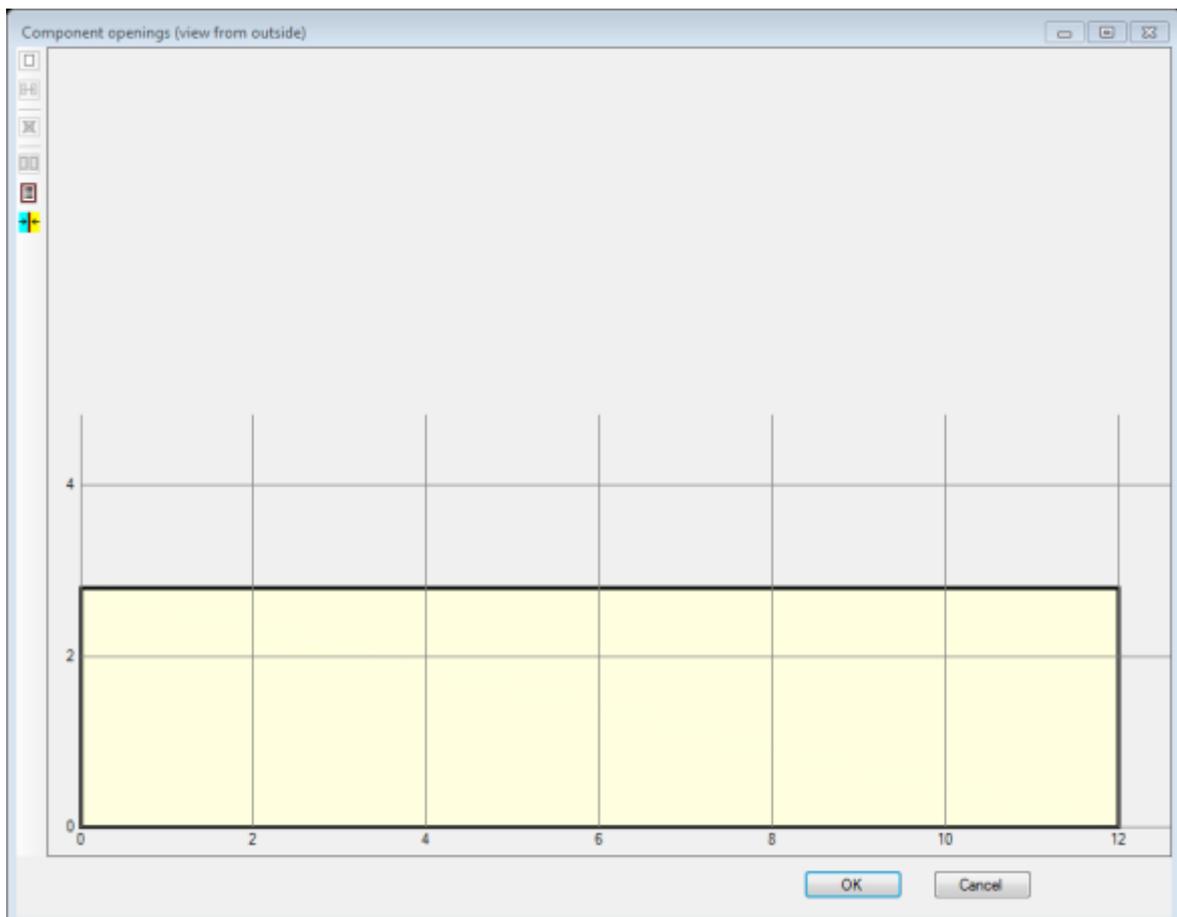


Figure 13:  
Component openings window.

#### Controls



##### **New**

New windows or openings can be created with this button. The "Opening" dialog will appear.  
*Hint: New windows or openings can also be created by right-clicking on the component.*



##### **New/copy move**

Allows copying or moving the selected window or opening.

	<b>Delete</b>	Delete the currently selected window or opening. <i>Hint: Selected windows or openings can also be deleted by pressing the "Delete"-key on the keyboard.</i>
	<b>Select All</b>	Select all windows and openings in this component.
	<b>Edit list</b>	Shows a list of all windows and openings and allows editing or adding new windows and openings.
	<b>Change view</b>	Change the view of the component. The currently active view is displayed in the caption bar of this menu.

New windows or openings can be created by clicking the "New"-Button or by right-clicking on the component. The "Opening" dialog appears and the window type (1), its position along the grid (2) and its measurements (3) can be entered, shown in the figure below:

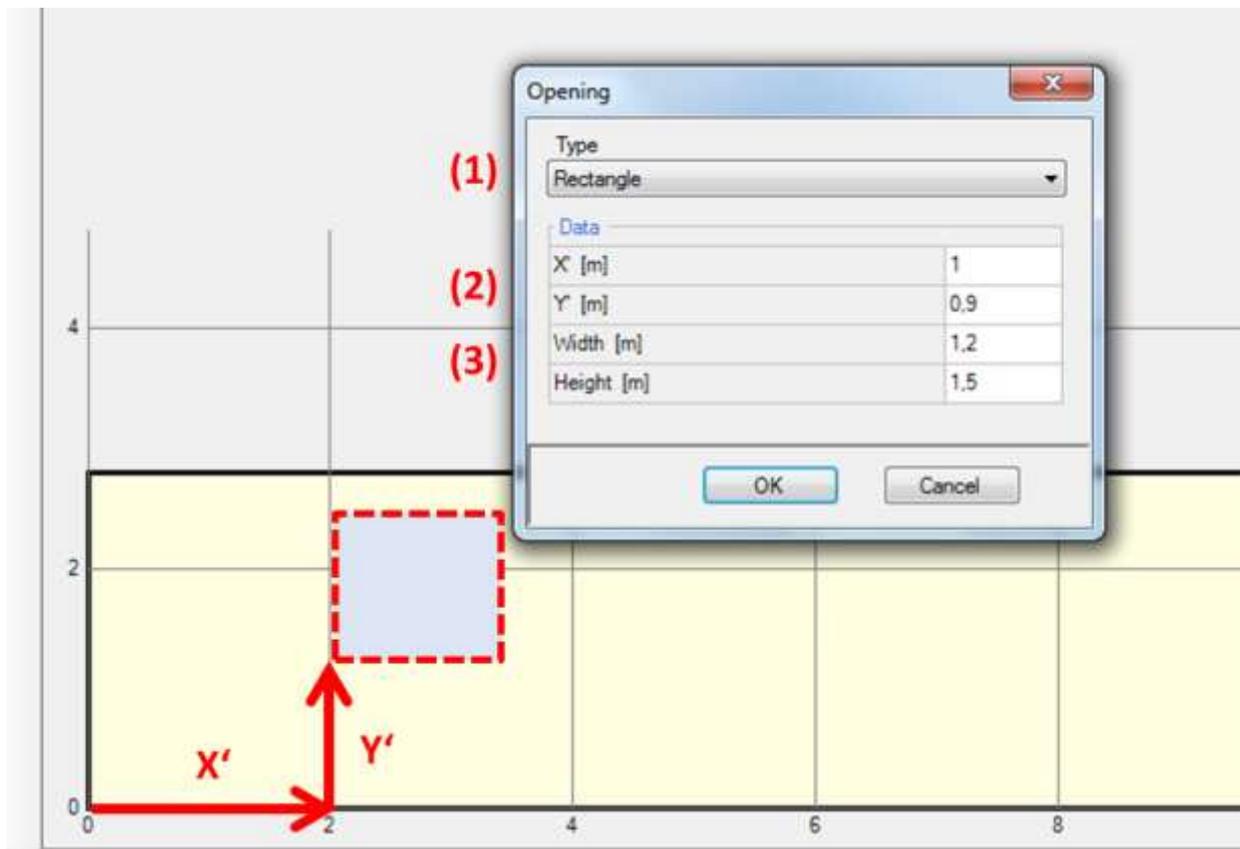


Figure 14:  
Creating a new window or opening.

With the "Opening" dialog these types of window geometries can be entered:

- Rectangle

- Triangle
- Circle
- Rectangle with arch above

Existing windows or openings can be moved or copied by selecting the window or opening and then clicking "New/ copy move" button. This also allows copying multiple windows or openings by changing the "Count" dialog.

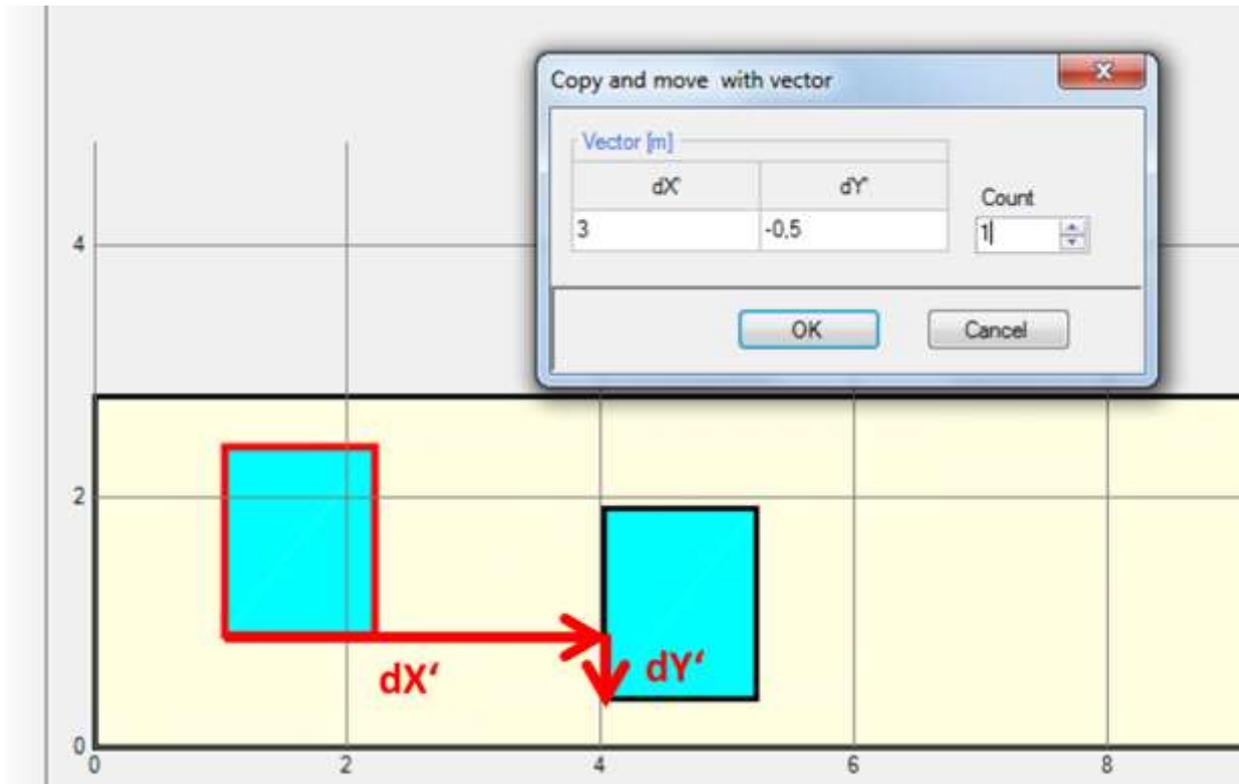


Figure 15:  
Copy a window or opening.

Windows or openings can also be created or edited with the "Edit list" button. All windows and openings in the current component are displayed in a tabular form and can be edited there. Also new windows or openings can be created, or existing ones can be deleted or copied and inserted.

## Controls



**New**

Create a new element in this list.



**Delete**

Delete the selected element.



### Copy

Copy the selected element.



### Insert

Insert a copied element. The *“Insert Position”* specifies where the copied element will be positioned.

### Insert Position

Controls where a copied element will be inserted:

- *“after”* the selected element
- *“before”* the selected element
- *“exchange”* the selected element with the copied one



Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about this feature. A tutorial movie shows in detail how to insert windows in components.

### 3.4.2 Creating and Modifying the Building Geometry

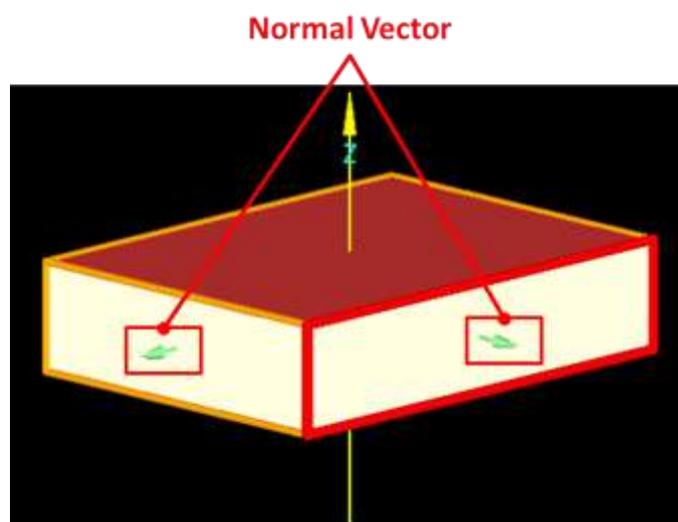
The geometry of the building can be expanded and changed in the “*Visualization Box*”, by using vertices and connecting them to components. This 3D editing allows the input of complex building shapes within WUFI® Passive and can also be used to create the whole building geometry.

It is advisable to first expand the “*Visualization Box*” and also the vertices must be switched to visible with the “*Vertices*” button.

New vertices can be defined by right clicking into the “*Visualization Box*”, choosing “*New Vertices*” and then entering the coordinates. By clicking on existing vertices, the “*Vertex Operations*” become available, which allows for example copying and moving or making components from vertices. By selecting two vertices, the “*Two Point Operations*” become available, which will find intersection points or show the distance between the two vertices, for example.

Also components can be edited in the “*Visualization Box*”. The options are for example showing the component properties, grouping or ungrouping them. Another important feature is changing their inner and outer orientation, which is visualized with a little green arrow that points from the inside to the outside of a component.

Always check the orientation and the normal vector of your components in the “*Visualization Box*”, as this definition is used throughout WUFI® Passive for the inner and outer sides of assemblies. This aspect is extremely important for windows, as the normal vector defines their orientation. For example, a wrong normal vector could change a southern oriented window to a northern oriented window, resulting in completely different solar gains. The normal vector always starts at the inner side and points to the outer side of an assembly or window.





Please refer to our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) for detailed information about 3D editing in WUFI® Passive. It also shows how to edit a building using vertices in a tutorial video.

### 3.5 Status & Results Box

The “*Status & Results Box*” helps the user during the process of completing a model. It shows the current status of a calculation and gives a brief summary of its main results.

#### Controls

	<b>Close/ Reestablish</b>	Hides or shows the “ <i>Status &amp; Results</i> ”-Box.
	<b>Status indicator</b>	The status indicator shows if all necessary input are entered. As soon as WUFI® Passive has all of the inputs needed to perform its calculations, it turns from red to yellow or green and the main results are shown in the “ <i>Status &amp; Results</i> ”-Box. As long as warnings are shown, the yellow symbol appears. After the Passive House Verification is successful, the green symbol appears.
	<b>Warnings/ Results</b>	After all necessary data is entered, the main calculation results will be shown in the “ <i>Status &amp; Results</i> ”-Box. WUFI® Passive also gives warnings if certain inputs are missing or seem to be unrealistic. This button switches between the calculation results and the warnings.

As long as there is still input data missing, the “*Status and Results Box*” will show error messages, see figure below. Double clicking on an error message makes WUFI® Passive jump to the source of the error. The error messages are constructed according to the structure of the “*Project Tree*”, so navigating to the source is just a matter of tracing the error message in the “*Project Tree*”.



Figure 16:  
Error Messages in the “*Status & Results Box*”.

After all essential data has been entered, the calculation results are displayed in the “*Status and Results Box*”, see figure below.

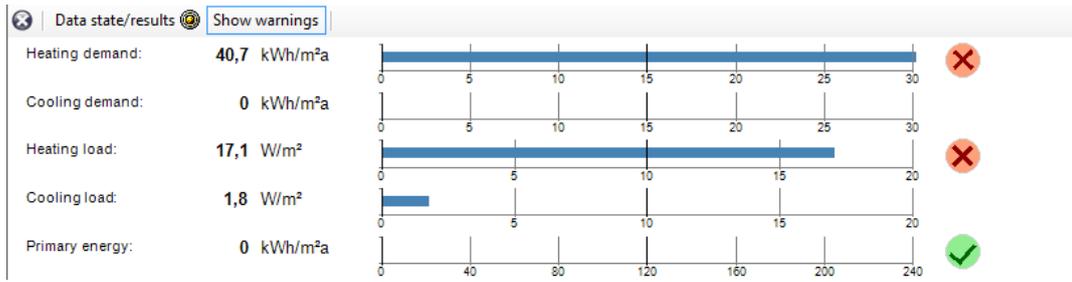


Figure 17:  
Summary of main calculation results in the "Status & Results Box".

## 4 Project Tree

The “*Project Tree*” offers easy and quick access to all dialogs, which are necessary for defining a WUFI® Passive project. It is advisable to follow its structure while working on a project, to ensure that no important information is left out.

Clicking on a symbol in the “*Project Tree*” opens the corresponding menus in the “*Dialog Box*”.

### Elements of the Project Tree

	<b>Project</b>	General information about the current project. See chapter 4.1.
	<b>Case</b>	General settings for a case. See chapter 4.2.
	<b>Localization / Climate</b>	Settings for outdoor climate and primary energy/ CO <sub>2</sub> -factors. See chapter 4.3.
	<b>Building</b>	Provides access to building geometry creation or import. See chapter 4.4.
	<b>PH case</b>	General settings for the calculation. See chapter 4.4.2.
	<b>Zone</b>	General settings and information about a zone. See chapter 4.4.3.
	<b>Visualized components</b>	Lists all visualized components in a zone. See chapter 4.4.4.
	<b>Visualized Component</b>	Definition of a visualized component. See chapter 4.4.4. Components are automatically categorized, depending on their orientation and boundary conditions: <ul style="list-style-type: none"><li>▪ Roof</li><li>▪ Wall against unheated attic</li><li>▪ Ceiling against unheated attic</li><li>▪ Flat roof</li><li>▪ Exterior Wall</li><li>▪ Opening</li><li>▪ Window</li><li>▪ Interior wall between two heated zones</li><li>▪ Interior wall against an unheated zone</li><li>▪ Interior wall within a heated zone</li><li>▪ Ceiling between two heated zones</li><li>▪ Ceiling against an unheated zone</li><li>▪ Floor against an unheated zone</li><li>▪ Floor against air</li><li>▪ Floor against unheated cellar</li><li>▪ Wall against ground</li><li>▪ Floor against ground</li></ul>

	<b>Not visualized components</b>	Lists all non-visualized components in a zone. See chapter 4.4.5.
   	<b>Not visualized component</b>	Definition of a non-visualized component. See chapter 4.4.5.
	<b>Internal Loads / Occupancy</b>	Definition of internal loads. See chapter 4.4.7.
	<b>Ventilation/ Rooms</b>	Ventilation settings. See chapter 4.4.8.
	<b>Thermal bridges</b>	List of all thermal bridges in the building. See chapter 4.4.9.
	<b>Attached zones</b>	List of all attached zones. See chapter 4.4.6.
     	<b>Attached Zone</b>	General settings and information about an attached zone. See chapter 4.4.6. Available types: <ul style="list-style-type: none"> <li>▪ Unheated Space</li> <li>▪ Unheated Cellar</li> <li>▪ Space under suspended floor (crawl space)</li> <li>▪ Wintergarden, not heated</li> <li>▪ Unheated Attic</li> <li>▪ Conditioned Space</li> </ul>
	<b>Remaining elements</b>	List of all elements which are not connected to a zone. See chapter 4.4.10.
	<b>Remaining component</b>	Properties of a remaining component. See chapter 4.4.10.
	<b>HVAC – Systems</b>	List of all HVAC systems. See chapter 4.5.
	<b>System</b>	Settings for a specific HVAC system. See chapter 4.5.
           	<b>Device</b>	Settings for a specific HVAC device. See chapter 6. Available devices: <ul style="list-style-type: none"> <li>▪ User defined. Allows a combination of space heating and cooling as well as air humidification and dehumidification</li> <li>▪ Mechanical ventilation</li> <li>▪ Electric Heating / DHW</li> <li>▪ Boiler</li> <li>▪ Combined Heat and Power (CHP)</li> <li>▪ District Heating</li> <li>▪ Heat Pump</li> <li>▪ Solar Collector</li> <li>▪ Water storage</li> <li>▪ Photovoltaics</li> </ul>



### **New/ Copy Current Case**

This button appears on the left side of the *“Project Tree”* when a *“Case”* is selected. By clicking this button the current case is copied and inserted as the last case in the *“Project Tree”*.



### **Delete Current Case**

This button appears on the left side of the *“Project Tree”* when a *“Case”* is selected and there are at least two *“Cases”* in a project. By clicking this button the current case will be deleted.



The example in chapter 11 shows how to create a project and how its results can be evaluated and exported. It's highly recommended to work through this example case when using WUFI® Passive for the first time.

## 4.1 Project Information

Information about the current project can be entered with this dialog, including the client, the building, its owner and your personal information. Also a picture of the building can be added, either from the current view in the “*Visualization Box*” or from an external image.

The data entered in this dialog will appear on the results report, which can be created and exported after a simulation. Please refer to section 5 for further information about the results reports.



If you add your personal information in the “*General Options*”, see chapter 3.2.3, it will be filled in the “*Project Information*” automatically.

## 4.2 Case Menu



This menu allows switching the certification criteria (“Default” or “PHIUS+ 2015”). Please refer to chapter 4.2.1 for further information.

The “Case Menu” dialog allows the user to name the current case and provides a place to add annotations. Furthermore it provides access to the “Report: Data & results” tab which sums up all calculation results.

This is where the certificate criteria can be switched between “Default Standard” and “PHIUS+ 2015 Standard”. All explanations in this manual refer to “Default Standard”. Chapter 4.2.1 explains the differences between those two verification modes.

A WUFI® Passive Project can contain several cases. This can be used to create multiple models and variations for a project.

### 4.2.1 Differences between “Default” and “PHIUS+ 2015” Certification Modes

Depending on the selected certification criteria, different user inputs are necessary in some cases:

Certification criteria

- For “PHIUS+ 2015 Standard” criteria demands AND loads have to be below the target. For “Default Standard” criteria, the demand OR the load should meet the requirement.

Localization/ Climate

- “PHIUS+ 2015 Standard”: Requires additional information about climate data, which can be entered in the “Localization”-tab.
- “PHIUS+ 2015 Standard”: The target values for certification criteria vary depending on the location of the building.

Primary energy

- “PHIUS+ 2015 Standard”: Primary energy is calculated per person for residential buildings. The target is 6200 kWh/person yr.
- “Default Standard”: Primary energy is calculated per square area.

- *"PHIUS+ 2015 Standard"*: Primary energy factor for electricity mix in the United States is 3.16 (*"Default Standard"*: 2.70).
- *"PHIUS+ 2015 Standard"*: Photovoltaic savings are considered in the Primary Energy calculation.

#### PH case, zone information

- *"PHIUS+ 2015 Standard"*: The resulting net volume for the PH case has to be calculated from the real building geometry and must be entered directly.
- *"Default Standard"*: In contrary to the *"PHIUS+ 2015 Standard"*, the net volume is calculated with the treated floor area multiplied by the clearance height.

#### Recommend user input for *"PHIUS+ 2015 Standard"*

- The input for infiltration should be changed to the envelope airtightness coefficient, instead of the ACH50.
- PHIUS+ 2015 Standard internal loads should be added as devices for residential buildings. 80% of the RESNET load is calculated.

#### Differences in calculation for *"PHIUS+ 2015 Standard"*:

- Mostly the calculation of the cooling demand, the peak cooling load and cooling devices is changed. It includes per default the dehumidification energy demand, which requires the monthly dew point temperature from the climate data.
- The summer internal heat gains are calculated apart from the winter internal gains (slightly increased, e.g. the DHW count in).
- The peak cooling load can be calculated comparing two different weather conditions. The resulting higher peak cooling load is used.
- Different cooling devices (cooling with supply air, recirculation air, or dehumidification) can be regarded with different COP's.
- Renewable on site produced energy, like from photovoltaics are regarded by decreasing the primary energy demand.



Blue Difference Boxes like this one are shown throughout the manual where user input differs because of the two certification criteria.

### 4.3 Localization & Climate

Buildings are exposed to outer climatic boundary conditions. For Passive House calculations, the climate data must be provided in a special format:

- Monthly mean values of ambient temperature are always necessary. In addition, monthly mean values of dew point temperature are highly recommended, and necessary for the "*PHIUS+ 2015 Standard*" to calculate the latent cooling demand. Sky and ground temperatures are optional and if there is no input, they are calculated by the foundation interface and the ambient temperature. For further information about the foundation interface refer to chapter 4.4.2.
- Monthly mean values of solar radiation are always necessary: Global, North, East, South and West.
- Also extreme (peak) weather conditions for the above described temperature and solar radiation parameters are necessary: Two for the calculation of heating load and two for cooling load (the second weather conditions for cooling load are optional).

Climate data can either be selected from standard-values or user-defined data can be entered. A user-defined climate can be imported from an external file (Text- or Excel-files) or it can be entered manually into WUFI® Passive. Also, climate files can be selected in the WUFI® Database. The WUFI® Database allows storing a connected climatic dataset for a specific location consisting of the monthly data for the Passive House calculation and detailed hourly climate data for the dynamic simulations with WUFI® Plus. This simplifies switching through the calculation scopes.



Please refer to our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn how external climate files can be included into WUFI® Passive calculations. A tutorial video shows how this is done.

### 4.3.1 Climate Data



There are different inputs depending on the certification criteria (“Default” or “PHIUS+ 2015”) including the PHIUS+ 2015 performance targets. Please refer to chapter 4.2.1 for further information.

Necessary climate data can be entered in the “Localization” - and the “Climate” tab. See figures below:

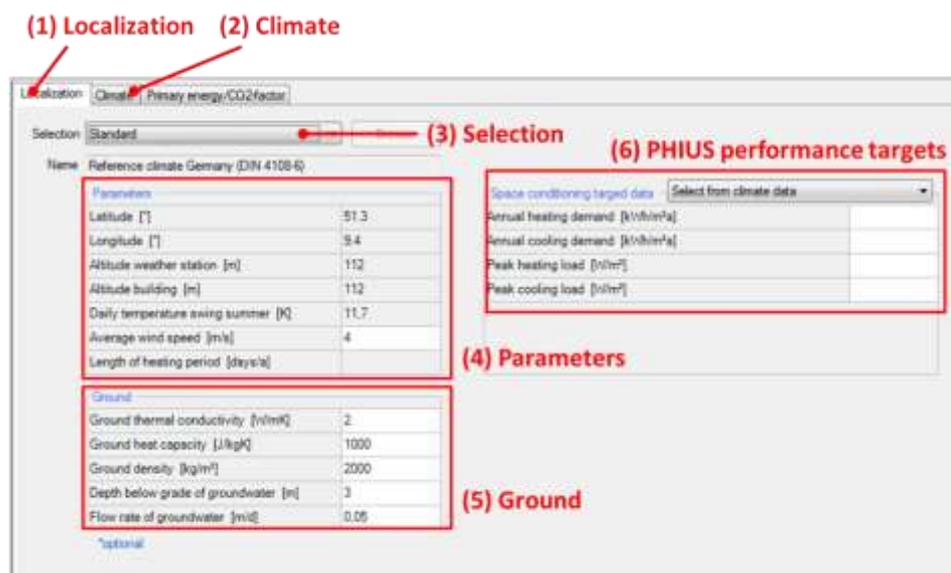


Figure 18:  
Localization dialog.

## Controls

- (1) Localization** The “Localization” tab allows the user to set the outer climate.
- (2) Climate** The “Climate” tab shows a table and diagrams of the climate data. If a user-defined climate is selected (3), the table can be edited.
- (3) Selection** For Passive House calculations, a standard-climate can be set, that represents the reference climate from the German standard DIN 4108-6. Climate data can also be loaded from the WUFI® Climate Database or user-defined climate data can be selected. User-defined climate data can be imported from an external file (Text- or Excel-files) or it can be entered in the “Climate” tab (2).

#### (4) Parameters

General parameters concerning location of the building.

#### (5) Ground

General parameters concerning ground.

#### (6) PHIUS performance targets

Shows the PHIUS+ climate specific performance targets for the selected location. This data can either be read from the climate data or it can be entered by the user.

Only appears for the "PHIUS+ 2015" certification mode, as described in chapter 4.2.1.

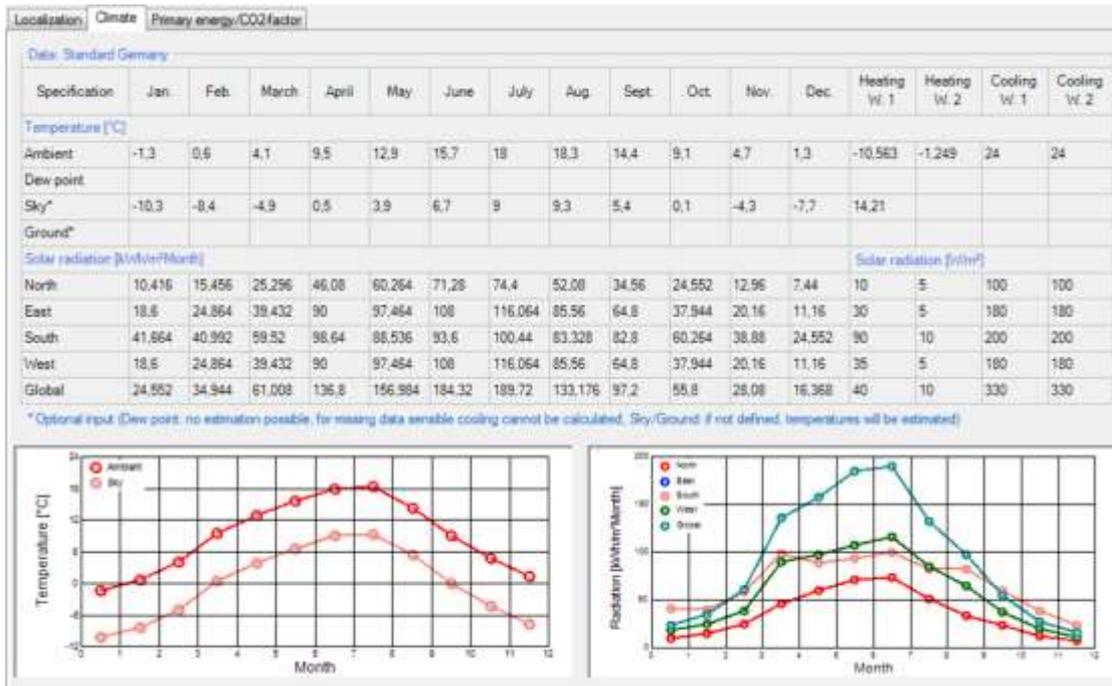


Figure 19:  
Climate Dialog.

### 4.3.2 Primary Energy/ CO<sub>2</sub>-Factors

Depending on the energy source used, the energy demand is multiplied by a "Primary Energy Factor". This "Primary Energy Factor" takes the generation process and the transportation of an energy source into account. The "CO<sub>2</sub>-Factor" allows the conversion of the energy use into an equivalent amount of CO<sub>2</sub>.

WUFI® Passive comes with predefined standard-values for both factors for Germany, USA and Italy. User-defined values can also be entered.



There are different values for the primary energy factor of electricity mix in the United States depending on the certification criteria ("Default" or "PHIUS+ 2015"). Please refer to chapter 4.2.1 for further information.

## 4.4 Building Menu

All user inputs which describe a building are grouped in this section. It provides access to available elements of the building, gives methods for geometry creation or import, and allows changing the orientation:

- Available elements: Lists available elements of the current building. Double-clicking on an element opens the corresponding dialog.
- Building Wizard: Opens the "*Building Wizard*" which helps to create simple geometries by combining predefined footprints, roof and foundation constructions. Refer to chapter 4.4.1 for further information.
- Change orientation: Changes the orientation of the building.
- 3-D Editor: Creates or modifies a building geometry directly in WUFI® Plus. Clicking this button expands the "*Visualization Box*" to facilitate working with the 3-D Editor. Refer to chapter 3.4.2 for further information.
- SketchUp-Import: Imports geometry data from a wps-file created with the WUFI® Plus SketchUp-plugin. Refer to chapter 7.1 for further information.
- gbXML-Import: Imports geometry data from a gbXML-file. Refer to chapter 7.2 for further information.

#### 4.4.1 Creating a Building

WUFI® Passive offers multiple ways to create or import 3D-geometries, which can all be accessed by clicking the *"Building"*-entry in the *"Project Tree"*:

- Building Wizard, as described in this chapter.
- Modifying vertices, as described in chapter 3.4.2.
- Importing a SketchUp-Geometry, see chapter 7.1.
- Importing gbXML-data, see chapter 7.2.

The *"Building Wizard"* is the easiest way to create a building in WUFI® Passive. It uses a collection of predefined footprints (1) as well as roof (2) and foundation (3) constructions to create building geometry, see figure below. The dimensions of these presets can be changed by the user.

On the bottom side of the dialog, the orientation of the main facade needs to be defined either by means of the main orientations or by Azimuth (4). The main facade depends on the footprint of the building and is shown in the selection graph of the footprint selection.

On the right side there are two other options which allow grouping of similar components and dividing components by stories (5). Components can be ungrouped in the *"Visualization Box"* by right-clicking on them.

Geometries created with the *"Building Wizard"* can be modified with the 3D editing methods described in chapter 3.4.2.

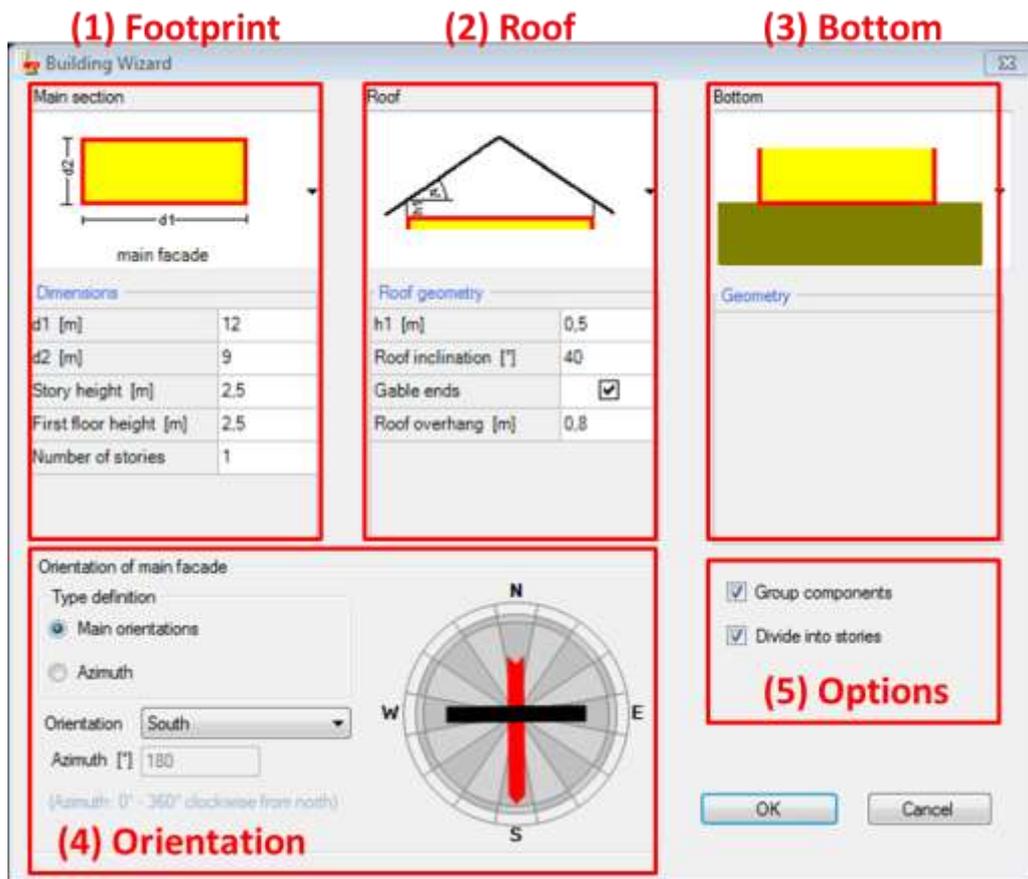


Figure 20:  
Building Wizard.



Here, only the "Building Wizard" is explained, as the other three ways for creating a building geometry are described in separate sections of this manual.

Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) for tutorial videos of all three ways of creating geometries for buildings.

## 4.4.2 PH Case

WUFI® Passive uses PH Cases to differ between different usage types inside a single building model. For example, if a building consist of an office in the first floor and flats in the second floor.

The “PH Case”-dialog provides access to general settings of the building type, its usage, additional parameters, and the foundation interface. Also, “*Simulated Zones*” can be added or deleted. Chapter 4.4.3 describes zones. A PH Case can consist of multiple zones, which can be used to further specify the PH Case, for example to model single rooms. So, after switching to the WUFI® Plus scope, dynamic hygrothermal simulations can be performed and assessed for every room.

The figures in this chapter show the parts of the “PH Case”-dialog.

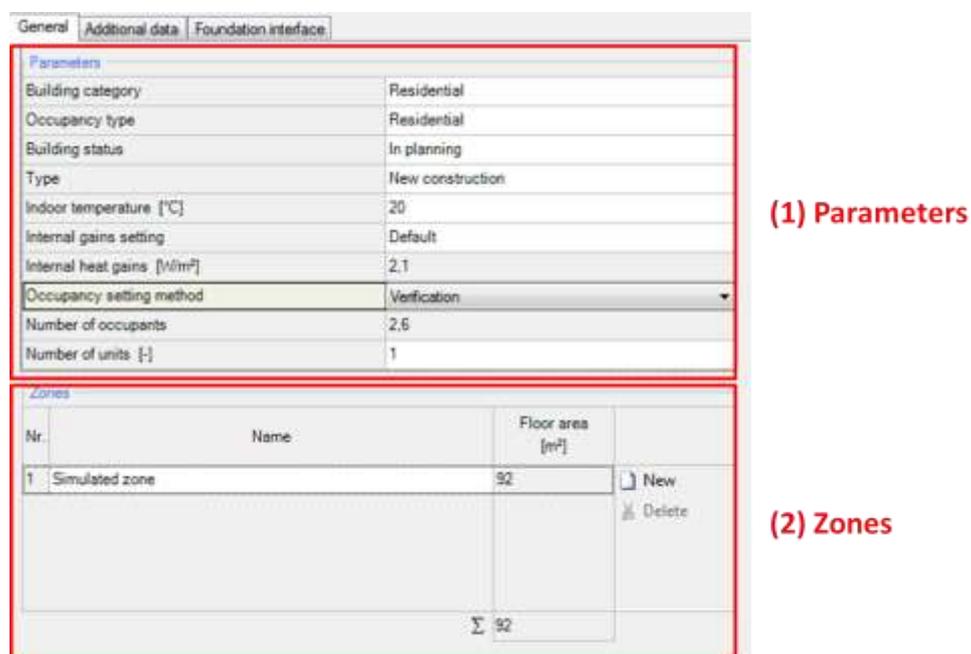


Figure 21:  
PH Case: General Settings.

## Controls

### (1) Parameters

These parameters describe the building’s usage and occupancy type.

### (2) Zones

List of all zones of a case.



### New

Creates a new zone



### Delete

Deletes the selected zone

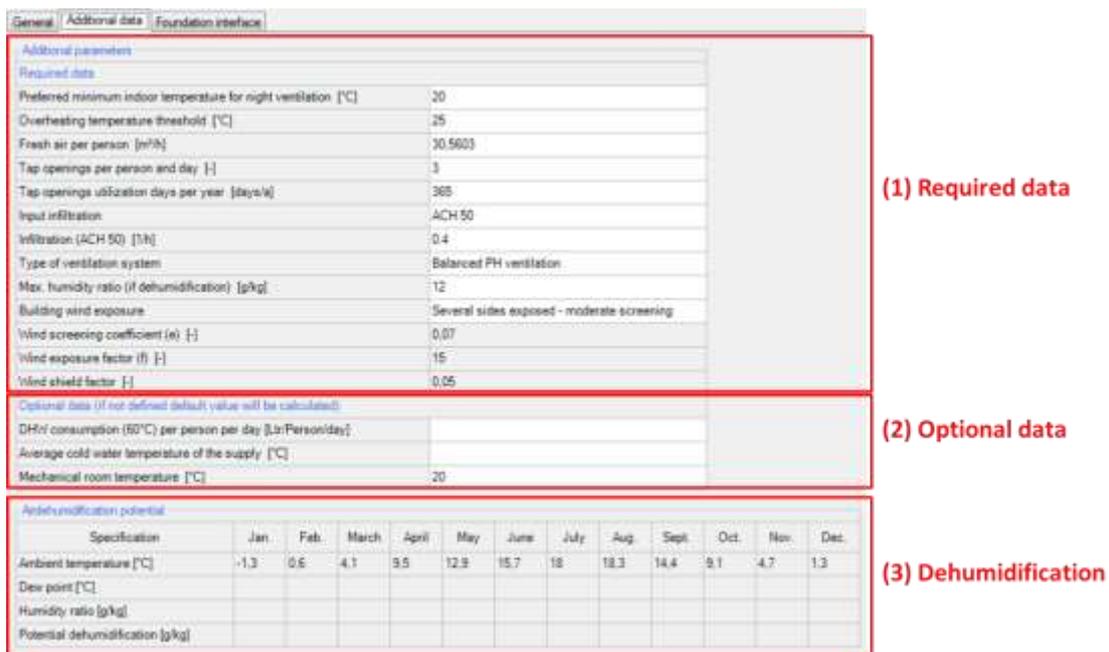


Figure 22:  
PH Case: Additional Data.

## Controls

- |                             |   |
|-----------------------------|---|
| <b>(1) Required Data</b>    | Necessary data that must be entered for a calculation.  |
| <b>(2) Optional Data</b>    | Optional data, no input must be made here. If not defined, default values will be calculated.   |
| <b>(3) Dehumidification</b> | This table describes the monthly dehumidification potential, which is calculated from the outdoor temperature, the dew point, and the inner moisture loads. This table is only informative. |

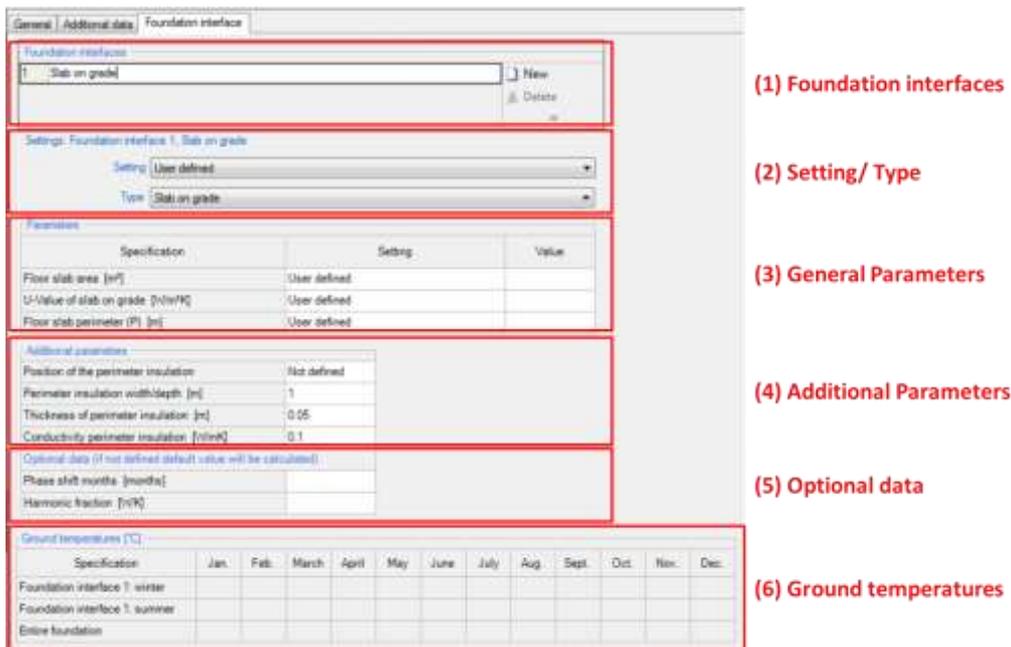


Figure 23:  
PH Case: Foundation Interface.

## Controls

### (1) Foundation Interfaces

This list allows entering different foundation interfaces (maximum: Three), which can be specified with the settings made in (2) to (5).



#### New

Create a new element in this list.



#### Delete

Delete the selected element.



#### Copy

Copy the selected element.



#### Insert

Insert a copied element. The *“Insert Position”* specifies where the copied element will be positioned.

#### Insert Position

Controls where a copied element will be inserted:

- *“after”* the selected element
- *“before”* the selected element
- *“exchange”* the selected element with the copied one

### (2) Setting/ Type

The foundation-type can either be detected automatically or entered by the user. WUFI® Passive supports these types:

- Heated basement or underground floor slab
- Unheated basement
- Slab on grade
- Suspended floor
- No foundation

	Depending on the selected foundation-type, further inputs are required in (3) to (5).
<b>(3) General Parameters</b>	These parameters describe the geometry of the foundation and physical properties.
<b>(4) Additional Parameters</b>	Additional parameters, that were not defined in (2) or (3).
<b>(5) Optional Data</b>	Optional parameters that describe the ground.
<b>(6) Ground temperatures</b>	<p>Ground temperatures are shown in this table. These temperatures are calculated depending on the user input in this tab and the outdoor climate. The "<i>entire foundation</i>" ground temperature is calculated from the "<i>winter</i>" and "<i>summer</i>" temperatures.</p> <p>If the selected exterior climate provides information about ground temperature, these values will always be used for further calculations and the values shown in this table won't be considered further.</p> <p>This table is only informative. No direct user input is possible.</p>

### 4.4.3 Simulated Zones



There are different inputs for the net volume depending on the certification criteria ("Default" or "PHIUS+ 2015"). Please refer to chapter 4.2.1 for further information.

In WUFI® Passive a building is created and then calculated using PH Cases and zones. In general there are two kinds of zones:

- Heated Zones are simulated zones. They will be calculated during the verification process.
- "Attached Zones" are not part of the calculation, for example an unheated attic. However, they influence the conditions in the simulation area and must be precisely defined. See chapter 4.4.6 for further information.

These zones and climates must be assigned to the components of the building. See chapter 5 for more information about components.

Clicking on a simulated zone in the "Project Tree" opens the "Simulated Zones" dialog, which provides access to the general settings for this zone, see figure below.

Project information		
Name	Simulated zone	
Type	Simulated zone	
PH case	Passive house: Residential	

**(1) Information**

Geometry / Specific heat capacity		
Specification	Setting way	Value
Visualized volume [m <sup>3</sup> ]	From visualized geometry	270
Gross volume [m <sup>3</sup> ]	From visualized volume and components	270
Interior conditioned floor area [m <sup>2</sup> ]	User defined	92
Clearance height [m]	Standard value	2.5
Specific heat capacity [Wh/m <sup>3</sup> K]	Massive	204

**(2) Geometry**

Additional data	
Humidity capacity [g/(g/kg)/m <sup>3</sup> ]	700

**(3) Additional Data**

Figure 24:  
Simulated Zone Settings.

## Controls

### (1) Information

Information about the zone: Name, type, PH-Case.

**(2) Geometry**

Information about the zone's geometry and its specific heat capacity, which depends on the construction type of the building.

**(3) Additional Data**

Humidity capacity is defined here, which specifies the amount of water stored in the building components.



Always double-check that the geometry-data was entered correctly, as these values can have a huge impact on calculation results.

#### 4.4.4 Visualized Components

All components of the building that require a definition of structure, materials or environment are listed under "*Visualized Components*" and can be edited here. Clicking on the respective component in the entry window table or in the "*Project Tree*" opens the "*Component*" dialog, where its properties are defined. WUFI® Passive distinguishes three component types:

- Opaque components, like for example walls, ceilings or roof construction.
- Transparent components, like windows.
- Openings, which are not relevant here, as they need no further user input.

Depending on the selected component type, there are various subsections to input all necessary data. These are described in detail in chapter 5. Also the example at the end of this manual shows how components can be entered into WUFI® Passive.



Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) for detailed information about components and tutorial videos about creating them.

#### 4.4.5 Not Visualized Components

These components can't be seen in the *"Visualization Box"*. In the Passive House calculation scope they are only part of the calculation, as long as an outer climate is assigned either on their inner or outer side. Theoretically, all components of the building envelope can be entered as not visualized components and no visualization is necessary for the Passive House calculation.

In the WUFI® Plus scope, the indoor components have an impact on dynamic hygrothermal simulations. So in *"Not Visualized Components"* components affecting the indoor environment can be included in the simulation, like for example partitions or furniture.

*"Not Visualized Components"* can be entered in the list of this dialog. The definition of these components, their properties, and their parameters are the same as that of *"Visualized Components"*.

### Controls

	<b>New</b>	Create a new element in this list.
	<b>Delete</b>	Delete the selected element.
	<b>Copy</b>	Copy the selected element.
	<b>Insert</b>	Insert a copied element. The <i>"Insert Position"</i> specifies where the copied element will be positioned.
	<b>Insert Position</b>	Controls where a copied element will be inserted: <ul style="list-style-type: none"><li>▪ <i>"after"</i> the selected element</li><li>▪ <i>"before"</i> the selected element</li><li>▪ <i>"exchange"</i> the selected element with the copied one</li></ul>



Don't forget to make input concerning the area of *"Not Visualized Components"*.

#### 4.4.6 Attached Zones

*Attached Zones* are areas that do not belong to the simulation volume, such as an unheated attic. These zones are not considered directly in the calculations. However, they influence the conditions in the simulated zone and must be precisely defined. The adjacent zones can be named and the type of zone can be selected in the drop-down menu. Dependent on the type, additional input can be required:

- For unheated cellars additional geometry information is necessary
- Other types require a temperature difference reduction factor that adjusts the heat loss as it would occur, relative to outer climate conditions.

*Attached zones* can include visualized and not visualized components..

#### 4.4.7 Internal Loads & Occupancy

If additional loads or electronic devices occur in a "Simulated Zone" they have to be defined in the dialog "Internal Loads/ Occupancy". This dialog differs depending on the building category (*residential* or *non-residential*) defined in the "PH Case"-dialog described in chapter 4.4.2.



Always check the reference of your internal loads in the "Device List" (2) to ensure that they are calculated as desired.

Residential buildings:

The internal load and occupancy settings for residential buildings are shown in the figure below. The example case at the end of this manual explains how "Internal Loads" of residential buildings can be entered in WUFI® Passive.

**(1) General**

Occupant quantity [-]	4
Humidity sources [g/m³h]	2

**(2) Device List**

Device/End use	Reference quantity	Quantity	In conditioned space	Additional info	
Kitchen dishwasher	PH case occupants		<input checked="" type="checkbox"/>	DH/W connection	New
Kitchen fridge/freeze combo	PH case Units	1	<input checked="" type="checkbox"/>		Delete
Kitchen cooktop	PH case occupants		<input checked="" type="checkbox"/>	Cooking with electricity	Copy
Laundry - washer	PH case occupants		<input checked="" type="checkbox"/>	DH/W connection; Utilization factor 1	Insert
Laundry - dryer	PH case occupants		<input checked="" type="checkbox"/>	Condensation dryer; Remaining dampness	New/Insert

**(3) Additional Data**

Additional data: Kitchen dishwasher	
Choice	DH/W connection
Energy demand (norm) [kWh/Use]	1,1
Comment	

Figure 25:  
Internal Loads/ Occupancy dialog for residential buildings

## Controls

### (1) General

General settings concerning the occupancy quantity and internal humidity sources due to respiration or evaporation.

Please refer to the information in the attention box below!

## (2) Device List

Lists all devices in this zone. Devices can either be chosen from presets or user-defined. Also a "Standard-dataset" representing a common household can be created with the button on the right side. This "Standard dataset" can be used if the exact number or type of household appliances are not yet known. It does not contain predefined energy consumptions or similar requirements. This must be defined by the user. Also, the reference quantity of a device can be selected.

## (3) Additional Data

Here, additional data that describes the selected device can be entered, for example energy demand.



**New**

Create a new element in this list.



**Delete**

Delete the selected element.



**Copy**

Copy the selected element.



**Insert**

Insert a copied element. The "Insert Position" specifies where the copied element will be positioned.

### Insert Position

Controls where a copied element will be inserted:

- "after" the selected element
- "before" the selected element
- "exchange" the selected element with the copied one



There are different recommended inputs depending on the certification criteria ("Default" or "PHIUS+ 2015"). Please refer to chapter 4.2.1 for further information.



Depending on the occupancy setting method, defined in the "PH case" dialog (chapter 4.4.2) the count of occupants can be defined in (1), if the method is set to "design". If it's set to "verification" the occupants are calculated depending on the interior conditioned floor area.

## Non-residential buildings:

The internal loads and occupancy settings of non-residential buildings are more complex. Their definition is divided into 5 sections:

- Utilization pattern: Different utilization types are described in this dialog. They are used to differ between zones. These utilization types are used in the following dialogs. (according to DIN EN V 18599)
- Occupancy: Defines the number of occupants of the building as well as humidity sources. Occupancy can be assigned to utilization patterns together with the type of occupants and their quantity.
- Office equipment: Lists the electronic devices (PC, monitor, ...) used for office purposes in the building. Again, the devices, their type and quantity are assigned to utilization patterns.
- Kitchen equipment: Lists the kitchen applications in the building. Again, the devices, their type and quantity are assigned to utilization patterns.
- Lighting: Defines the lighting devices of the rooms and zones in the building.

The input for these 5 sections is explained in the next pages.

Name	Begin utilization [h]	End utilization [h]	Annual utilization days [days/a]	Illumination level [lux]	Height of utilization level	Relative absence [-]	Part use factor of operating period for lighting [-]
Example					Level 1: 0 m		

(1) Utilization list

Optional data: Example

Average occupancy [m²/Person]	
Room setpoint temperature [°C]	
Heating reduction temperature [K]	
Daily utilization hours [hrs/d]	
Annual utilization hours [hrs/a]	
Annual utilization hours during daytime [hrs/a]	
Annual utilization hours during nighttime [hrs/a]	
Daily heating operation hours [hrs/d]	
Daily ventilation operation hours [hrs/d]	
Number of max water taps per day [-]	

(2) Optional data

Figure 26:  
Internal Loads/ Occupancy dialog for residential buildings

## Controls

**(1) Utilization list** The different utilization patterns (zones) of the building are defined in this list.

**(2) Optional data** Additional data can be provided here, to specify the usage of a certain utilization profile. This input is optional. Please note: In the "*Occupancy*" tab, the number of occupants can be calculated automatically from the floor area of a zone. To do this, an input is necessary in the "*Average occupancy*" field.



**New**

Create a new element in this list.



**Delete**

Delete the selected element.



**Copy**

Copy the selected element.



**Insert**

Insert a copied element. The "*Insert Position*" specifies where the copied element will be positioned

**Insert Position**

Controls where a copied element will be inserted:

- "*after*" the selected element
- "*before*" the selected element
- "*exchange*" the selected element with the copied one

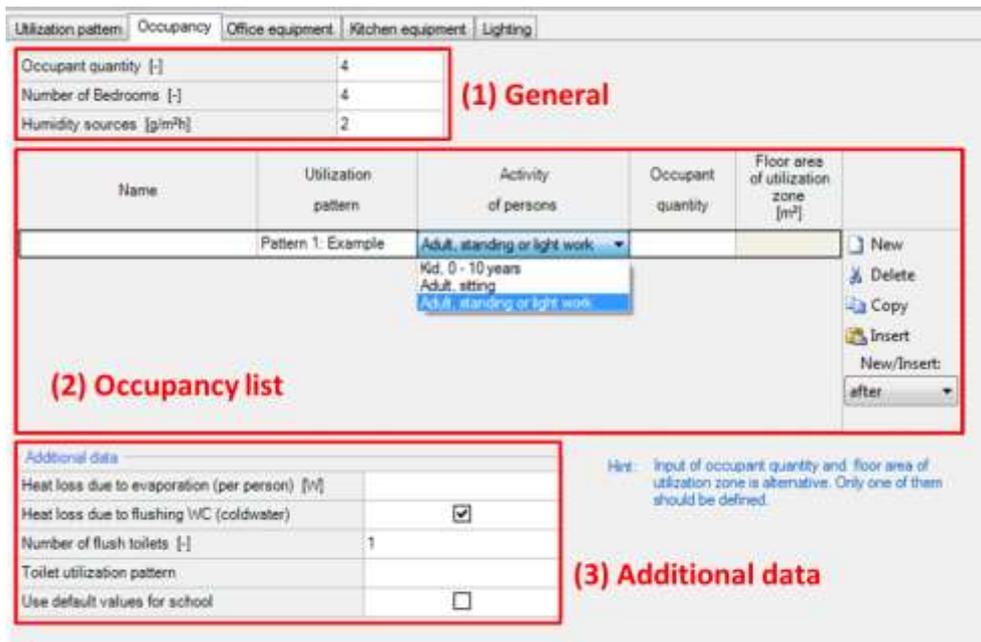


Figure 27:  
Internal Loads/ Occupancy dialog for residential buildings

## Controls

### (1) General

General settings concerning the number of bedrooms and internal humidity sources due to respiration or evaporation. The occupancy quantity is calculated from the input in the occupancy list (2).

### (2) Occupancy list

Here the number of occupants is defined for each utilization pattern. Also their activity can be selected from preset standard values (children, sitting adults, standing/ light working adults). Instead of entering the number of occupants directly, this value can be calculated from the area of the respective utilization pattern. To do this, the "average occupancy" must be defined for the utilization pattern in the "Utilization pattern" tab. After that, the floor area can be entered in the occupancy list (2).

### (3) Additional data

The additional data section contains a value about additional heat losses through evaporation and toilet usage/settings. If the simulated building is a school, default values can be used.



### New

Create a new element in this list.

**Delete**

Delete the selected element.

**Copy**

Copy the selected element.

**Insert**

Insert a copied element. The "*Insert Position*" specifies where the copied element will be positioned.

**Insert Position**

Controls where a copied element will be inserted:

- "*after*" the selected element
- "*before*" the selected element
- "*exchange*" the selected element with the copied one

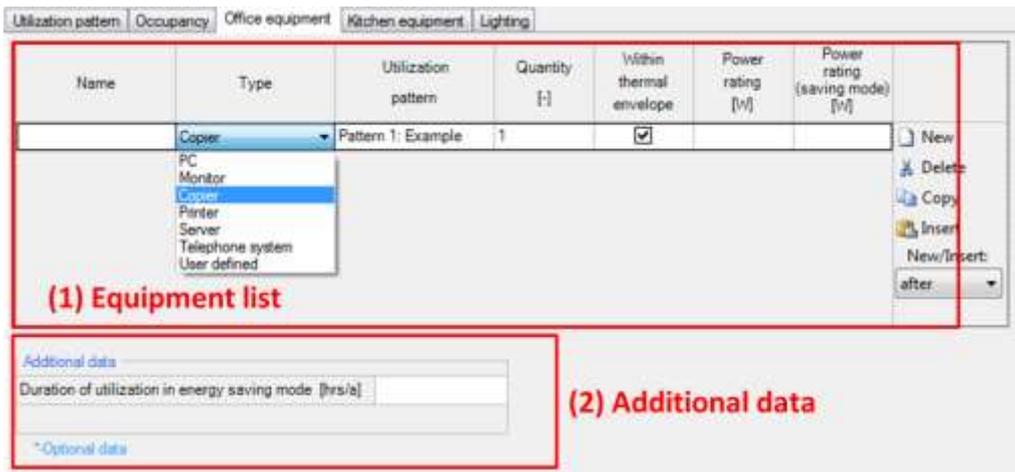


Figure 28:  
Internal Loads/ Occupancy dialog for residential buildings

## Controls

### (1) Equipment list

Any office equipment can be input here and assigned to a utilization pattern. WUFI® Passive comes with the following devices: PC, monitor, copier, printer, server and telephone system.

If further devices are needed, they can be inserted with the "user defined"-type. "User defined" devices cannot be attached to a utilization pattern, therefore the utilization hours/year have to be given.

### (2) Additional data

For some office devices additional data can be provided here. This box only shows up, if additional information can be added.



#### New

Create a new element in this list.



#### Delete

Delete the selected element.



#### Copy

Copy the selected element.



#### Insert

Insert a copied element. The "Insert Position" specifies where the copied element will be positioned.

#### Insert Position

Controls where a copied element will be inserted:

- "after" the selected element
- "before" the selected element
- "exchange" the selected element with the copied one

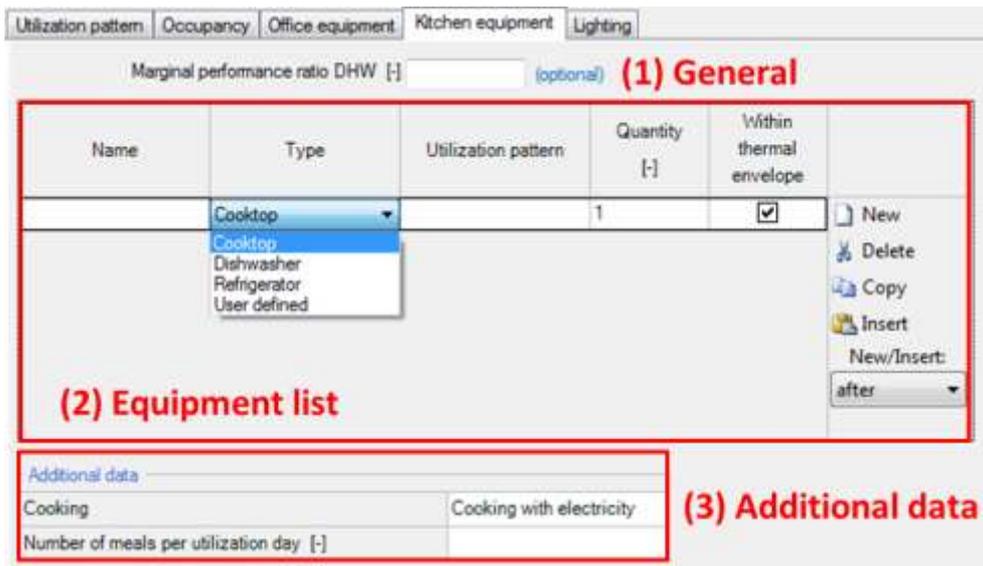


Figure 29:  
Internal Loads/ Occupancy dialog for residential buildings

## Controls

- |   |  |
|---|--|
| <b>(1) General</b>  | Optional input for marginal performance ratio of DHW.  |
| <b>(2) Equipment list</b>   | Kitchen appliances can be defined here and assigned to a utilization pattern. WUFI® Passive provides the options cooktop, dishwasher and refrigerator. Use the "user defined"-type if different appliances are needed.                     |
| <b>(3) Additional data</b>  | Additional data for the selected equipment-type can be provided here.  |
|  <b>New</b>    | Create a new element in this list.   |
|  <b>Delete</b> | Delete the selected element.   |
|  <b>Copy</b>   | Copy the selected element.   |
|  <b>Insert</b> | Insert a copied element. The "Insert Position" specifies where the copied element will be positioned.  |
| <b>Insert Position</b>  | Controls where a copied element will be inserted: <ul style="list-style-type: none"> <li>▪ "after" the selected element</li> <li>▪ "before" the selected element</li> <li>▪ "exchange" the selected element with the copied one</li> </ul> |

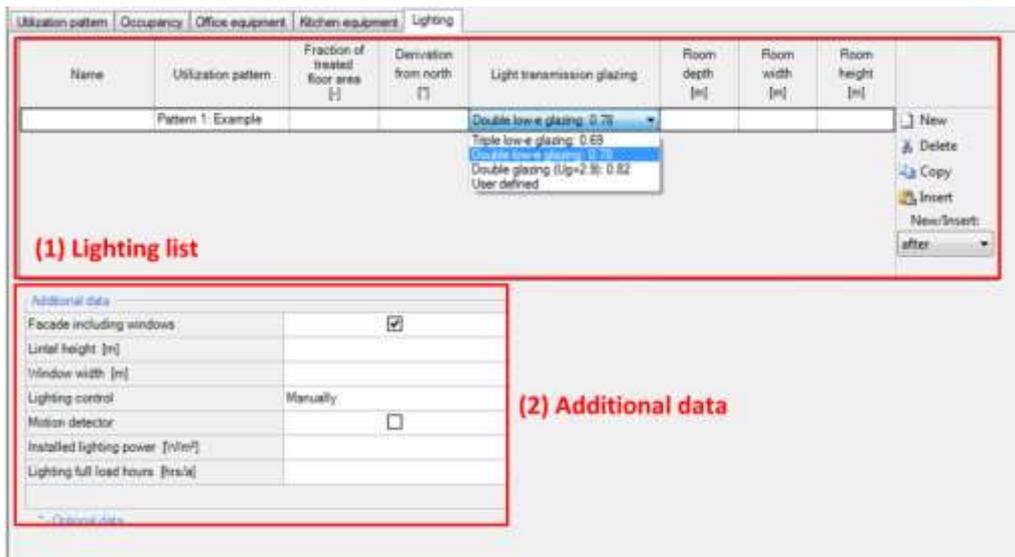


Figure 30:  
Internal Loads/ Occupancy dialog for residential buildings

## Controls

### (1) Lighting list

The required lighting is estimated depending on the amount of daylighting. Therefore data on room geometry, glass transparency and occupancy (utilization pattern) is needed.

### (2) Additional data

Additional data can be provided for the lighting calculation.



#### New

Create a new element in this list.



#### Delete

Delete the selected element.



#### Copy

Copy the selected element.



#### Insert

Insert a copied element. The *“Insert Position”* specifies where the copied element will be positioned.

#### Insert Position

Controls where a copied element will be inserted:

- *“after”* the selected element
- *“before”* the selected element
- *“exchange”* the selected element with the copied one

#### 4.4.8 Ventilation/ Rooms

The ventilation profiles of the building have to be defined in this dialog with these four tabs:

- Utilization pattern
- Rooms ventilation
- Summer ventilation
- Exhaust ventilation

The input of these tabs is explained on the following pages.

Utilization pattern:

**(1) Utilization list**

Name	Operating days per week [d/week]	Operating weeks per year [week/a]
Example	7	52

**(2) Intermediate results**

Specification	Daily operation schedule [h]	Fraction of design air flow [-]
Maximum	1	1
Standard	20	0
Basic	3	0
Minimum	0	0

**(3) Additional data**

Figure 31:  
Ventilation dialog: Utilization pattern

## Controls

**(1) Utilization list** This section defines the utilization pattern of the ventilation system. If you have different patterns for different rooms, this is the place to create them. They are assigned to the different rooms in the "*rooms ventilation*"-tab.

**(2) Intermediate results** Sums up the intermediate results of the ventilation calculation. This facilitates the design of ventilation systems.

For the "*design air flow rate*" the maximum of "*supply air per person*" and "*total extract air demand*" is used. The "*volumetric requirement*" is only informative. However, WUFI® Passive will show a warning, if the "*design air flow rate*" is below the "*volumetric requirement*".

**(3) Additional data** Here, a daily operation schedule with different air flow rates and associated running hours must be defined.



**New**

Create a new element in this list.



**Delete**

Delete the selected element.



**Copy**

Copy the selected element.



**Insert**

Insert a copied element. The "*Insert Position*" specifies where the copied element will be positioned.

**Insert Position**

Controls where a copied element will be inserted:

- "*after*" the selected element
- "*before*" the selected element
- "*exchange*" the selected element with the copied one

## Rooms ventilation:

The screenshot shows the 'Rooms ventilation' dialog box. It features a table with the following data:

Name	Room type	Quantity	Utilization pattern	Design volume flow rate [m³/h]		Average volume flow rate [m³/h]		Average air change rate [1/h]	New	Delete
				supply air	exhaust air	supply air	exhaust air			
	Kitchen	1	Pattern 1: Example	0	60	0	2.5	0,05		
	Bathroom	1	Pattern 1: Example	0	40	0	1.7	0,06		
	Shower	1	Pattern 1: Example	0	20	0	0.8	0,05		
	WC	1	Pattern 1: Example	0	20	0	0.8	0,06		
				Σ	0	140	0	5,83	0	

Below the table, the 'Additional data' section contains:

- Design volume flow rate interzonal [m³/h]:
- Area [m²]: 20
- Clear room height [m]: 2.5

A 'Standard dataset' button is located at the bottom of the dialog.

Figure 32:  
Ventilation dialog: Rooms ventilation

## Controls

### (1) Rooms list

Here, all ventilated rooms are assigned to an utilization pattern. You can define all rooms or use a standard dataset (3).

The design volume flow rate of supply and exhaust air needs to be given for each room. WUFI® Passive will then calculate an average volume flow rate depending on the given utilization pattern and its operation schedule.

### (2) Additional data

Additional data may be input to evaluate the average air change rate per room. This information is not necessary for the whole building calculation.

### (3) Standard dataset

Assigns the standard dataset in WUFI® Passive, which contains one kitchen, bathroom, shower and a restroom.



**New**

Create a new element in this list.



**Delete**

Delete the selected element.



**Copy**

Copy the selected element.



## **Insert**

Insert a copied element. The "*Insert Position*" specifies where the copied element will be positioned.

### **Insert Position**

Controls where a copied element will be inserted:

- "*after*" the selected element
- "*before*" the selected element
- "*exchange*" the selected element with the copied one

## Summer ventilation:

Utilization pattern	Rooms ventilation	Summer ventilation	Exhaust ventilation
<b>Summer ventilation</b>			
Summer HRV/humidity recovery		None	
ACH via mechanical ventilation exhaust air [1/h]		0,3	
Specific power consumption [Wh/m <sup>3</sup> ]			
ACH via natural ventilation (day) [1/h]			
<b>Additional ventilative cooling (optional data)</b>			
ACH via mechanical ventilation [1/h]			
Mechanical automatic controlled ventilation [1/h]			
Specific power consumption [Wh/m <sup>3</sup> ]			
Automatic control system via		Temperature difference	
ACH via natural ventilation (night) [1/h]			

**(1) General**

**(2) Additional data**

Figure 33:  
Ventilation dialog: Summer ventilation

## Controls

### (1) General

General settings which specify the ventilation during the cooling period.

### (2) Additional data

Additional and optional settings for cooling via ventilation.



### New

Create a new element in this list.



### Delete

Delete the selected element.



### Copy

Copy the selected element.



### Insert

Insert a copied element. The *"Insert Position"* specifies where the copied element will be positioned.

### Insert Position

Controls where a copied element will be inserted:

- *"after"* the selected element
- *"before"* the selected element
- *"exchange"* the selected element with the copied one

## Exhaust ventilation:



Figure 34:  
Ventilation dialog: Exhaust ventilation

## Controls

### (1) Exhaust list

Here, all exhaust ventilation devices, their flow rate and run time can be specified.



### New

Create a new element in this list.



### Delete

Delete the selected element.



### Copy

Copy the selected element.



### Insert

Insert a copied element. The *"Insert Position"* specifies where the copied element will be positioned

### Insert Position

Controls where a copied element will be inserted:

- *"after"* the selected element
- *"before"* the selected element
- *"exchange"* the selected element with the copied one

#### 4.4.9 Thermal Bridges

The “*Thermal Bridges*”-dialog allows the input for all thermal bridges of a building. The following user-inputs are necessary when entering a new thermal bridge into this list:

- Name the thermal bridge (1).
- Enter its linear thermal heat transfer coefficient (Psi-value) (2).
- Enter the length of the thermal bridge (3).
- Define the attachment-type (4).

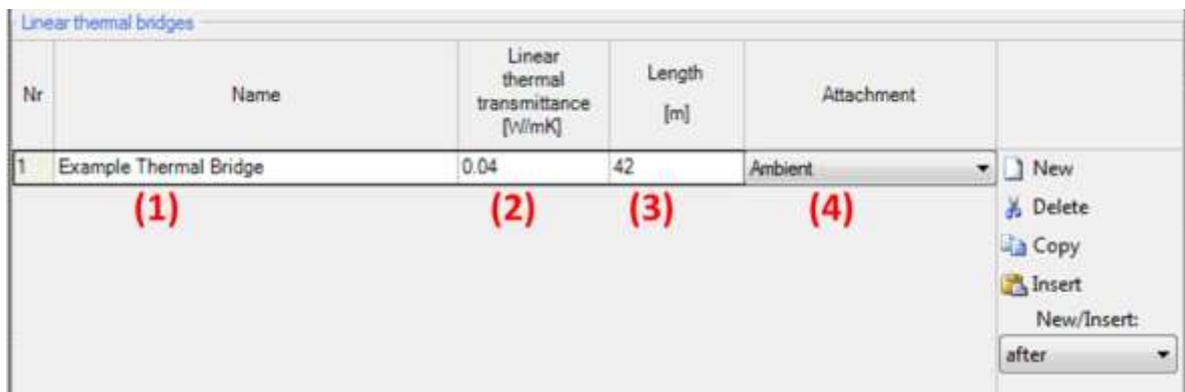


Figure 35:  
Thermal bridges dialog

### Controls

	<b>New</b>	Create a new element in this list.
	<b>Delete</b>	Delete the selected element.
	<b>Copy</b>	Copy the selected element.
	<b>Insert</b>	Insert a copied element. The “ <i>Insert Position</i> ” specifies where the copied element will be positioned.
	<b>Insert Position</b>	Controls where a copied element will be inserted: <ul style="list-style-type: none"><li>▪ “<i>after</i>” the selected element</li><li>▪ “<i>before</i>” the selected element</li><li>▪ “<i>exchange</i>” the selected element with the copied one</li></ul>

#### 4.4.10 Remaining Elements

This dialog lists all elements which are not connected to a zone. In the "*Passive House Calculation*"-scope, these components are only used for visualization.

In the "*WUFI® Plus*"-scope they also do not directly affect the simulation, except for the shading calculation. In this scope, they also can be used to create a reference for automated detection of height above ground for other components. To do this, define the inner side of a remaining component as "*Ground*" and the outer side as "*Outer air*". WUFI® Plus will now use this component as ground-reference with a height of 0. Please refer also to the WUFI® Plus manual for further information.

## 4.5 HVAC-Systems Menu

In this element of the navigation tree the "HVAC - Heating, Ventilating & Air Conditioning" systems of a building can be defined. With "New" a new "HVAC-System" is created and its "System Type" can be selected from a dropdown-menu, see figure below. In general, WUFI® Passive supports two categories of "System types":

- User defined systems (ideal systems)
- Predefined systems

The example at the end of this manual explains how "HVAC Systems" can be entered in WUFI® Passive.

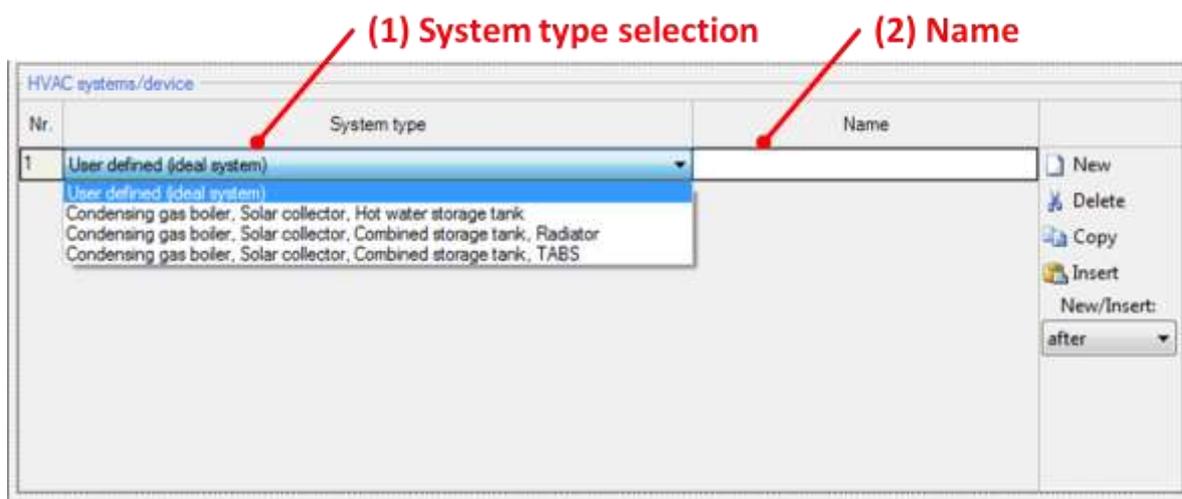


Figure 36:  
HVAC dialog

### Controls

#### (1) System type selection

Selection of a "System Type". These types can be divided into two groups:

- Ideal, user defined HVAC system and
- detailed, predefined HVAC systems.

Currently, the use of ideal, user defined systems is recommended.

#### (2) Name

This field allows naming the selected system type.



#### New

Create a new element in this list.



#### Delete

Delete the selected element.



## Copy

Copy the selected element.



## Insert

Insert a copied element. The *"Insert Position"* specifies where the copied element will be positioned.

### Insert Position

Controls where a copied element will be inserted:

- *"after"* the selected element
- *"before"* the selected element
- *"exchange"* the selected element with the copied one

## 4.5.1 Ideal User-Defined Systems

“User-defined HVAC-Systems” in WUFI® Passive allow a custom combination of certain devices of a “HVAC-System” to be input. New “Devices” can be added with the “New”-Button and their “Type” can be specified with a dropdown menu. These devices are assigned to different uses, specified by clicking on the checkboxes. Chapter 6 lists all available HVAC-devices and describes the necessary user input.

**(1) Name**

**(2) Devices**

Nr.	Type	Used for				
		Space heating	DHW	Space cooling	Space ventilation	
1	Mechanical ventilation				<input checked="" type="checkbox"/>	New
2	Photovoltaics					Delete
3	Heat pump	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>		Copy
4	Solar collector	<input type="checkbox"/>	<input checked="" type="checkbox"/>			Insert
5	Water storage		<input checked="" type="checkbox"/>			New/Insert:

**(3) Coverage**

	From other systems	Space heating	DHW	Space cooling	Space ventilation
1	Photovoltaics	0	0	0	
2	Heat pump	1	0.5	1	

Figure 37:  
List of HVAC Devices

## Controls

- |   |   |
|---|---|
| <b>(1) Name</b>   | Naming the current HVAC-system  |
| <b>(2) Device List</b>  | Here, all devices of the current HVAC-system are listed. Their usage is defined with the checkboxes.  |
| <b>(3) Coverage</b>   | Defines the coverage between different HVAC-devices. Their sum must be “1” for each column.           |
|  <b>New</b>    | Create a new element in this list.  |
|  <b>Delete</b> | Delete the selected element.  |
|  <b>Copy</b>   | Copy the selected element.  |
|  <b>Insert</b> | Insert a copied element. The “Insert Position” specifies where the copied element will be positioned. |
| <b>Insert Position</b>  | Controls where a copied element will be inserted:   |

- *"after"* the selected element
- *"before"* the selected element
- *"exchange"* the selected element with the copied one

After *"HVAC-Devices"* were created in the dialog above, they appear in the *"Project Tree"*. Selecting one of them opens a new dialog where the properties of a *"Device"* can be entered. Each device and the necessary input is explained in chapter 6.



A detailed explanation and a tutorial video on our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) show how *"User-defined HVAC systems"* can be entered in WUFI® Passive. The example at the end of this manual shows how this is done, too.

## 4.5.2 Detailed Predefined Systems

WUFI® Passive also offers several predefined and detailed “HVAC-Systems”:

- Condensing gas boiler, Solar collector, Hot water storage tank
- Condensing gas boiler, Solar collector, Combined storage tank, Radiator
- Condensing gas boiler, Solar collector, Combined storage tank, TABS

In WUFI® Passive, the devices of the predefined systems are treated like the devices of user-defined systems. Please refer to chapters 4.5.1 and 4.5.3 for further information.

The advantage of the predefined systems comes after switching to WUFI® Plus: These predefined system allow a detailed dynamic simulation of each of their parts in the dynamic simulations of WUFI® Plus. These detailed HVAC systems were created by Fraunhofer ISE and are currently implemented in WUFI® Plus. All single parts of these systems were already validated by Fraunhofer ISE. However, the implementation in WUFI® Plus is not fully validated, yet. So, these detailed HVAC systems must be regarded as experimental and provide a view on future improvements of WUFI® Plus. Currently, their usage is not recommended and is at the risk of the user.

Currently more detailed HVAC systems are developed. As soon as all systems are included and validated, an additional manual will explain their usage.



Please refer to our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) for detailed information about predefined HVAC-Systems.

### 4.5.3 Distribution

The distribution of all HVAC-devices can be specified in this dialog:

Hydronic heating:

Specification	Warm region	Cold region 1	Cold region 2
Design flow temperature [°C]			
Length of distribution pipes [m]			
Heat loss coefficient per meter pipe [W/mK]			
Temperature of the room the pipes pass through [°C]			
Design system heating load [kW]			
Flow temperature controlled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

\* Optional input

Figure 38:  
HVAC Distribution – Hydronic heating.

These inputs are only required if the Hydronic Heat distribution is accomplished by pipes. For the estimation of the heat loss, data about the pipe length, geometry, its insulation and the temperature difference between inside fluid and outside is necessary. The heat loss coefficient per length of pipe can be calculated by a separate tool which can be opened by clicking on the  button that shows up by clicking in the respective box.

WUFI® Passive distinguishes between warm regions and cold regions. In warm regions the indoor temperature is used for the calculation of the temperature difference, whereas for the cold region the temperature has to be defined.

## DHW:

Specification	Warm region	Cold region 1	Cold region 2
Design flow temperature [°C]	55		
<b>Circulation pipes</b>			
Length of circulation pipes [m]	20		
Heat loss coefficient per meter pipe [W/mK]	0.15		
Temperature of the room the pipes pass through [°C]			
Daily running hours of the circulation [h]	10		
<b>Individual pipes</b>			
Length of individual pipes [m]	12		
Exterior pipe diameter [mm]	25.4		

\* Optional input

Figure 39:  
HVAC Distribution – DHW.

The DHW distribution is very similar to the Hydronic Heating distribution. Additional information about the hours of operation for the circulation hot water systems are required. Usually the DHW circulation is running 24 hours per day for buildings with recirculation systems. Single family houses rarely have true recirculation systems, and therefore this section may be left blank.

Furthermore, the length (sum) and diameter of individual pipes needs to be entered. The pipe lengths are calculated starting from the circulation loop and end at the water tap.

In the case where no circulation system is used, only the sum of the individual pipes should be entered and the lengths calculated from the hot water tank/source to each individual tapping point.

The Design Flow Temperature must always be entered, regardless of recirculation or not.

The heat loss coefficient per length of pipe can be calculated by a separate tool which can be opened by clicking on the  button that shows up by clicking in the respective box.

## Cooling:

The screenshot shows the 'Cooling' configuration window with the following details:

Section	Parameter	Value / Status
(1) Distribution	Cooling via ventilation air	<input checked="" type="checkbox"/>
	Cooling via air recirculation	<input checked="" type="checkbox"/>
	Dehumidification	<input checked="" type="checkbox"/>
	Panel cooling	<input checked="" type="checkbox"/>
(2) Additional Data	Supply air cooling with cycling operation	<input type="checkbox"/>
	Recirculating air cooling with cycling operation	<input type="checkbox"/>
	Minimum temperature of cooling coil surface supply air [°C]	
	Max. supply air cooling power [kW]	
	Supply air cooling COP [-]	
	Minimum temperature of cooling coil surface recirculation air [°C]	
	Recirculation air volume [m³/h]	0
	Controlled recirculation volume flow	<input type="checkbox"/>
	Max. recirculation air cooling power [kW]	
	Recirculation cooling COP [-]	
	Usefull dehumidification heat loss	<input type="checkbox"/>
	Dehumidification COP [-]	
	Panel cooling COP [-]	

Figure 40:  
HVAC Distribution – Cooling.

Depending on the types of cooling distribution selected in (1), additional data can be defined in (2). Available types of cooling distribution are:

- Cooling via ventilation air: Describes cooling via supply air, aligning with the air flow rate calculated in ventilation section. The operation mode, cooling coil temperature, cooling power and COP must be defined.
- Cooling via air recirculation: Describes devices that use recirculating air, like for example indoor units of a split system. The operation mode, recirculation air flow parameters, cooling power and COP must be defined.
- Dehumidification: If heat loss due to dehumidification is available, it can be considered here and its COP needs to be defined.
- Panel cooling: Describes additional cooling through radiant wall or ceiling cooling units. Its COP needs to be defined.

## Ventilation:

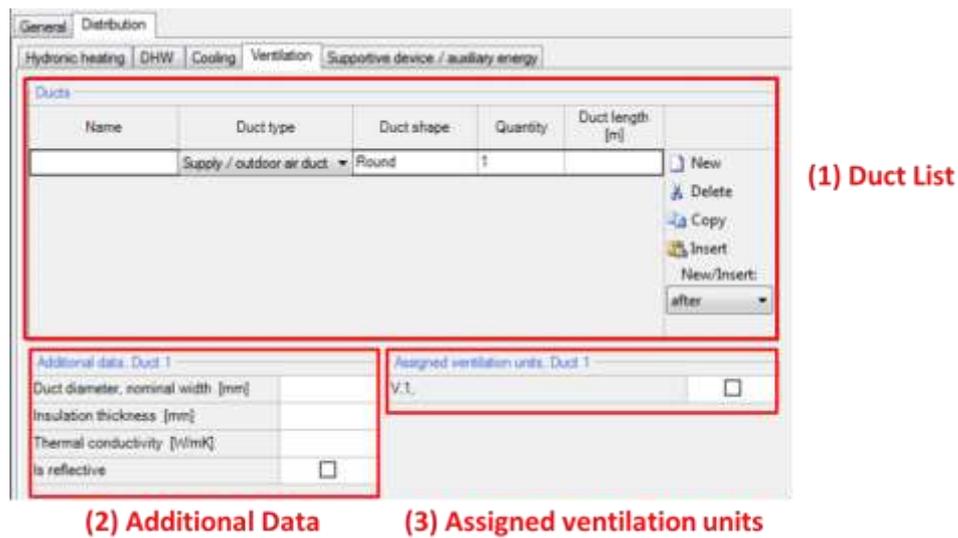


Figure 41:  
HVAC Distribution – Ventilation.

Here you will input information about the ducts that run from the ventilation unit to the outside. The duct length, geometry and insulation influence the efficiency of the ventilation system.

Ducts are listed with their type, shape, quantity and length in the duct list (1). Additional data for the geometry and insulation of a duct can be entered in the additional data section (2). Each duct has to be assigned to one or more ventilation unit(s) (3). Unlike other components it is not necessary to create an assembly for the pipes as the thermal resistance is only estimated by the insulation.

## Supportive device/ auxiliary energy:

The screenshot shows the 'Supportive device / auxiliary energy' configuration window. It is divided into four main sections:

- (1) Default Values:** A table with columns: Name, Device type, Quantity, In conditioned space, Energy demand (norm) [W], and Additional info. It lists three device types: Heating circulating pump, DHW circulating pump, and DHW storage load pump, each with a quantity of 1 and the 'In conditioned space' checkbox checked. The 'Additional info' for the heating pump is 'Controlled'. There are 'New' and 'Delete' buttons to the right of the table.
- (2) Device List:** A section for listing devices in the system, currently empty.
- (3) System Devices:** A list of devices in the system, showing 'User defined: Heating, DHW, Cooling' and 'Mechanical ventilation: Ventilation'.
- (4) Additional Data:** A section for additional data for the heating circulating pump, with the 'Controlled' checkbox checked.

Figure 42:  
HVAC Distribution – Supportive device/ auxiliary energy.

Auxiliary energy demand regarding supportive devices of the HVAC systems can be considered as default values (1). Depending on other inputs, default energy demands are calculated (e.g. if a water storage exists, a storage load pump is used).

If a detailed calculation is necessary, this checkbox needs to be unmarked. Now, all supportive devices can be listed and their type, quantity, location and energy demand must be defined (2). For common HVAC systems a standard dataset can be used. Some supportive devices need additional data which can be entered in a section below the list (4). The devices that are available in the HVAC system are shown below the list (3). The input for the auxiliary energy demand (electric power) of those devices is entered in their device input mask.

## 5 Components

Clicking on the respective component in the entry table or the in the “*Project Tree*” opens the “*Component*” dialog, where its properties are defined. WUFI® Passive distinguishes three component types:

- “*Opaque Components*” like walls, ceilings or roof construction.
- “*Transparent Components*” like windows.
- “*Openings*”, which are not relevant here, as they need no further user input.

Depending on the selected component type, there are various tabs to input all necessary data. These are described in detail in the following subsections of this chapter. The example at the end of this manual shows how components can be entered into WUFI® Passive.



Please refer to our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) for detailed information about “*Components*” and their settings.

### 5.1 Opaque Components

Various steps are necessary for the definition of an “*Opaque Component*”. Clicking on a component opens a dialog with three tabs:

- General
- Assembly
- Surface

These tabs are explained in detail in the next chapters.

## 5.1.1 General Settings

This dialog allows you to change some general settings and gives a short summary about the component.

General	
Name	
Exterior Wall	
Type/Attachment	
Type	Opaque
Inner side	Zone 1: Simulated zone
Outer side	Outer air
Data	
Area [m <sup>2</sup> ]	29,16 / 230,76
Inclination [°]	90
Orientation	S (27 %), E (22 %), W (22 %), N (29 %)
Parameters	
R <sub>si</sub> [m <sup>2</sup> K/W]	0,13
R <sub>se</sub> [m <sup>2</sup> K/W]	0,04
Thermal resistance (homogenous) [m <sup>2</sup> K/W]	4,17
Thermal resistance (EN ISO 6946) [m <sup>2</sup> K/W]	3,784
U [W/m <sup>2</sup> K]	0,2525
<input type="checkbox"/> Exterior door	

Figure 43:  
Opaque Component – General Settings.

## Controls

- |                          |  |
|--------------------------|--|
| <b>(1) Name</b>          | Name of the component.   |
| <b>(2) Type</b>          | Definition of the component type (opaque, transparent or opening) and the boundary conditions on the inner and outer side. |
| <b>(3) Data</b>          | Summary of the component's geometry.   |
| <b>(4) Parameters</b>    | Summary of the component's thermal properties.   |
| <b>(5) Exterior door</b> | Selecting this option defines the component as an exterior door. Refer to chapter 5.1.5 for further information.           |

## 5.1.2 Assembly – Selection

The construction of a component can be entered in the “*Assembly*” tab, see figure below. At the top of this dialog, the currently assigned assembly (1) is shown. This assembly can be replaced by a previously defined assembly from the “*Database*” or it can be built from scratch with the “*Edit*”-Button, as described in chapter 5.1.3. Below this there is a list which shows all assemblies that are currently used in this project (2). Selecting an assembly in this list and clicking on the “*Assign*”-Button replaces the currently active assembly with the one from the list (Double-clicking the assembly in the list has the same effect). On the bottom of this dialog a graphic sums up the most important information about the currently selected assembly (3).

(1) Assigned assembly

(2) Available assemblies

(3) Summary

#	Material, layer (from outside to inside)	$\rho$ [kg/m <sup>3</sup> ]	C [kJ/kg]	$\lambda$ [W/mK]	Thickness [m]	Color
1	Spruce, radial	485	1800	0.09	0.018	Light Blue
2	Air Layer 25 mm	1.3	1800	0.155	0.025	Light Blue
3	82 minute Building Paper	288	1500	12	0.001	Dark Red
4	Mineral Wool (heat cond.: 0.04 W/mK)	80	850	0.04	0.15	Yellow
5	PE-Membrane 0.15 mm (sd = 70 m)	130	2200	2.2	0.001	Blue
6	Gypsum Board	850	850	0.2	0.012	Light Blue

Figure 44:  
Opaque Components – Assembly Selection



Assemblies that were created in a project can't be saved in the database. So, if you want to re-use an assembly in another project, you have to create it in the database first. Afterwards it can be included in all of your projects. Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about the database.

### 5.1.3 Assembly – Editing

Clicking the “Edit”-Button in the “Assembly”-tab, see chapter 5.1.2, opens the “Edit assembly”-window:

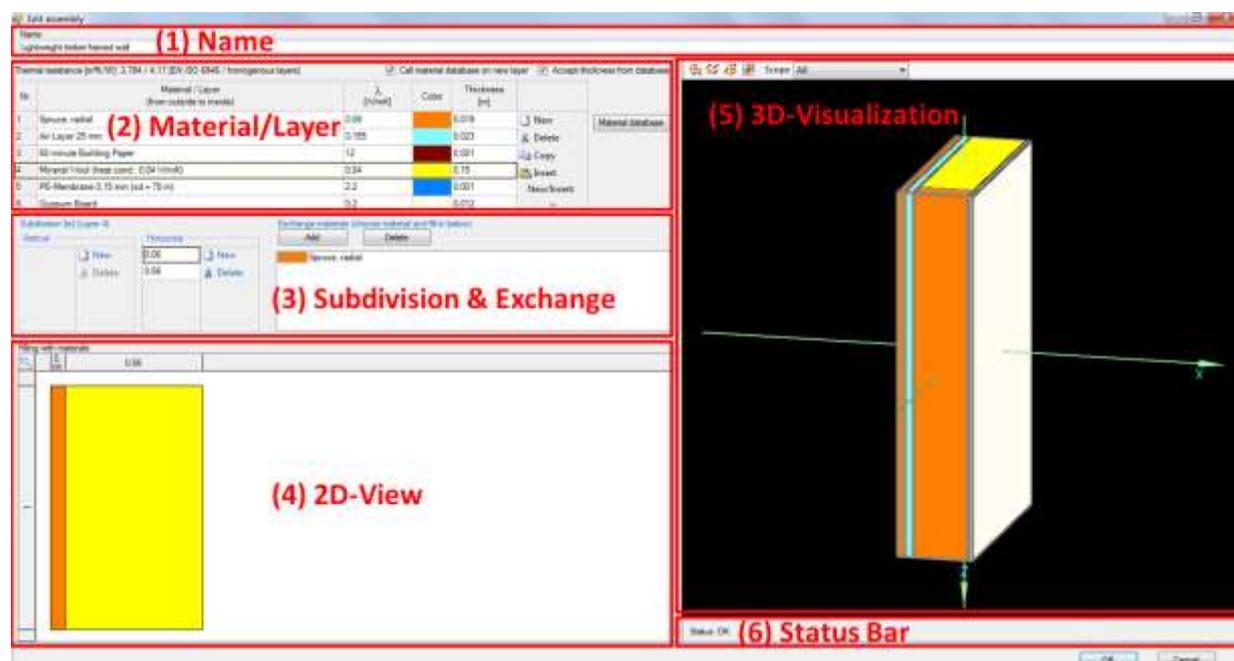


Figure 45:  
Opaque Component – Edit Assembly

## Controls

### (1) Name

Name of the assembly.

### (2) Material/ Layer

A component is built from several material layers. Here, all layers are listed in a table and their thickness can be modified by clicking the corresponding element. New layers can be added with the “New”-button and existing materials can be replaced by clicking the “Material database”-button.

### (3) Subdivision & Exchange

With this dialog, each layer defined in (2) can be divided into several horizontal and vertical parts. Each of these parts can be assigned with different exchange materials with help of the 2D-View (4). Exchange materials can be added with the “Exchange materials”-list.

This function allows the input of inhomogeneous assemblies.

When switching to the dynamic hygrothermal simulations scope of WUFI® Plus, the inhomogeneous assemblies cannot be transferred! Only the main layers, without subdivisions, are transferred.

<b>(4) 2D-View</b>	This window shows a 2D-visualization of the layer selected in (2) and, if available, its subdivisions (3). Materials can be exchanged by clicking them first in the “ <i>Exchange materials</i> ”-list (3) and then clicking the desired subdivision in the 2D-View to assign that material to the subdivision.
<b>(5) 3D-Visualization</b>	This window shows a 3D-visualization of the assembly. The controls for this 3D-view are similar to the “ <i>3D-Visualization Box</i> ” described in chapter 3.4.
<b>(6) Status Bar</b>	This status bar helps to identify potential errors.
 <b>New</b>	Create a new element in this list.
 <b>Delete</b>	Delete the selected element.
 <b>Copy</b>	Copy the selected element.
 <b>Insert</b>	Insert a copied element. The “ <i>Insert Position</i> ” specifies where the copied element will be positioned.
<b>Insert Position</b>	Controls where a copied element will be inserted: <ul style="list-style-type: none"> <li>▪ “<i>after</i>” the selected element</li> <li>▪ “<i>before</i>” the selected element</li> <li>▪ “<i>exchange</i>” the selected element with the copied one</li> </ul>

 Pay attention that your assemblies are built in the correct order. The table (2) always lists the material layers from outside to inside. You can also use the visualizations (4) & (5) to check your components.

 When switching to the dynamic hygrothermal simulations scope of WUFI® Plus, the inhomogeneous assemblies cannot be transferred! Only the main layers, without subdivisions, are transferred. Please refer to chapter 9 to learn more about the data transfer between the different calculation scopes.

The example case in chapter 11 shows how homogeneous and inhomogeneous assemblies are entered in WUFI® Passive.

### 5.1.4 Surface

Parameters for the inner and outer surfaces can be changed in this dialog, see figure below.

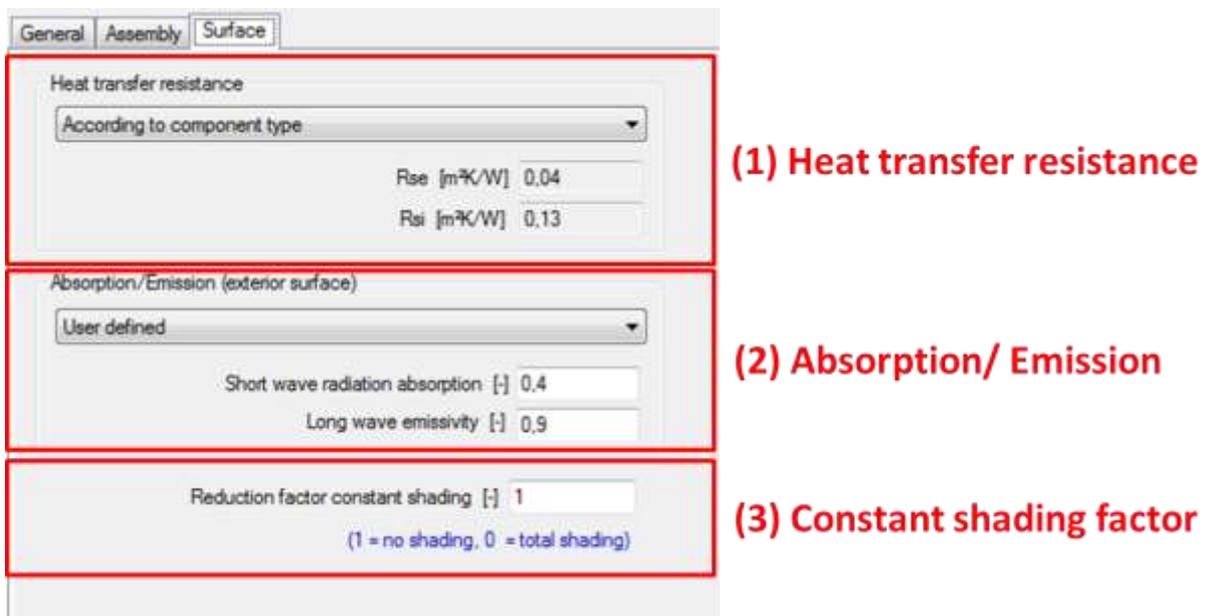


Figure 46:  
Opaque Component – Thermal surface settings

## Controls

### (1) Heat Transfer Resistance

The “*Heat Transfer Resistance*” can either be entered user-defined or it can be assigned automatically according to the component type.

### (2) Absorption/ emission

These factors are used to calculate radiation on exterior surfaces. If there are no user defined values available you can select predefined values from a list with typical exterior surfaces.

### (3) Constant shading factor

The shading factor is a reduction of solar radiation on the component, for example, by trees or other buildings. The factor is set to 1 (no shading) by default but can be altered.

### 5.1.5 Exterior Door

To create an exterior door, select an exterior, vertical and opaque component and check mark the option "*Exterior Door*" in the components "*General*"-Tab, see chapter 5.1.1.

The Example Case in chapter 11 shows, how exterior doors can be included in WUFI® Passive.

## 5.2 Transparent Components

The procedure for defining "*Transparent Components*" is very similar to that of "*Opaque Components*", yet there are differences.



Chapter 3.4.1 describes how geometries of "*Transparent Components*" or "*Openings*" can be entered into WUFI® Plus.

## 5.2.1 General Settings

This dialog allows you to change general settings and gives a short summary about the window.

General	Window parameters	Solar protection								
<b>(1) Name</b> Name Window										
<b>(2) Type</b> Type/Attachment Type: Transparent Inner side: Zone 1: Simulated zone Outer side: Outer air										
<b>(3) Data</b> Data Area [m <sup>2</sup> ]: 1,8 Inclination [°]: 90 Orientation: S (100 %) Window width [m]: 1,2										
<b>(4) Parameters</b> Parameters Uw [W/m <sup>2</sup> K]: 0,8733 Frame factor [-]: 0,7										
<b>(5) Psi-value</b> Frame-Wall Psi-value [W/mK] <input checked="" type="checkbox"/> From window parameters <table border="1"> <thead> <tr> <th>Left</th> <th>Right</th> <th>Top</th> <th>Bottom</th> </tr> </thead> <tbody> <tr> <td>0,03</td> <td>0,03</td> <td>0,03</td> <td>0,03</td> </tr> </tbody> </table>			Left	Right	Top	Bottom	0,03	0,03	0,03	0,03
Left	Right	Top	Bottom							
0,03	0,03	0,03	0,03							

Figure 47:  
Transparent Component – General Settings.

## Controls

- |                                 |  |
|---------------------------------|--|
| <b>(1) Name</b>                 | Name of the window.  |
| <b>(2) Type</b>                 | Definition of the components type (opaque, transparent or opening) and the boundary conditions on the inner and outer side.  |
| <b>(3) Data</b>                 | Summary of the component's geometry.   |
| <b>(4) Parameters</b>           | Summary of the component's thermal properties.   |
| <b>(5) Frame-Wall Psi-value</b> | Psi-values for the connection between the window frame and the surrounding wall. If the check-box is selected, these values are taken from the " <i>Window parameters</i> "-tab described in chapter 5.2.2.<br>If a window is not mounted to a wall and, for example ad- |

Adjacent to another window, the frame-wall Psi-value from the window type (the window parameters) can be adjusted or zeroed out here.

## 5.2.2 Window Parameters

Windows can be selected from the “*Window Database*” or their parameters can be set manually: After clicking the “*Edit*”-Button the “*Window Parameters*” dialog opens, see figure below:

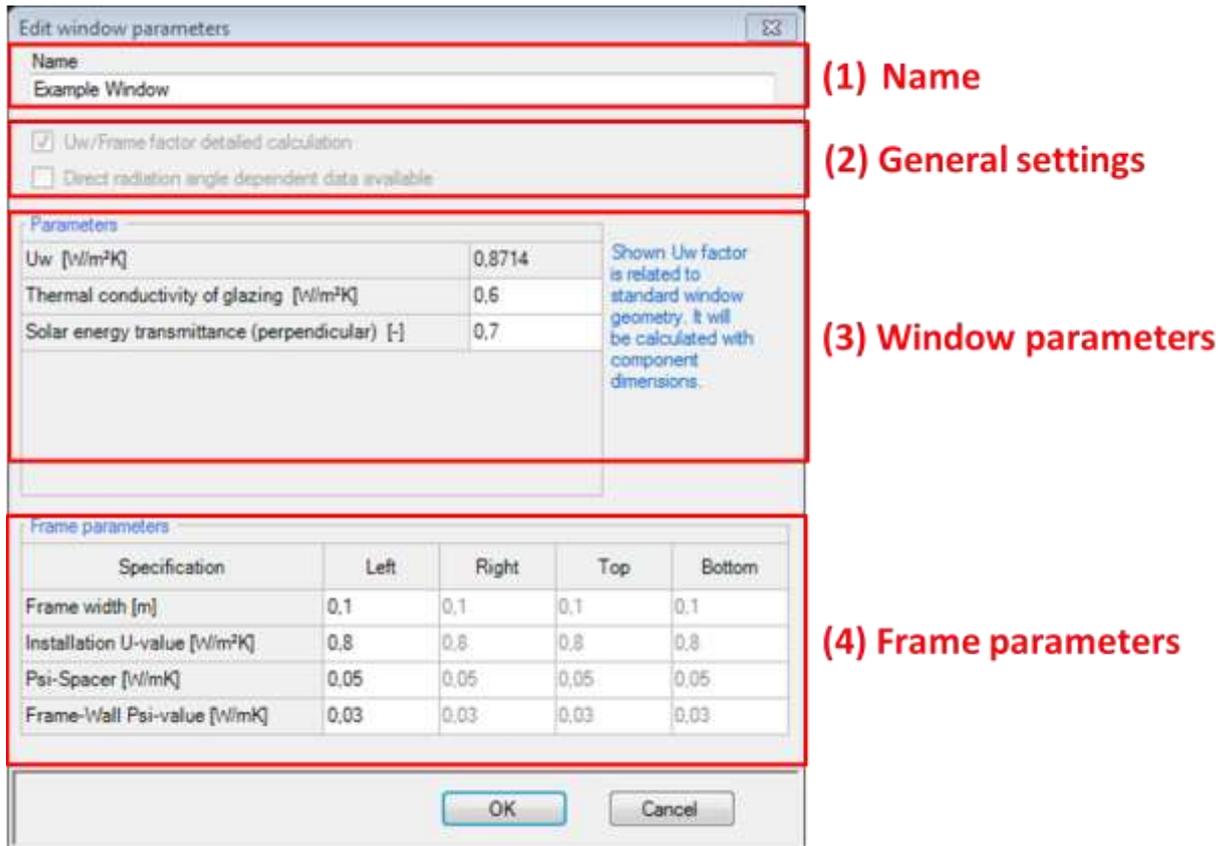


Figure 48:  
Edit Window Parameters.

## Controls

- (1) Name** Naming the window parameter.
- (2) General Settings** These checkboxes allow additional inputs for window parameters. Disabled in passive house verification mode, but enabled in dynamic hygrothermal simulations with WUFI® Plus and in the windows database.
- (3) Window Parameters** General parameters that describe the window are entered here.  $U_w$  is calculated automatically from the input in (4).

Please note: This  $U_w$  value is calculated for a standard window with standard measurements (1.23 m x 1.48 m). The real  $U_w$  value for the selected window can be found in the "General Settings" tab, described in chapter 5.2.1.

#### (4) Frame Parameters

Here, detailed about the window frame is entered. These values are used for calculation of  $U_w$  in (3).



**New**

Create a new element in this list.



**Delete**

Delete the selected element.



**Copy**

Copy the selected element



**Insert**

Insert a copied element. The "Insert Position" menu specifies where the copied element will be positioned

**Insert Position**

Controls where a copied element will be inserted:

- "after" the selected element
- "before" the selected element
- "exchange" the selected element with the copied one

### 5.2.3 Solar Protection

General settings for solar protection can be entered in the “Solar protection - General”-tab:

**(1) Parameters**

Parameter	Value
Depth of window reveal [m]	0,1
Distance from daylight opening to reveal [m]	0,05
Height of landscape obstruction [m]	0
Distance of landscape obstruction [m]	0
Other shading fraction of solar exposure (1=full exposure, 0=total shading) [-]	1
Other shading summer fraction of solar exposure (1=full exposure, 0=total shading) [-]	1

*\* Optional input if not defined, default value will be calculated*

**(2) Shading factors**

Specification	Winter	Summer
Reveal total	0,925	0,969
Landscape obstruction	1	1
Overhang	0,933	0,997
Total shading reduction factor	0,863	0,966

Figure 49:  
General settings for solar protection of a transparent component.

## Controls

### (1) Parameters

General parameters for the calculation of shading factors (2) can be entered here. The shading factor refers to the incoming solar radiation. It can take a value from 0 to 1, where 0 means total shading and 1 means total exposure.

These general parameters include window reveals, landscape obstruction and factors for other shading types. There is also an input for a special summer shading factor for the calculation of the cooling load and overheating frequency.

### (2) Shading factors

This table sums up the shading factors calculated from the values entered in (1).

WUFI® Passive supports two additional solar protection types: “Sunscreen Devices” and “Window Overhangs”:

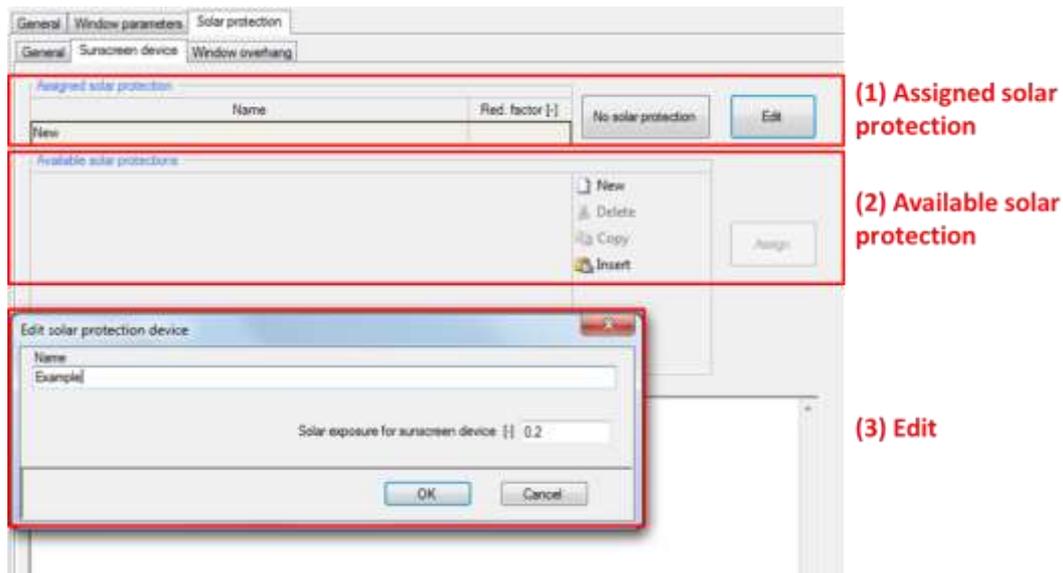


Figure 50:  
Solar protection of transparent components: Settings for sunscreen devices.

Sunscreen devices only affect the cooling calculations and do not affect the heating calculations.

## Controls

### (1) Assigned solar protection

The currently assigned sunscreen device. Clicking the "Edit"-button opens the respective dialog (3). The "No solar protection"-button dismisses the currently assigned sunscreen device.

### (2) Available solar protection

This list shows all of the sunscreen devices that are currently used in this project.

### (3) Edit

In this dialog, the sunscreen device can be named and its shading factor can be entered.

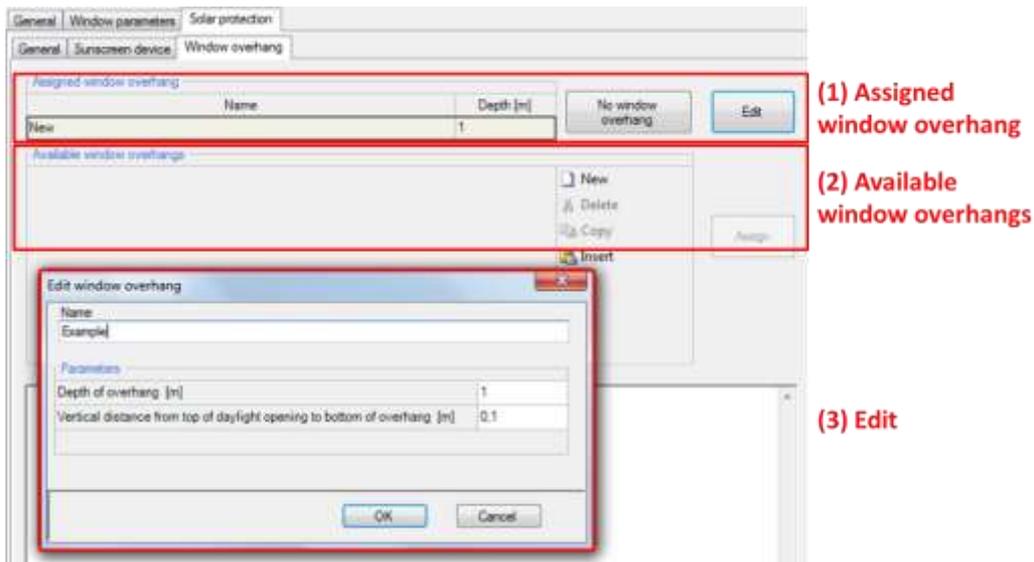


Figure 51:  
Solar protection of transparent components: Settings for window overhang.

## Controls

### (1) Assigned solar protection

The currently assigned window overhang. Clicking the "Edit"-button opens the respective dialog (3). The "No window overhang"-button dismisses the currently assigned window overhang.

### (2) Available solar protection

This list shows all window overhangs that are currently used in this project.

### (3) Edit

In this dialog, the window overhang can be named and its geometry can be entered.



Please check the input in the "General" tab, as the shading factors of sun-screen devices and window overhang are multiplied with these values to determine the overall shading reduction factor for each transparent component.

## 6 HVAC-Devices

WUFI® Passive comes with a variety of HVAC-devices that can be included in the building as described in chapter 4.5. The chapters 6.1 to 6.10 list these devices and their necessary inputs. For some devices, general information can be saved in the WUFI® Passive database. This is described in chapter 6.11.

### 6.1 Mechanical Ventilation

This chapter describes the user inputs for a mechanical ventilation device.

(1) Name		(2) Database relevant data	
Name Mechanical Ventilation		Assign from database	
Database relevant data		Remaining parameters	
Required data		Required data	
HRV/ERV efficiency [-]	0.84	Quantity	1
Electric efficiency [Wh/m³]	0.37	Humidity recovery efficiency [-]	0
Equipped with frost protection	<input checked="" type="checkbox"/>	HRV/ERV in conditioned space	<input checked="" type="checkbox"/>
Rooms ventilated by this unit		No summer bypass feature (summer ventilation with HRV/ERV)	<input type="checkbox"/>
Z.1. R.1. Kitchen	<input checked="" type="checkbox"/>	Defrost active	<input checked="" type="checkbox"/>
Z.1. R.2. Bathroom	<input checked="" type="checkbox"/>	Temperature below which defrost must be used [°C]	-2
Z.1. R.3. Shower	<input checked="" type="checkbox"/>	Optional data (if not defined default value will be calculated)	
Z.1. R.4. WC	<input type="checkbox"/>	Subsoil heat exchanger efficiency [-]	0
(3) Ventilated Rooms		(4) Remaining Parameters	

Figure 52:  
Settings for mechanical ventilation device.

## Controls

- |                                   |   |
|-----------------------------------|---|
| <b>(1) Name</b>                   | Name of the mechanical ventilation device.  |
| <b>(2) Database relevant data</b> | Necessary inputs for the efficiency of the mechanical ventilation device and the availability of frost protection. Data that is entered in this section can also be assigned from the WUFI® Passive database by clicking the respective button and selecting the desired device in the database. The imported data will overwrite already entered values. Please refer to chapter 6.11 for further information. |
| <b>(3) Ventilated Rooms</b>       | Here, all rooms are listed that were defined in the "Ventilation/ Rooms"-dialog described in chapter 4.4.8. Select all rooms that are ventilated by this mechanical ventilation device.   |
| <b>(4) Remaining Parameters</b>   | Additional parameters can be entered that describe the quantity of the mechanical ventilation devices, humidity recovery, summer bypass and defrost. The subsoil heat exchanger efficiency can also be entered.   |

## 6.2 Electric Heating/ DHW

No special user input is necessary for an direct electric heating/ DHW device. Naming the device is possible.

## 6.3 Boiler

This chapter describes the user input for a boiler device. An input is possible for boilers with four types of energy sources: Gas, oil, wood pellets and wood log. The input varies depending on the energy source or boiler type: gas/ oil or wood. However, the general structure for all boiler types is described by the figure below:

The screenshot shows a software interface for configuring a boiler. It is divided into four main sections:

- (1) Name:** A text input field containing the word "Boiler".
- (2) Type:** A dropdown menu currently set to "Gas".
- (3) Database relevant data:** A table with a "Assign from database" button. It contains fields for "Condensing boiler" (checked), "Boiler efficiency at 30% load [-]" (0.38), "Boiler efficiency at nominal output [-]" (0.94), "Average return temperature measured at 30% Load [°C]" (30), "Average boiler temperature at design 70°C/55°C [°C]" (41), "Average boiler temperature at design 55°C/45°C [°C]" (35), and "Average boiler temperature at design 35°C/25°C [°C]" (24). Below this are fields for "Maximal heating power [kW]", "Standby heat loss boiler at 70°C [-]", "Auxiliary energy (electric power) [W]", and "Auxiliary energy DHW (electric power) [W]".
- (4) Remaining Parameters:** A section for "Remaining parameters" with a "Required data" checkbox (unchecked) and "Optional data (if not defined default value will be calculated)" section containing a "Solar fraction for space heating [-]" field.

Figure 53:  
Settings for a boiler device.

## Controls

- |                                   |   |
|-----------------------------------|---|
| <b>(1) Name</b>                   | Name of the boiler device.  |
| <b>(2) Type</b>                   | Selecting the energy source or boiler type. Depending on this selection, the necessary user inputs in (3) and (4) vary.   |
| <b>(3) Database relevant data</b> | Necessary inputs including the boilers efficiency and characteristic temperature points. The input in this section varies depending on the energy source or boiler type defined in (2).<br>Data that is entered in this section can also be assigned from the WUFI® Passive database by clicking the respective button and selecting the desired device in the database. The imported data will overwrite already entered values. Please refer to chapter 6.11 for further information. |

#### (4) Remaining parameters

This input includes the boilers location and supply situation. A solar fraction for space heating can be defined here. The input in this section varies depending on the energy source or boiler type defined in (2).

This input is specific for each building, so no entries from the database can be imported.

### 6.4 Combined Heat and Power (CHP)

No special user input is necessary for an CHP device. Naming the device is possible.

### 6.5 District Heating

This chapter describes the user input for a district heating device.

Name	
District Heating	
Energy carrier district heat	
Gas CGS 70% PHC	
Parameters	
Required data	
Solar fraction for space heating [-]	0
Utilization factor of heat transfer station [-]	
Optional data (if not defined default value will be calculated)	
Auxiliary energy (electric power) [W]	

Figure 54:  
Settings for a district-heating-device.

## Controls

- |                           |   |
|---------------------------|---|
| <b>(1) Name</b>           | Name of the district heating device.  |
| <b>(2) Energy carrier</b> | Selection of the energy carrier for district heating.   |
| <b>(3) Parameters</b>     | Input of the solar fraction of space heating and the utilization factor of the heat transfer station. In addition, the auxiliary energy can be specified, for example for an electronic control system. If it's not entered, WUFI® Passive estimates standard values. |

## 6.6 Heat Pump

This chapter describes the user input for a heat pump device. WUFI® Passive supports two types of heat pump devices: Standard “*Heat pumps*” and “*Combined Heat Pumps*”.

(1) Name

(2) Type

(3) Parameters

Figure 55:  
Settings for a heat pump device.

### Controls

<b>(1) Name</b>	Name of the heat pump device.
<b>(2) Type</b>	Selecting the type of heat pump: The standard “ <i>Heat pump</i> ” is described here, the input for a “ <i>Combined heat pump</i> ” will be described on the next page.
<b>(3) Parameters</b>	Input for annual heating and cooling COP and system performance ratio of heat generator.

The screenshot shows the configuration window for a 'Heat Pump - Combined Unit'. It includes fields for Name, Type, and Database relevant data. The Database relevant data section contains a table for Required data and a table for Measured values. The Remaining Parameters section includes fields for Annual cooling COP, Solar fraction for space heating, and Efficiency SHX exhaust air mixing. The Measured values section includes a table for Measured values from laboratory tests.

Specification	Test point 1	Test point 2	Test point 3	Test point 4
<b>Heating</b>				
Ambient air temperature [°C]	-7	2	7	
Measured thermal power heat pump heating [kW]	0.5	0.9	1.1	
Measured COP heating [·]	2.2	3	3.3	
<b>DHW</b>				
Ambient air temperature [°C]	-7	2	7	
Measured thermal power DHW storage heating-up [kW]	1	1.3	1.5	
Measured thermal power DHW storage reheat [kW]	0.8	1.4	1	
Measured COP DHW storage heating-up [·]	3.5	3.7	3.8	
Measured COP DHW storage reheat [·]	3	3.5	3	
<b>Standby</b>				
Ambient air temperature [°C]				
Measured thermal power heat pump standby [kW]				
Measured COP standby [·]				

Figure 56:  
Settings for a combined heat pump device.

## Controls

- (1) Name** Name of the combined heat pump device.
- (2) Type** Selecting the type of heat pump: The standard “*Heat pump*” was described before, the input for a “*Combined heat pump*” is described here.
- (3) Database relevant data** Necessary inputs describing the characteristics of the combined heat pump device. Data that is entered in this section can also be assigned from the WUFI® Passive database by clicking the respective button and selecting the desired device in the database. The imported data will overwrite already entered values. Please refer to chapter 6.11 for further information.
- (4) Remaining parameters** Input concerning the annual cooling COP, the solar fraction for space heating and the efficiency of SHX exhaust air mixing.
- (5) Measured values** Characteristic values for the capacity of the combined heat pump device for heating, DHW and standby can be entered here. This data can be taken from measured values from laboratory tests.

## 6.7 Solar Collector

This chapter describes the user input for a solar collector device.

The screenshot shows the configuration window for a solar collector. It includes the following sections:

- (1) Name:** A text field containing "Example Solar Collector".
- (2) Type:** A dropdown menu set to "Vacuum tube collector (VTC)".
- (3) Database relevant data:** A table with columns for parameter names and values. Parameters include Total efficiency, Heat loss coefficient k1, Temperature dependence of heat loss coefficient k2, Effective thermal capacity, Incidence angle modifier, Incidence angle modifier (k<sub>iso</sub>), Solar thermal yield, and Area of module. An "Assign from database" button is present.
- (4) Remaining parameters:** A table for geometry and orientation, including Area of solar thermal array, Orientation of array, Inclination angle of array, DHW priority, and Auxiliary energy used in conditioned space. It also includes optional data for shading, such as vertical and horizontal distances between shading obstructions and the array, and other shading fraction.
- (5) External heat gain calculation:** A table with columns for months (Jan to Dec) and rows for Solar gain DHW and Solar gain heating.

Figure 57:  
Settings for a solar collector device.

### Controls

- |   |   |
|---|---|
| <b>(1) Name</b>                           | Name of the solar collector device.   |
| <b>(2) Type</b>                           | Selecting the collector type. WUFI® Passive supports vacuum tube and flat plate collectors.   |
| <b>(3) Database relevant data</b>         | Necessary inputs describing the specifications of the solar collector. This data is provided by the manufacturer of the solar collector. The auxiliary energy can be entered, for example for the electronic control system. If it's not entered, WUFI® Passive estimates standard values. Data that is entered in this section can also be assigned from the WUFI® Passive database by clicking the respective button and selecting the desired device in the database. The imported data will overwrite already entered values. Please refer to chapter 6.11 for further information. |
| <b>(4) Remaining parameters</b>           | These values describe the geometry and orientation of the solar collector. The usage priority and auxiliary energy usage can be defined. Also optional settings for shading of the collector can be entered.  |
| <b>(5) External heat gain calculation</b> | Data from an external heat gain calculation or from measurements can be entered here. However, this entry is optional and WUFI® Passive calculates  |

these values internally if left blank.

## 6.8 Water Storage

This chapter describes the user input for a water storage device.

The screenshot shows a software interface for configuring a water storage device. It is divided into five numbered sections:

- (1) Name:** A text input field containing "Water Storage".
- (2) Input Options:** A dropdown menu currently set to "Specific losses standby part only".
- (3) Database relevant data:** A section with a "Assign from database" button and two input fields: "Storage capacity [Liter]" with a value of 400 and "Specific storage losses standby part only [1/K]" with a value of 0.68.
- (4) Connected solar collector:** A list of solar collectors with checkboxes. "SC 1 - Solar Collector 1" is checked.
- (5) Remaining parameters:** A section with a "Required data" header and three input fields: "Within thermal envelope" (checkbox), "Storage ambient temperature [°C]" (empty), and "Quantity" (value 1). Below this is an "Optional data" section with "Typical storage water temperature [°C]" (empty).

Figure 58:  
Settings for water-storage device.

### Controls

<b>(1) Name</b>	Name of the water storage device.
<b>(2) Input Options</b>	Data for water storage devices can be entered in three ways: <ul style="list-style-type: none"> <li>▪ Specific total losses (per Kelvin temperature difference)</li> <li>▪ Specific losses by standby part only (losses in standby mode)</li> <li>▪ Total losses (sum of all losses)</li> </ul>
<b>(3) Database relevant data</b>	Necessary inputs including the storage capacity and specific storage losses. The inputs in this section vary depending on the input options defined in (2). Data that is entered in this section can also be assigned from the WUFI® Passive database by clicking the respective button and selecting the desired device in the database. The imported data will overwrite already entered values. Please refer to chapter 6.11 for further information.
<b>(4) Connected solar collector</b>	All available solar collector devices are listed here. Check marking the box besides the solar collector connects it with the water storage device.
<b>(5) Remaining parameters</b>	The ambient conditions for water storage device are defined here.

## 6.9 Photovoltaics

This chapter describes the input for a photovoltaics device.

Name	
<input type="text"/>	
Parameters	
Required data	
Photovoltaic / renewable energy [kWh/a]	<input type="text"/>
Onsite utilization [-]	<input type="text"/>

Figure 59:  
Settings for photovoltaics device.

### Controls

<b>(1) Name</b>	Name of the photovoltaics device.
<b>(2) Required data</b>	Necessary inputs of the renewable energy created with photovoltaics and the onsite utilization.

## 6.10 User-Defined

This device can be selected to input a user-defined HVAC-device that couldn't be described by the other devices. Depending on its usage type, defined in the "System"-dialog (described in chapter 4.5.1), different inputs are required.

## 6.11 Creating Database Entries for HVAC Devices

Some of the HVAC devices described in the previous chapters allow assigning their settings from database entries:

- Mechanical ventilation unit
- Boiler
- Heat pump
- Solar collector
- Water storage

Some predefined examples are saved in the database when installing the software. Additional entries can be entered by the user. This chapter shows how to do this.



Settings for HVAC devices that were created in a project can't be saved in the database. So, if you want to re-use settings for a HVAC device in another project, you have to create it in the database first. Afterwards it can be included in all of your projects.

Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about the database.

First, open the database by clicking "Database" in the "Menu bar" and then "HVAC devices":

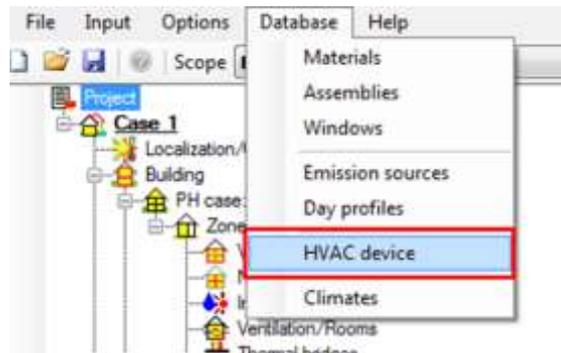


Figure 60:  
Open the WUFI® HVAC database.

Then, create a new entry by clicking the "New"-button (1). Existing database entries can be copied and then modified with the "Copy/New"-button (2):



Figure 61:  
Structure of the WUFI® HVAC database.

After a new device was either created or copied, a new window opens, where the device can be specified. First, name the device. Depending on the type of HVAC device selected, additional data must be entered. The device can also be assigned to user-defined catalogs of the database and a description can be added. After all required information is entered, confirm it with the OK-button. The device is now part of your personal database and can be used in future projects.

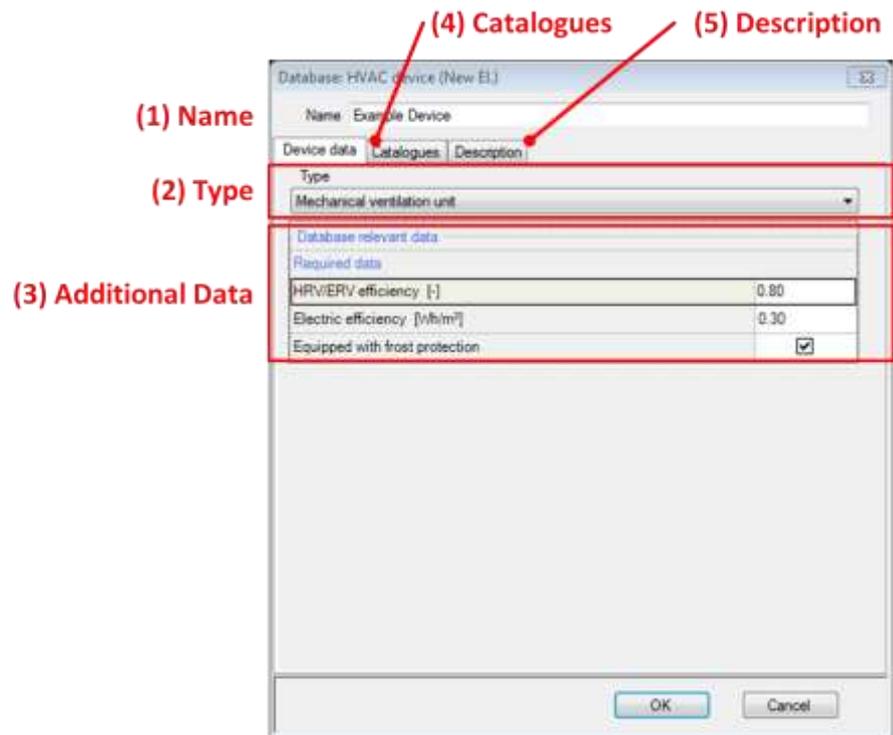


Figure 62:  
Creating a new device for the WUFI® HVAC database.

## 7 Importing geometry data

WUFI® Passive imports 3D geometries from other applications:

- SketchUp: A plugin for SketchUp allows defining zones and properties of components directly in SketchUp. This geometry data is then transferred directly to WUFI® Plus.
- gbXML: With the gbXML-format, geometry data can be imported from CAD-programs like Revit®.

### 7.1 SketchUp Plugin

WUFI® Passive imports 3D geometries from [SketchUp](#) by using a plugin.

The plugin has to be installed manually after the installation of WUFI® Passive and requires an existing installation of SketchUp version 8 or higher. To install the plugin, open "Menu Bar > Options > WUFIplus SketchUp plugin", as described in chapter 3.2.3. The following dialog appears:

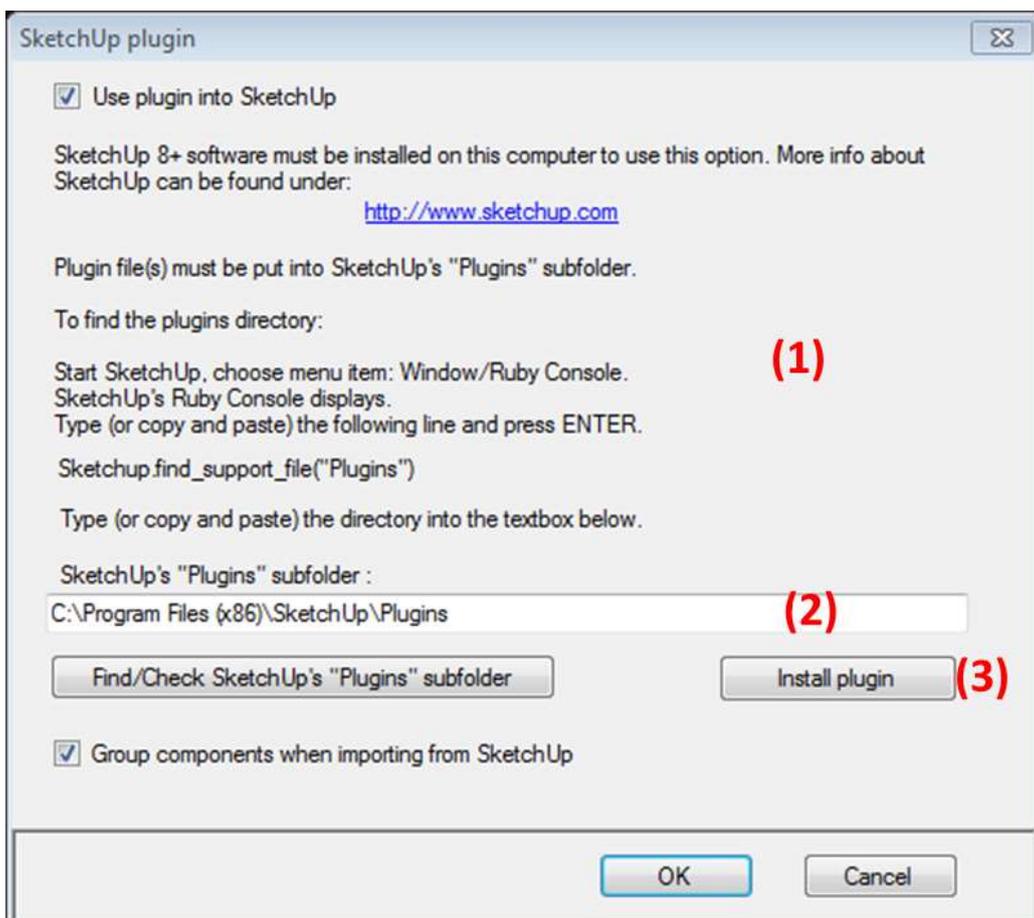


Figure 63:  
Options for the WUFI® Passive SketchUp Plugin.

Find SketchUp's plugins subfolder as described in the dialog (1). Then enter the path to SketchUp's plugins subfolder in (2) and click "Install plugin" (3) to complete the installation of the plugin. Afterwards it can be found in SketchUp's Menu Bar under "Plug-ins", see figure below. This menu provides access to three functions:

- Zones (1): Enter the number your buildings number of zones. Always open the "Zones"-dialog and adjust the number of zones before setting the properties of objects. Or, the number of zones must be altered afterwards.



Due to a bug in SketchUp, the number of zones is not imported, if SketchUp is started by double-clicking on a ".skp"-File. The properties of all objects are still saved correctly, but will only show up, if you enter the correct number of zones.

**This problem can be avoided by first starting SketchUp and open the ".skp"-File afterwards.**

- Export geometry (2): Exports the current geometry directly to WUFI® Passive. If WUFI® Passive is already running, the current geometry will be overwritten, so be careful when using this function. If WUFI® Passive isn't running, it will be prompted open when selecting this option.
- Save geometry (3): Saves the geometry as a .wps-file which can be imported in WUFI® Passive through the "Building"-dialog, as described in chapter 4.4. It's recommended to use this function instead of the direct export (2).

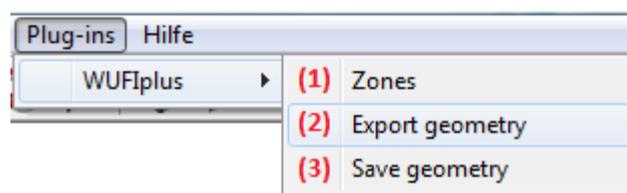


Figure 64:  
Dialogs in SketchUp for the WUFI® Passive SketchUp Plugin.

The properties need to be defined for all objects which should be imported into WUFI® Passive. This can be done by right-clicking on a surface (1) and setting the properties (3), see figure below. A red arrow represents the normal vector, which shows from the inner side of the object to its outer side (2). This helps to check if its orientation is correct.

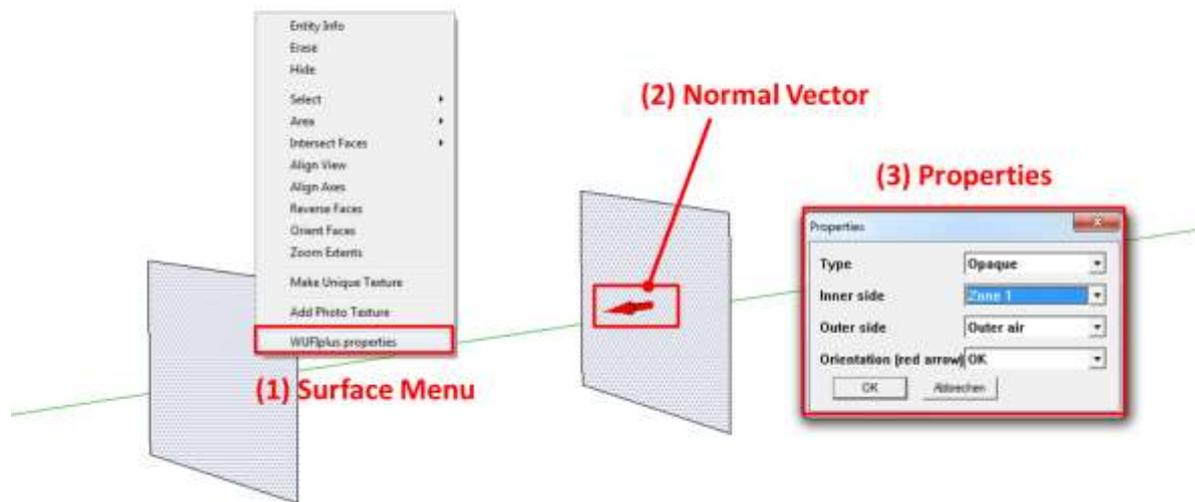


Figure 65:  
Setting the properties of an object in the WUFI® Passive SketchUp Plugin.



Always check your models after importing a SketchUp-geometry into WUFI® Passive to make sure that all parts are imported in the right way. Also, always check the orientations of all of your components as described in chapter 3.4.2.



Visit our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about this feature. A tutorial movie shows in detail how to import the 3D geometry of a building from SketchUp to WUFI® Passive.

## 7.2 gbXML-Import

gbXML-files can be imported with an external program, found in the “Tools”-folder of the WUFI® Passive main installation folder. This folder is defined during the installation process described in chapter 2.2. The external program is called “gbXML\_project\_import.exe”. With this tool gbXML Project files can be converted to WUFI® Passive XML project files which can be read from WUFI® Passive. This chapter explains the import-process.



Always check your analytical gbXML Project model export via your CAD software. If the analytical model is not well prepared, the tool can't import a usable model.

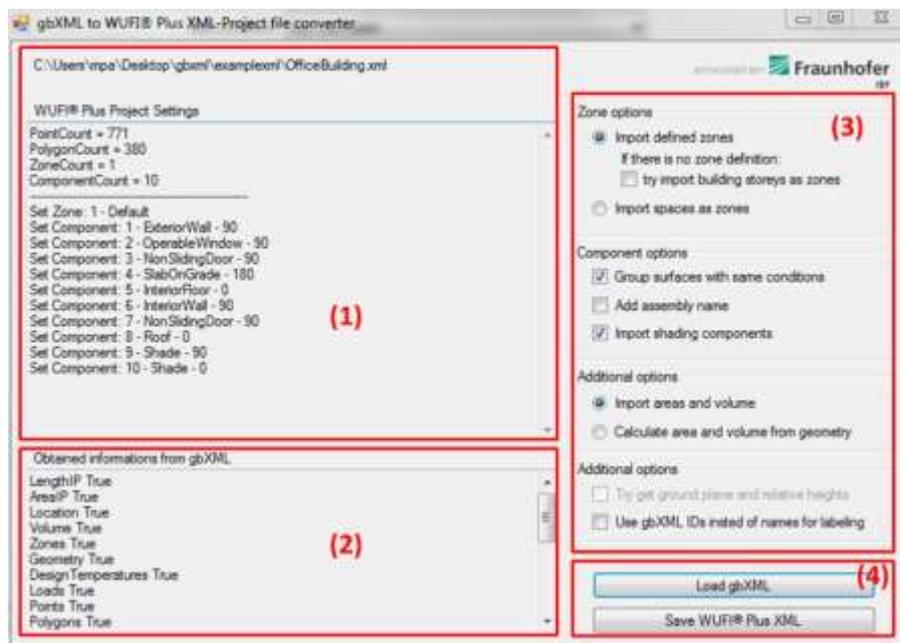


Figure 66:  
External program for gbXML-import.

### Controls

- |                          |   |
|--------------------------|---|
| <b>(1) Result screen</b> | General information about imported zones and components |
| <b>(2) Information</b>   | Information about data obtained from the gbXML Project  |

translated to the WUFI® Passive Project

### (3) Import options

General settings concerning the import of the gbXML geometry, zone definition, and additional data. Further information about these options is provided below the box.

### (4) Load and Save options

Two functions are available:

- *"Load gbXML"*: Choose the gbXML file you want to use with WUFI® Plus.
- *"Save WUFI® Plus XML Project"*: Saves the loaded gbXML Project with the defined import options, as WUFI® Plus XML Project, openable in WUFI® Passive.

Some import options (2) are available:

Zone options:

- *"Import defined zones"*: Import the zones defined (in Revit the Export Category should be set to MEP-spaces for the gbXML-Project export). If you have set the Export Category to architecture rooms, you can import different building stories as WUFI® Passive zones, or the building will consist of only one zone.
- *"Import spaces as zones"*: Ignores zone definition in the gbXML-Project (may not obtainable). All defined rooms or spaces are imported as separate WUFI® Passive zones.

Component options:

- You can *"Group surfaces with same conditions"* for a tidy project tree. If you uncheck this option, each Surface of the building will become a new WUFI® Passive component.
- The import tool tries to get the construction information (assembly) of each component. If you check *"Add Assembly Name"* the Name of the construction will be added to the component Name.

Additional options:

- *"Import areas and volume"*: The area and volume of each space is calculated with the CAD software (Revit) and stored in gbXML. You can import this information, or you can let WUFI® Passive calculate it, depending on the building geometry data.
- *"Use gbXML IDs instead of names for labelling"*: If no names for zones or components is defined within the gbXML project, you can take the IDs for labelling.

## Open WUFI® Passive xml project files

- Click on open in the WUFI® Passive "*Menu Bar*", choose "*XML Project Files (\*.xml)*" as data type and search for the WUFI® Passive XML Project file you have saved before with the Convert-Tool. Refer to chapter 3.2.1 for further information.
- Another option is found in the "*Building*"-entry of the "*Project Tree*". There, choose "*gbXML Import*" and select and browse to the WUFI® Passive XML Project file you have saved before with the Convert-Tool. Refer to chapter 4.4.1 for further information.

## 8 Passive House Verification

Once all necessary data is input to WUFI® Passive a variety of reports including the Passive House verification report can be accessed through the *“Report: Data & Results”*-tab in the *“Case”*-entry of the *“Project Tree”*.

### 8.1 General Reports

After the calculation, the results for the whole building can be accessed through the *“Report: Data & Results”*-Tab in the *“Case”*-dialog, see figure below. WUFI® Passive comes with a variety of predefined reports:

- **Passive House verification:** Creates the Passive House verification report. Please refer to chapter 8.2 for further information.
- **Project Data:** Information about the current project, as described in chapter 4.1.
- **Climate:** Information and visualization of the selected outdoor climate.
- **Passive house data:** Summary of passive house data, mainly from the *“PH case”* dialog, described in chapter 4.4.2.
- **Zones/ components:** General information about all zones in the building. In addition, their internal loads and ventilation settings as well as general information about their components are described.
- **Assemblies:** Lists and visualizes all assemblies used in the building.
- **HVAC:** Summarizes all HVAC systems including their devices and distribution. The settings for each device are described, too.
- **Results:** Sums up the main calculation results, like for example specific heating demand or specific heat load.
- **User defined:** A custom combination of the reports described above.

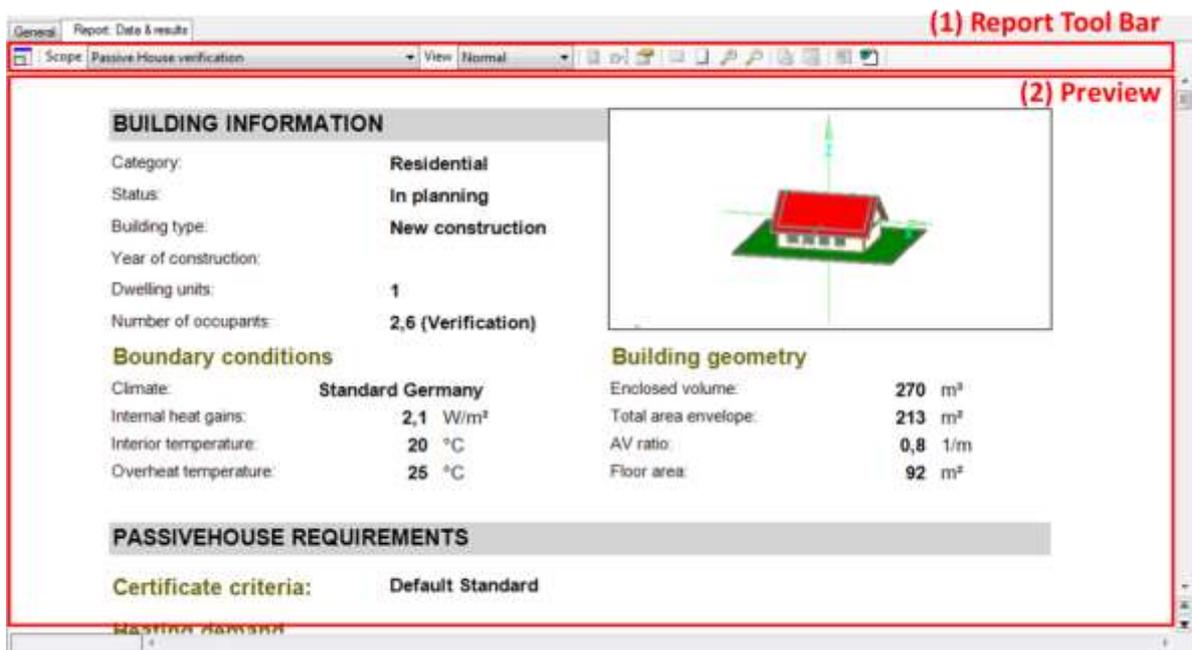


Figure 67:  
Report dialog.

## Controls

### (1) Report Tool Bar

This tool bar allows you to select, modify, print and export individual reports. The buttons in this tool bar are explained below.



### Expand/ Shrink Window

Expands the "Report Box".

### Scope

Switches through different types of reports.

### View

Changes between two options:

- "Normal": The standard report viewer in WUFI® Plus.
- "Print layout" shows how the report will look, when it's printed.



### Page Setup

Defines the page layout.  
Only available if "View" is set to "Print Layout".



### Scope/ Sequence

If a "User defined" report is selected it can be customized with this button.



### Options

Settings for the appearance of the report.



### Whole width

Zooms on the whole width of the report in the Preview Box (2).

	<b>Whole page</b>	Shows the whole page in the Preview Box (2).
	<b>Zoom in/ out</b>	Zooming in or out in the Preview Box (2).
	<b>Print all</b>	Prints the current report with the default printer. Only available if "View" is set to "Print Layout".
	<b>Print dialog</b>	Opens a standard Windows printer-dialog, where the printer and its properties can be selected. Only available if "View" is set to "Print Layout".
	<b>Word Export</b>	Saves the report as an Microsoft Office (2007+) .docx-file. A standard Windows save-dialog opens and the file can be named. Only available if "View" is set to "Normal".
	<b>(2) Preview</b>	Shows a preview of how the selected report will look.

## 8.2 Passive House Verification Report

WUFI® Passive creates an Passive House Verification report that sums up all relevant user inputs and shows if the Passive House criteria is fulfilled or not. The report can be accessed by clicking on the "Report: Data, results" tab in the "Case"-entry of the "Project Tree", see figure below:

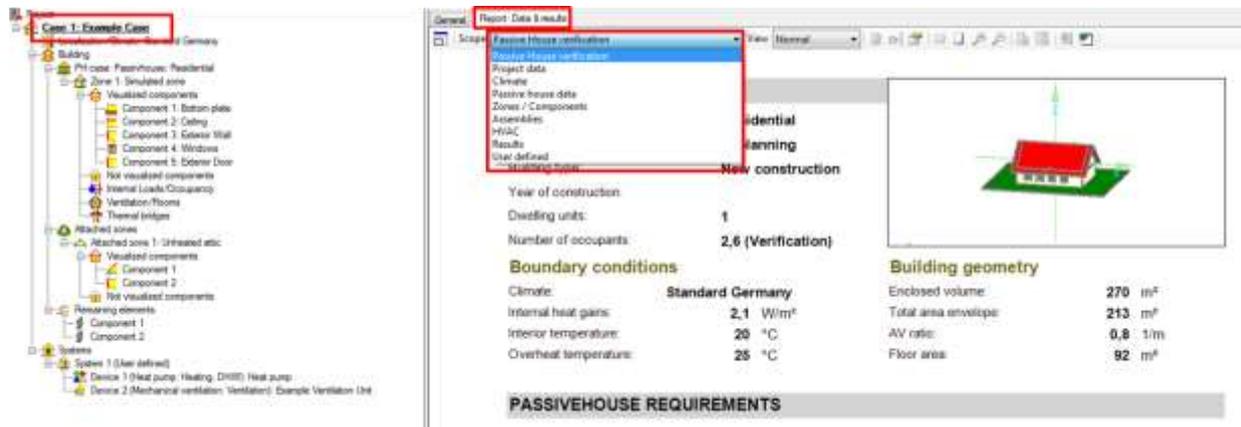


Figure 68:  
Opening the Passive House verification report.

The controls for the Passive House verification report are the same as for other reports, so please refer to chapter 8.1 for further information.



The different sections of the Passive House Verification report are explained in detail on our [WUFI® Wiki](#).

## 9 Hygrothermal building simulation

The major advantage of WUFI® Passive is the possibility to compare the results of the static passive house calculation method with the dynamic hygrothermal building simulation of WUFI® Plus. Please note that the simulation of WUFI® Plus requires additional input data, especially for materials, which require data like heat storage capacity and hygrothermal properties. This data can be taken from the WUFI® database.

Once the certification criteria are met in the Passive House Verification scope, the full hygrothermal building simulation of WUFI® Plus is available for this building model. Switching between the calculation scopes is possible with the respective dropdown menu in the *“Tool Bar”*, as described in chapter 3.3. Please refer to the WUFI® Plus manual for detailed information on working with hygrothermal simulations.

### 9.1 Data-transfer between the Calculation Modes

Most parts of the building can be transferred between the different calculation modes of WUFI® Passive and WUFI® Plus:

- The structure of the *“Project Tree”* is transferred in most parts.
- The whole building geometry including simulated and attached zones, visualized and not-visualized components and remaining elements is transferred.
- HVAC-systems and their devices are transferred. However, most of their settings made in passive house verification mode cannot be transferred.

Limitations:

- A new outdoor climate has to be selected. This is necessary because the passive house verification uses monthly climate data and the dynamic hygrothermal simulations of WUFI® Plus need hourly climate data (or even a higher resolution). These detailed climate files can either be selected from the WUFI® Plus database, which comes with a huge variety of worldwide climate locations, or external climate files can be imported.
- WUFI® Plus can only calculate the 1D-heat and moisture transfer through assemblies. This means, that inhomogeneous assemblies entered in the passive house verification mode cannot be transferred to the WUFI® Plus mode. However, these assemblies are simplified automatically, so they remain compatible: Only the main layers, without subdivisions are transferred.

- Linear thermal bridges cannot be transferred. However, WUFI® Plus supports dynamic calculations of 3D- and 2D-objects, which allows modeling thermal bridges.
- Primary energy is not calculated in WUFI® Plus.
- DHW is not calculated in WUFI® Plus.

## 10 DIN 4108-2 Thermal Protection/ Building Simulation

WUFI® Passive and WUFI® Plus come with a special calculation mode for simulations used in context of the German thermal protection standard DIN 4108-2. These simulations differ from "usual" WUFI® Plus simulations as some user-inputs are pre-allocated with default values and some calculation options cannot be chosen, according to the assumptions made by the standard. After the calculation a report is created which sums up the results. The most important differences are:

- Only thermal simulations.
- Calculation time is predefined and can't be changed.
- For exterior climate data only three German Test-Reference-Years can be chosen. These are representative for climate regions A, B and C defined in the standard.
- In the "Case"-Dialog and the "Zone"-Dialog the building-category must be specified as "Residential" or "Non-residential".
- The "Floor Area" must be entered in the "Zone"-dialog.
- Calculation options in the "Numeric"-Tab of a component are preset and can't be changed.
- "Internal Loads" are predefined and can't be changed.
- "Design Conditions" are predefined and can't be changed.
- Predefined "Ventilation" profiles can be set according to the standard.
- A special "DIN 4108-2 Verification"-Report is created after a simulation. It can be accessed from the "Results"-Tab in the "Case"-Dialog. The report sums up all necessary data according to the standard and evaluates if the simulation results fulfill its criteria. This report includes the results of all simulated zones. The figure below shows an example of this report.

GENERAL INFORMATION	
Software	WUFI Plus
Calculation method	Thermal building simulation according DIN4108-2
Overheating Degree Hours	1813,4 kWh (> 500 demand value)
BUILDING INFORMATION	
General information	
Type	Non-residential
Year of construction	
Building geometry	
Envelope volume	385 m <sup>3</sup>
Total area envelope	334 m <sup>2</sup>
Air ratio	0,07
Traced floor area	108 m <sup>2</sup>
	
BOUNDARY CONDITIONS	
Boundary conditions	
Internal heat gains	13,1 W/m <sup>2</sup>
Internal temperature	21 °C
Overheat temperature	26 °C
Ventilation	
Natural	
During residence time	0,2 1/h (No increased day ventilation)
Other using time	1,5 1/h
Night ventilation	No increased night ventilation
Mechanical	
Night ventilation	No night mechanical ventilation
CLIMATE	
Climate: Climate region B	
Latitude	52,4 °
Longitude	13,1 °
Height above sea	91 m
Timezone	+1 h
Ground reflectance short	0,2
Ground reflectance long	0,1
Ground emission	0,9

Figure 69:  
Report for a calculation according to DIN 4108-2.

## 11 Example Case

This simple example provides a step by step guide on how to input and calculate a case. Below are some details about the example building:

- Residential building
- Location: Germany
- Dimensions: rectangular floor 12.0 m x 9.0 m, story height 2.5 m
- Unheated attic; roof inclination 40°; gable ends
- 4 windows with southern orientation, each 1.2 m x 1.5 m
- 1 door with northern orientation, 1.0 m x 2.0 m
- Internal loads from kitchen and bathroom devices
- No basement, slab on grade
- Heat-pump used for heating and DHW
- Mechanical ventilation. Ventilated rooms: Kitchen (air supply & exhaust), bathroom (exhaust), Shower (exhaust), WC (exhaust)

The figure below shows a visualization of the building.

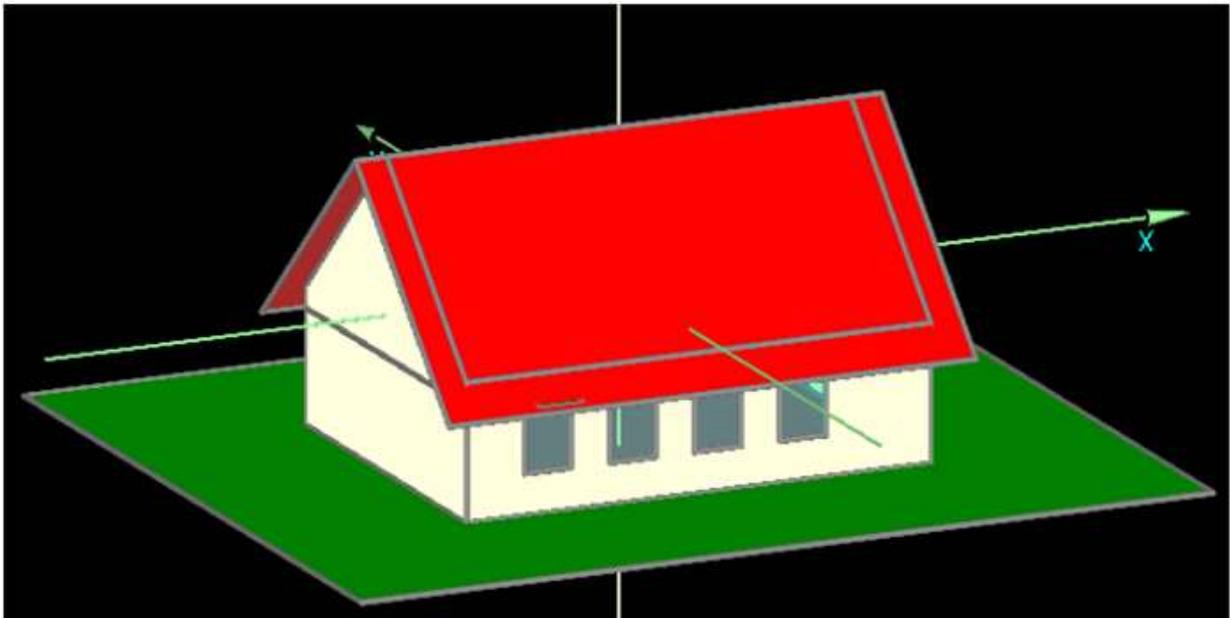


Figure 70:  
Example Case: View of the Example Building.



Tutorial videos on our WUFI®-Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) show how this example was created.

WUFI® Passive comes with a project file of this example. It can be found the "Projects" folder of the main installation directory of WUFI® Passive.

## 11.1 Step 01: Creating a new project

Create a new project by clicking the “New” button in the “Tool Bar”. Click on “Case 1” and name your project, like in the figure below. Then, select the certificate criteria “Default Standard”. WUFI® Passive supports two certification modes for Passive Houses, as explained in chapter 4.2.1.

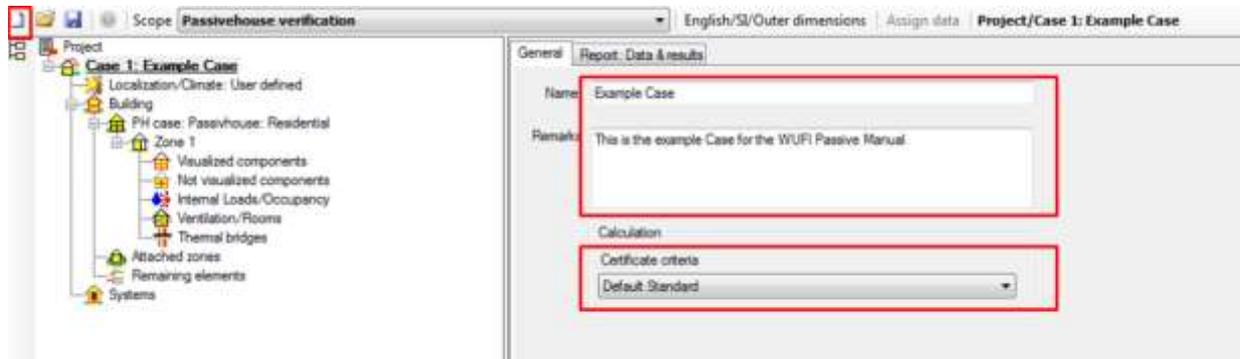


Figure 71:  
Example Case: Create a new project.

## 11.2 Step 02: Defining climatic conditions

In this example, we use the standard-climate that is predefined in WUFI® Passive as it describes a reference climate for Germany. So, in the "Localization/Climate"-dialog, select "Standard":

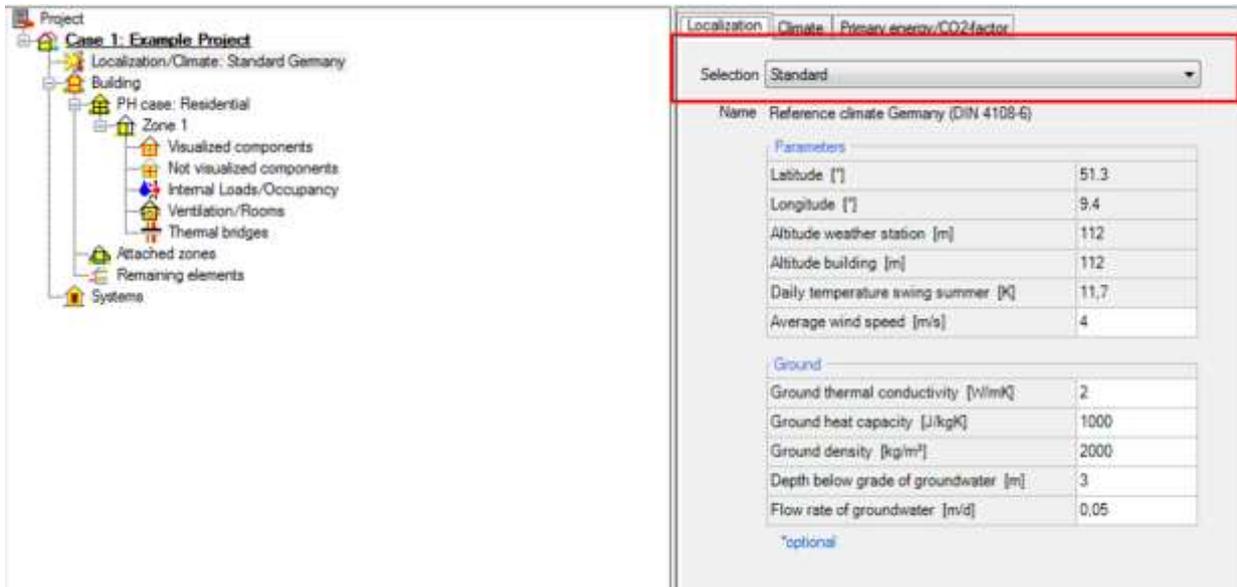


Figure 72:  
Example Case: Define climatic conditions

In the "Climate"-Tab, all climatic values can be observed:



Figure 73:  
Example Case: Climate-Tab.

As the building is located in Germany, we have to use the German Primary Energy Factors. They can be selected in the "Primary energy/ CO<sub>2</sub>-factor"-Tab:

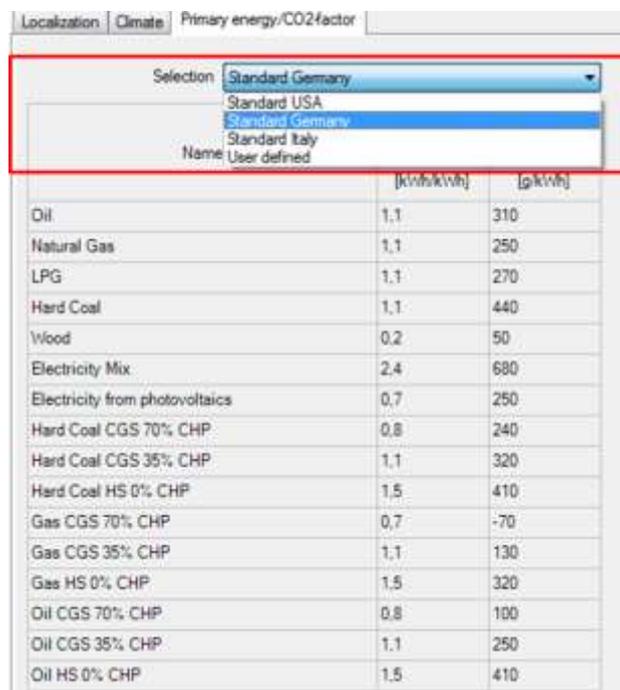


Figure 74:  
Example Case: Set Primary Energy & CO<sub>2</sub>-Factors.

### 11.3 Step 03: Creating the building geometry

In this example case we use the “*Building Wizard*” to create the geometry of our building. This helpful tool can be opened from the “*Building*” entry in the “*Project Tree*”. The “*Building Wizard*” is one way to create a building geometry in WUFI® Passive. Please refer to chapter 4.4.1 to learn about the other options.

Some of the presets in the “*Building Wizard*” suit the dimensions of our building, so only the highlighted inputs in the figure below must be changed:

- Dimensions: rectangular floor 12.0 m x 9.0 m, story height 2.5 m
- Unheated attic; roof inclination 40°; gable ends
- No cellar, slab on grade
- Main facade orientation: South

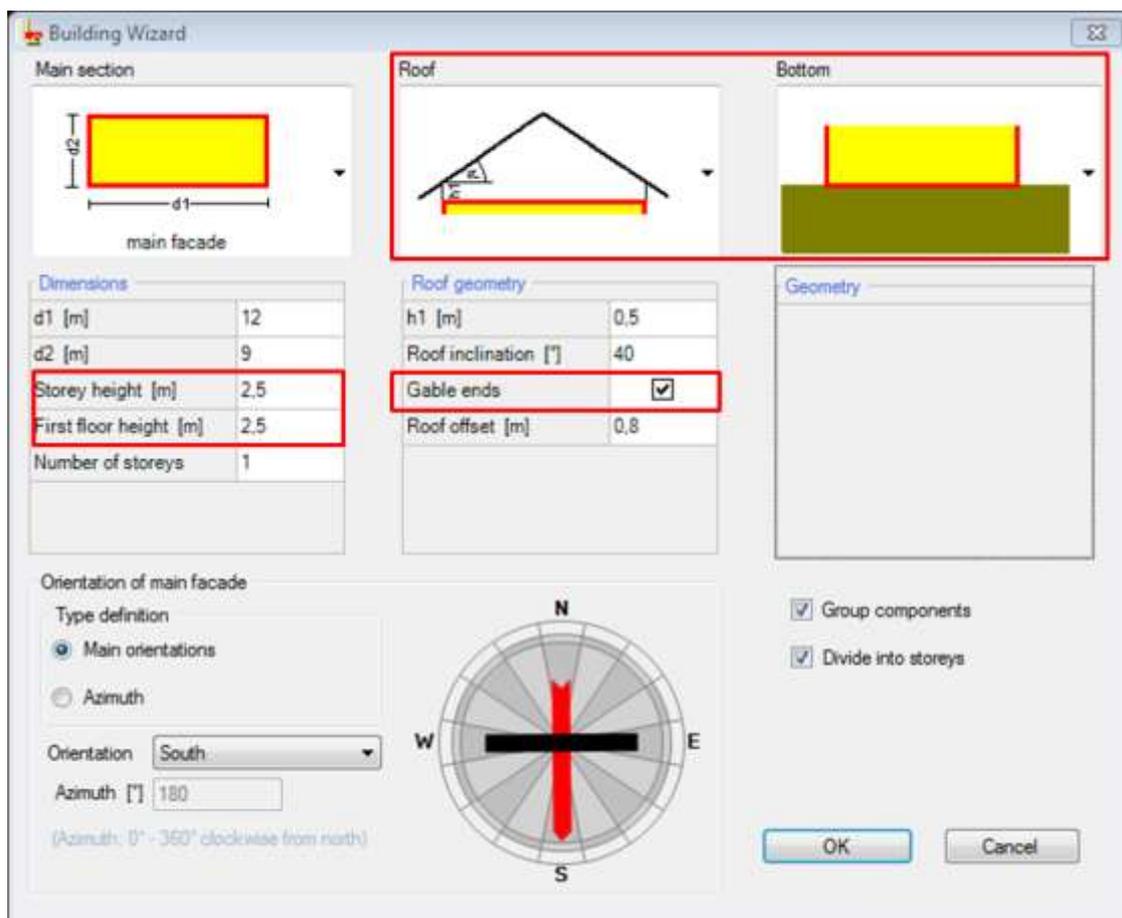


Figure 75:  
Example Case: Creating building geometry with the “*Building Wizard*”.

After all necessary information is entered confirm with the “OK” button. The building is now automatically created. All relevant zones and components appear in the “Project Tree” and an interactive 3D visualization is shown in the “Visualization Box” in the lower left corner of WUFI® Passive. Working with the “Visualization Box” is explained in detail in chapter 3.4.

## 11.4 Step 04: Adding windows and an external door

In our example building four windows are in the southern wall and one exterior door is in the northern wall.

### 11.4.1 Windows

In this step, four windows are added into the southern wall of the example building. First, find the southern wall by clicking the "Orientation" button (1). To create the windows, select the respective wall in the "Visualization Box", check its normal vector as described in chapter 3.4.2 and then click the "Windows/ Openings" button (2):

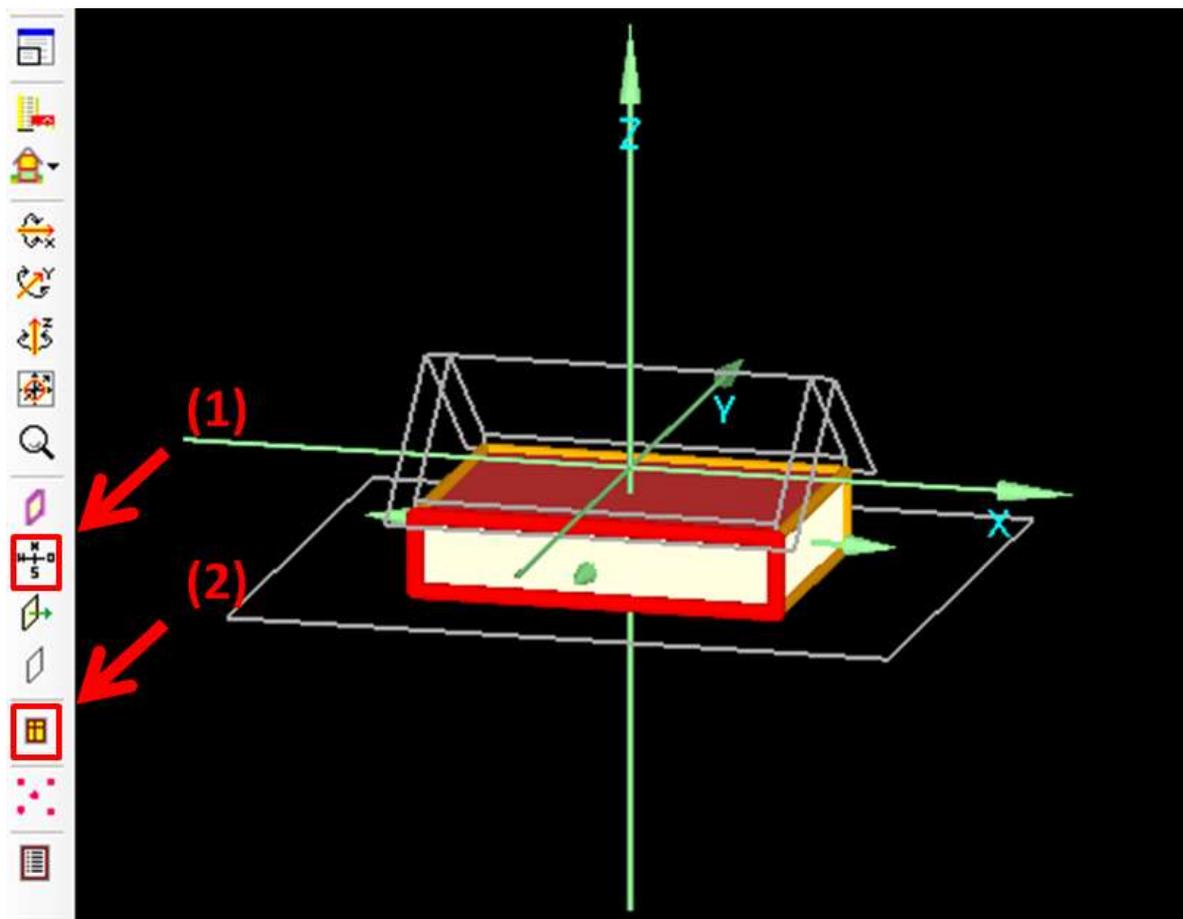


Figure 76:  
Example Case Step 04: Opening the "Windows/ Openings"-dialog from the "Visualization Box".

The "Component openings" dialog opens. First, check the direction of the view of the component (1), from inside or outside, to ensure that the entered window appears in the desired place. The view direction can be switched with the "Change View"-button (3). In this example, we use the view from outside. Next, click the "New"-button (2) to add the type (4), position (5) and size (6) of

the window in this wall. Confirm your input with the "OK"-button and the new window is inserted in the wall.

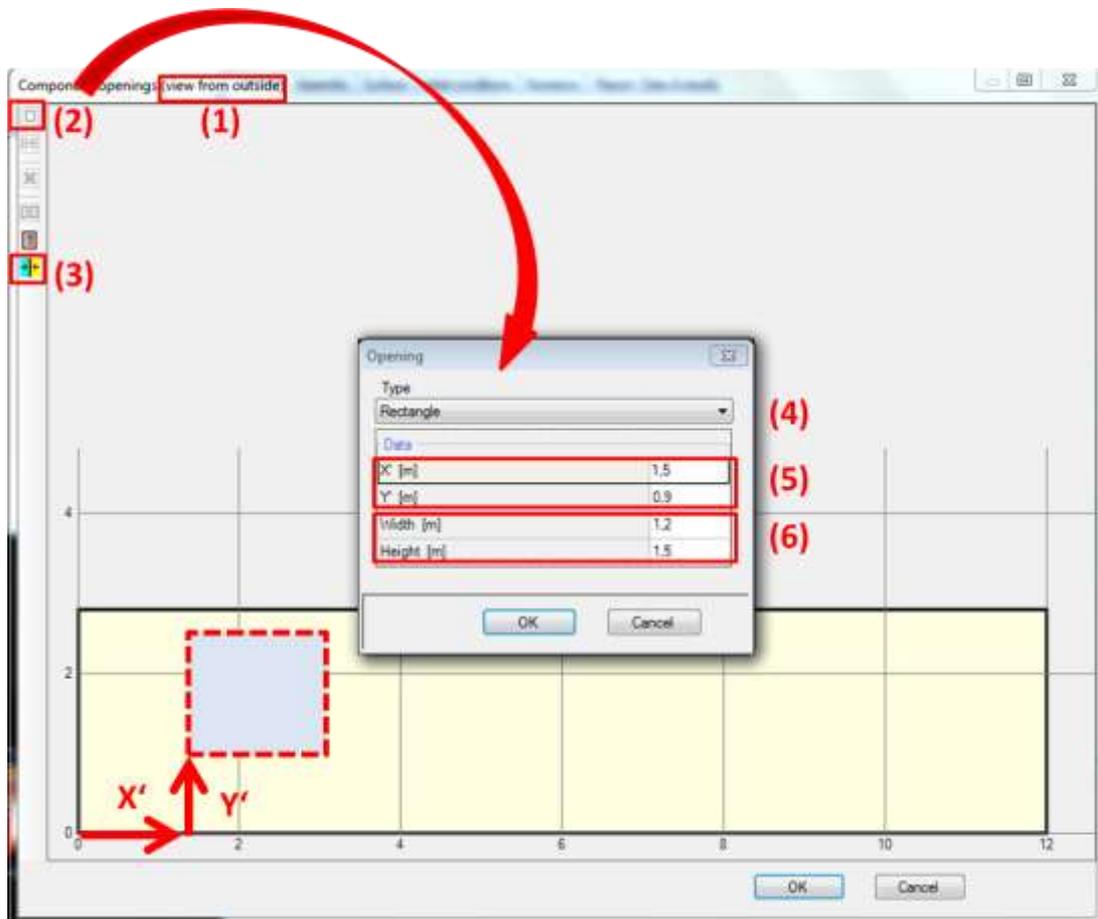


Figure 77:  
Example Case Step 04: Adding a window.

Now, the three remaining windows must be added. Instead of entering the exact positions of each window, we use the "New/ Copy Move" function to copy the existing window three times: Select the created window (1) and click the "New/ Copy Move" button (2). Enter the distance between the windows (3), select the number of inserted windows (4) and confirm your input with the "OK" button.

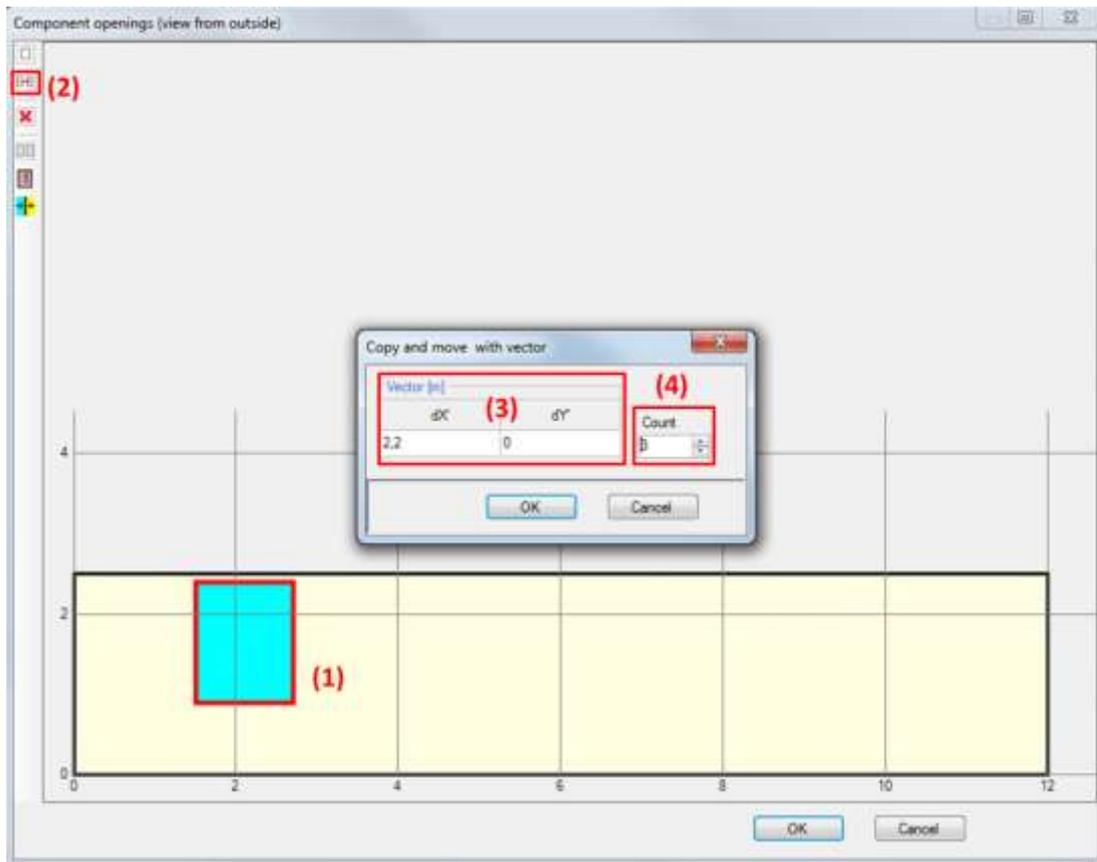


Figure 78:  
Example Case Step 04: Copying the existing window.

Now, all windows in the southern wall are created. Close the "Component openings" dialog with "OK" and the windows appear both in the "Visualization Box" and the "Project Tree".

#### 11.4.2 Exterior door

Exterior doors are added in the same way as windows. Rotate the view of the visualization box to the northern wall, check the normal vector and orientation and insert an opening with the measurements shown in the figure below:

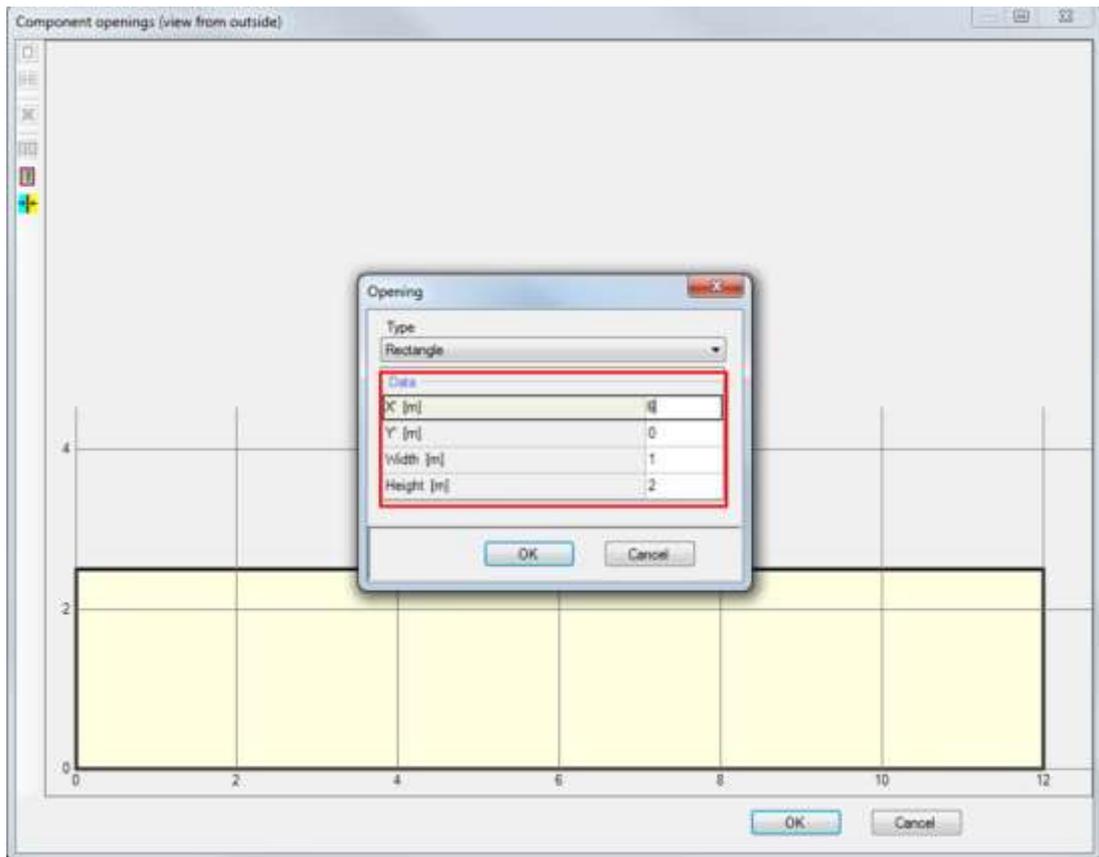


Figure 79:  
Example Case Step 04: Inserting the exterior door.

Doing this, our door was added just like the windows before: As a transparent component. When the exterior door should be an opaque component instead, this must be specified in the "Properties" of the component. Right click on the exterior door in the "Visualization Box", open the "Properties" and switch its type from "transparent" to "opaque".

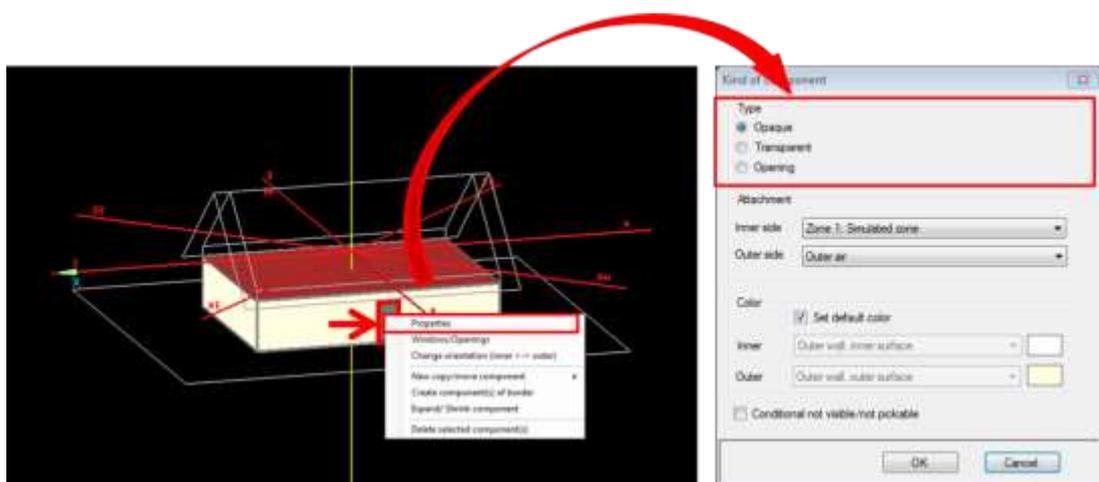


Figure 80:  
Example Case Step 04: Defining the exterior door as an opaque component.

## 11.5 Step 05: General Passive House settings

General settings must be defined for the Passive house verification of the building. Click on the "PH case" entry in the "Project Tree":

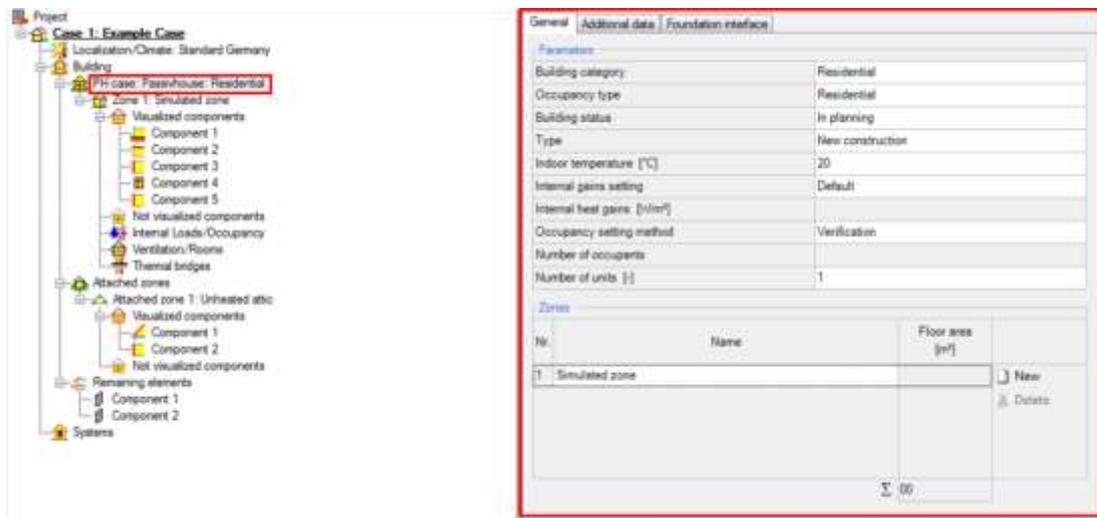


Figure 81:  
Example Case Step 05: General Passive House settings.

Our example building is a residential building, and the default values fit our needs. So, no further user input is necessary here.

Now, the building's natural ventilation needs to be defined. Switch to the "Additional data"-tab. In our simple example we stick to the preset values whenever possible. However, the ACH 50 value and the net air volume for the pressurization test must always be entered (Usually, the net air volume will be a detailed calculation. In our example we use an approximation).

Infiltration (ACH 50) [1/h]	0.40
Net air volume for pressurization test [m <sup>3</sup> ]	230.00

The screenshot shows a software interface with three tabs: 'General', 'Additional data' (selected and highlighted with a red box), and 'Foundation interface'. Under the 'Additional data' tab, there is a section titled 'Additional parameters' containing a table of settings. The 'Required data' section is highlighted with a red box and contains the following entries:

Preferred minimum indoor temperature for night ventilation [°C]	20
Overheating temperature threshold [°C]	25
Fresh air per person [m <sup>3</sup> /h]	30.5603
Tap openings per person and day [-]	3
Tap openings utilization days per year [days/a]	365
Input infiltration	ACH 50
Infiltration (ACH 50) [1/h]	0.4
Net air volume for press. test [m <sup>3</sup> ]	230

Below the 'Required data' section, other parameters are listed:

Type of ventilation system	Balanced PH ventilation
Max. humidity ratio (if dehumidification) [g/kg]	12
Building wind exposure	Several sides exposed - moderate screening
Wind screening coefficient (e) [-]	0.07
Wind exposure factor (f) [-]	15
Wind shield factor [-]	0.05

The 'Optional data (if not defined default value will be calculated)' section includes:

DHW consumption (60°C) per person per day [Ltr/Person/day]	
Average cold water temperature of the supply [°C]	
Mechanical room temperature [°C]	20

Figure 82:  
Example Case Step 05: Natural ventilation settings.

The last tab in the PH Case branch is for the foundation interface. Switch to the respective tab. We only have one type of foundation interface in our building, so there is no need to insert more in the list on the top of the menu (1). Now, define the type of foundation interface as: "Slab on grade" (2). The floor slab area should be calculated "from visualized geometry" (3). The U-value shall be 0.21 W/m<sup>2</sup>K (4) and the floor slab perimeter is 42.0 m (2 \* 12.0 m + 2 \* 9.0 m). The additional parameters describe the perimeter insulation, and should remain at their default values (5).

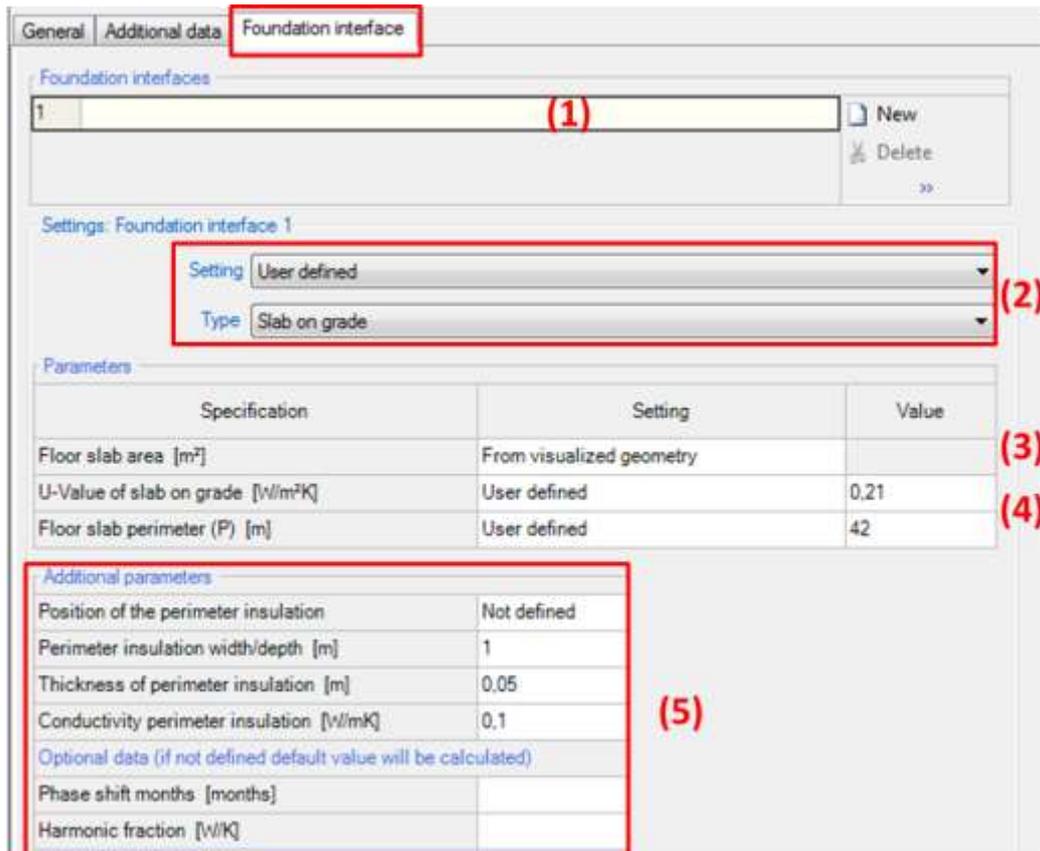


Figure 83:  
Example Case Step 05: Foundation interface.

## 11.6 Step 06: Zonal settings

Select "Zone 1: Simulated zone" in the "Project Tree". The gross volume (12.0 m \* 9.0 m \* 2.5 m = 270 m<sup>3</sup>) and the interior conditioned floor area (estimated: 92.0 m<sup>2</sup>) must be entered here (1). Also, switch the settings for the specific heat capacity to "Massive" (2).

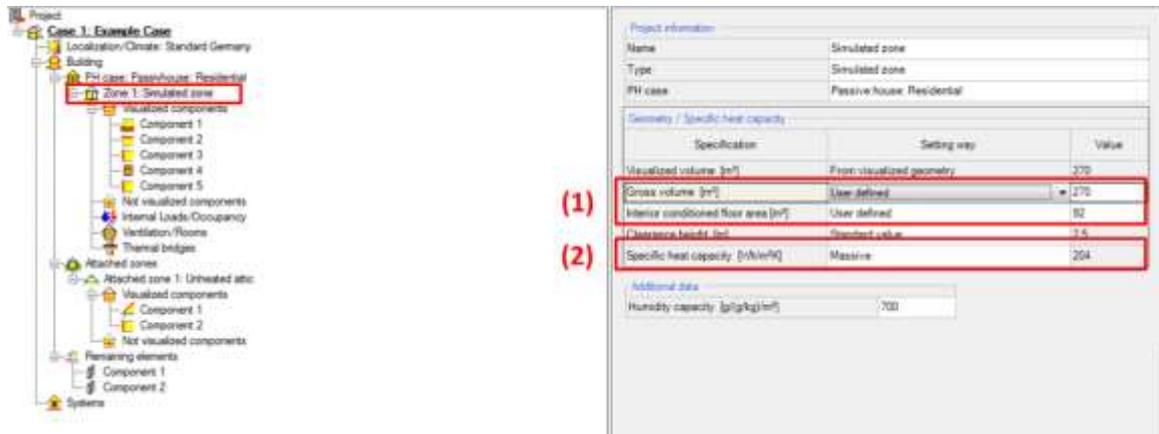


Figure 84:  
Example Case Step 06: Zonal settings.



A tutorial video on our [WUFI® Wiki](#) shows how the interior conditioned floor area is calculated correctly.

## 11.7 Step 07: Defining the visualized components

The example building consists of five visualized components that enclose the calculated zone: Floor slab, ceiling, exterior walls, windows and an exterior door. Here, we define the assemblies and additional parameters of these three components.

### 11.7.1 Floor Slab

We will start with the floor slab. Select the component in the "Project Tree" (1) and its general information is shown. Enter a descriptive name (2) and check if the type and the climates assigned to the inner and outer sides (3) are correct. The name of the component also appears in the "Project Tree" to facilitate navigation in the project.

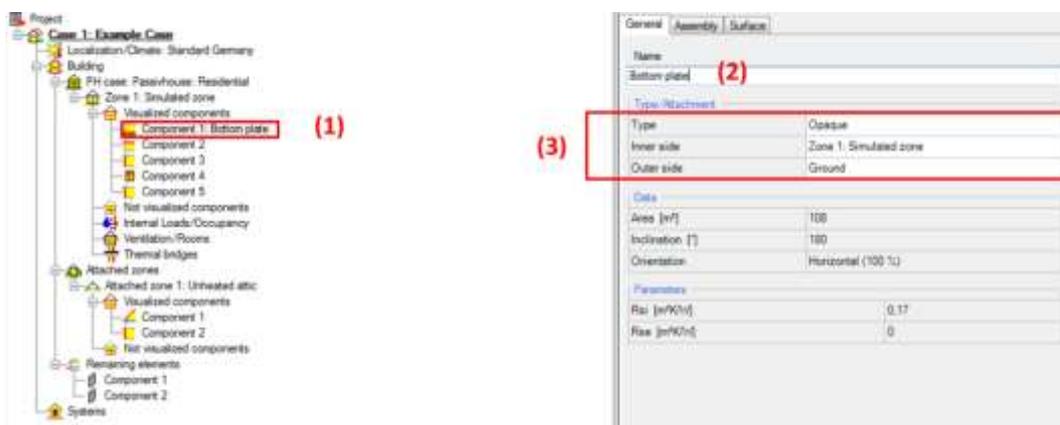


Figure 85:  
Example Case Step 07: General settings for the floor slab.

Next, the assembly of the component needs to be defined, so switch to the "Assembly" tab. There, click the "Edit" button and the "Edit assembly" window opens.

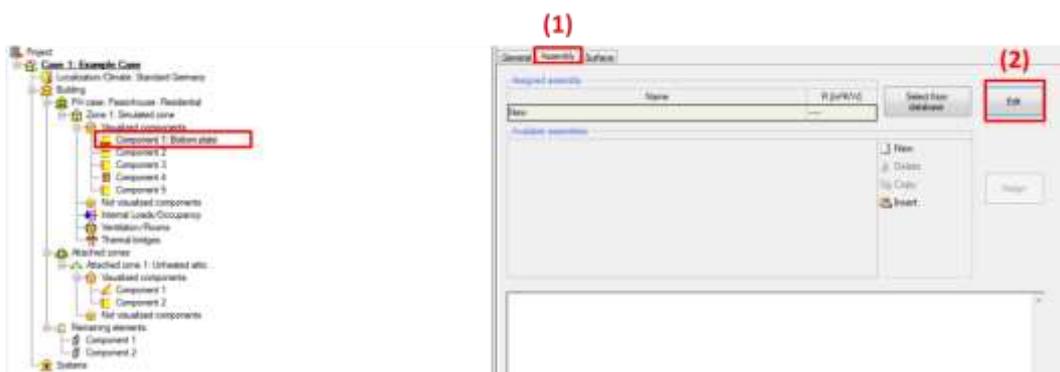


Figure 86:  
Example Case Step 07: Open the "Edit assembly" window.

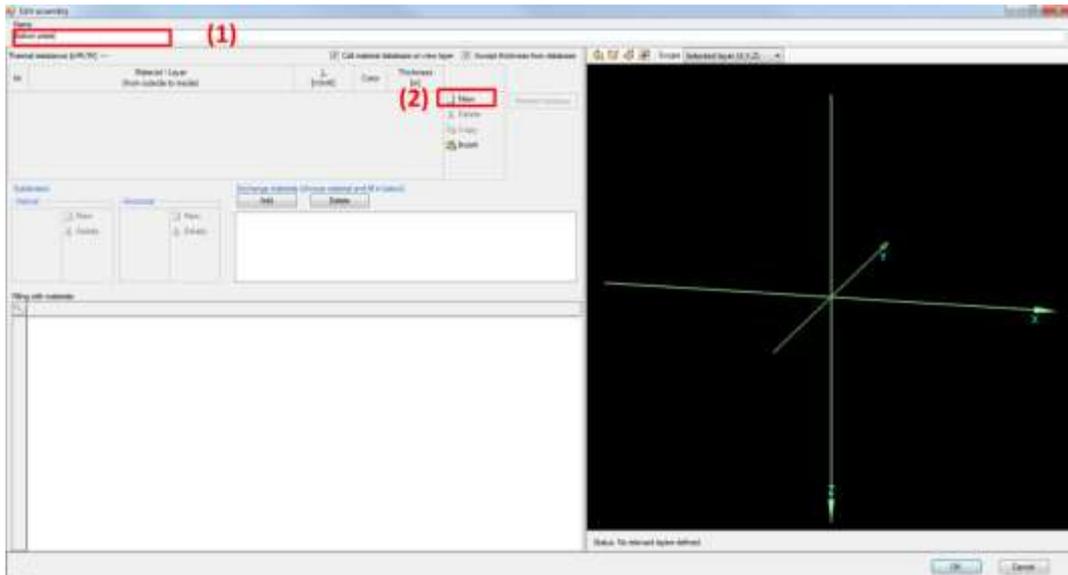


Figure 87:  
Example Case Step 07: Editing the assembly of the bottom plate.

At first, name the assembly, in this case "*Bottom Plate*" (1). Each assembly is built from different material layers. The construction of the exemplary bottom plate is summarized in this table, starting from outside to inside:

Nr.	Material (as named in WUFI® Database)	Thickness [m]
1	XPS Surface Skin (heat cond.: 0,03 W/mK)	0,010
2	XPS Core (heat cond.: 0,03 W/mK)	0,220
3	XPS Surface Skin (heat cond.: 0,03 W/mK)	0,010
4	PE-Membrane 0,2 mm (sd = 87 m)	0,001
5	Concrete, w/c=0,5	0,200

Click the "*New*"-button (2) to add a new material layer. The "*Material Database*" will open. Search for "*XPS Surface Skin*" and add this material to the assembly by clicking the "*Apply*"-button:

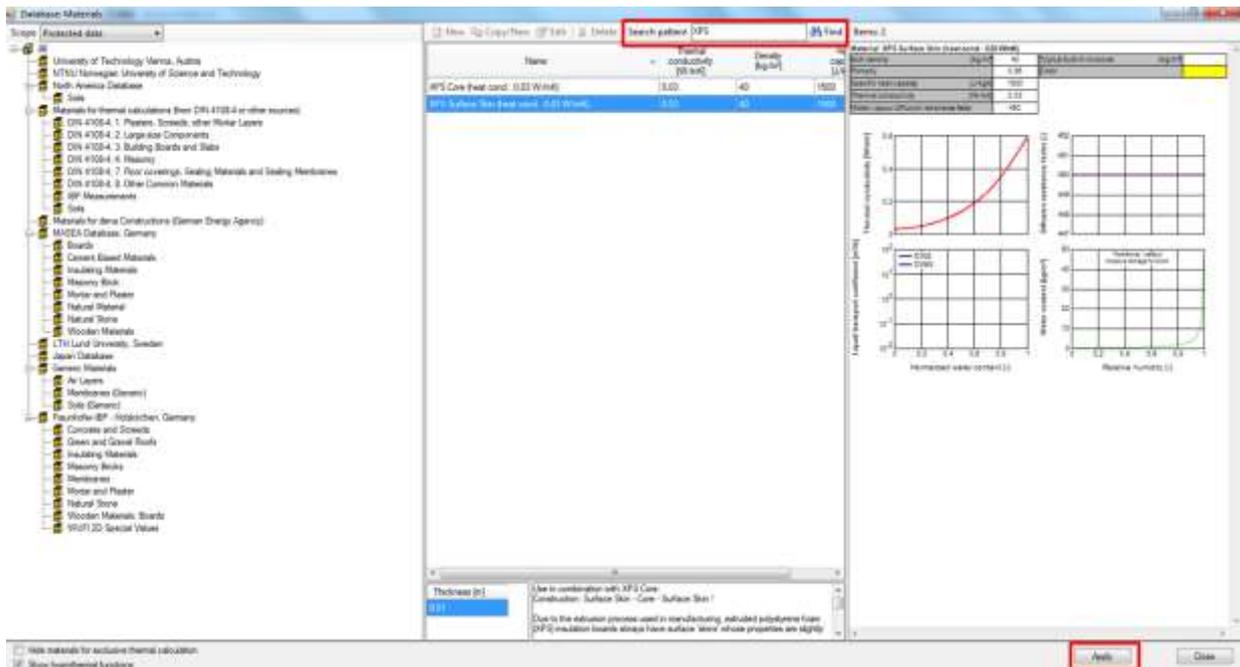


Figure 88:  
Example Case Step 07: Select a material from the WUFI® database.

The material now appears in the "Edit assembly"-window. Check, if the thickness is entered correct and make adjustments when necessary. Add all other material layers in the same way. When finished, the assembly should look like this:

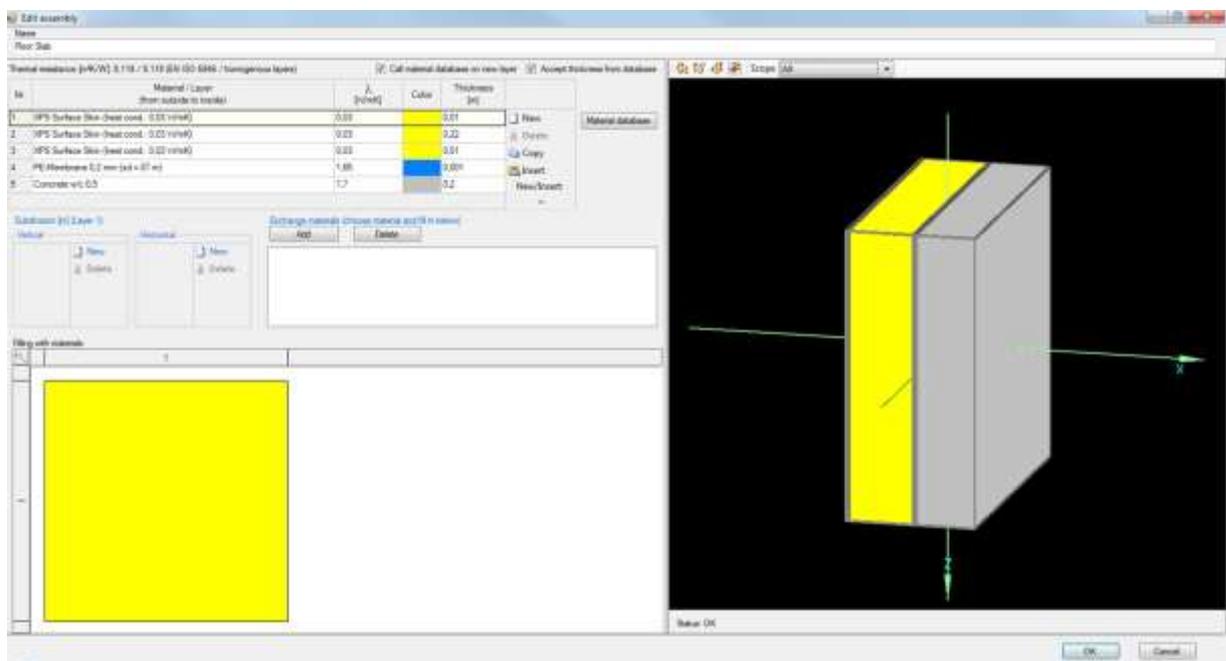


Figure 89:  
Example Case Step 07: Assembly for the bottom plate.

Click the "OK"-button and the assembly is assigned to the component.

The heat transfer resistance on the surfaces can be adjusted in the "Surface" tab. Check, if the automatically detected values are correct:

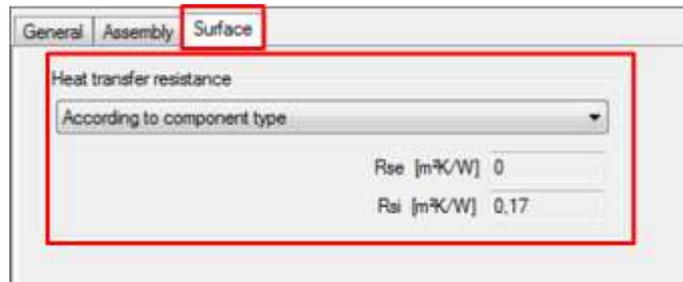


Figure 90:  
Example Case Step 07: Heat transfer resistance for the floor slab.

## 11.7.2 Ceiling

Now enter the assembly for the ceiling. Select the corresponding component in the "Project Tree" and proceed like before: Name the component, check the general settings and create a custom assembly with the "Edit assembly" window. The construction for the ceiling can be found in the table below:

Nr.	Material (as named in WUFI® Database)	Thickness [m]
1	Mineral Wool (heat cond.: 0,04 W/mK)	0,300
2	Concrete, w/c=0,5	0,200

In the end, the assembly should look like this:

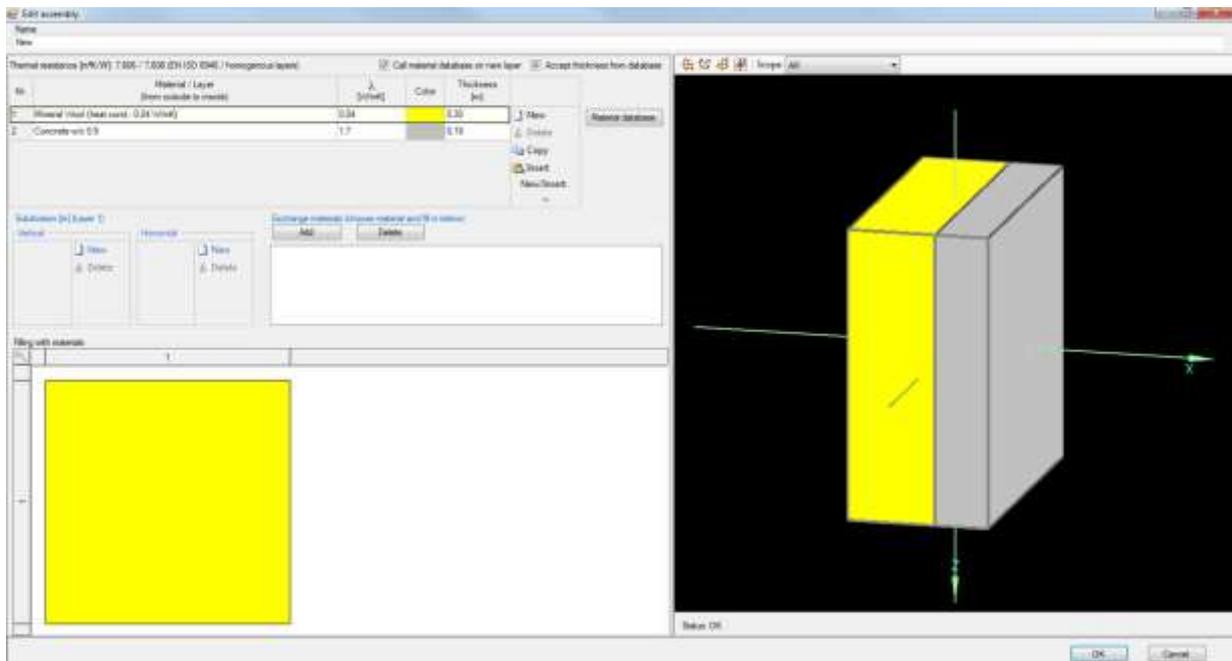


Figure 91:  
Example Case Step 07: Assembly for the ceiling.

### 11.7.3 Exterior Walls

The assembly for the exterior walls are more complex as these have two inhomogeneous layers (Nr. 3 & 5):

Nr.	Material (as named in WUFI® Database)	Thickness [m]
1	Cement lime plaster	0.020
2	Wood-Fibre Board	0,060
3a	Mineral Wool (heat cond.: 0,04 W/mK)	0,240
3b	Spruce, longitudinal	0,240
4	Oriented Strand Board (density 615 kg/m <sup>3</sup> )	0,018
5a	Mineral Wool (heat cond.: 0,04 W/mK)	0,080
5b	Spruce, longitudinal	0,080
6	Gypsumboard, interior	0,030

First, name the component and check its general settings. Afterwards, open the "*Edit assembly*" window to create the assembly. Entering inhomogeneous assemblies is more complex than entering homogeneous assemblies. At least 5 steps are necessary:

1. Define all main layers of the assembly.
2. Identify the layers with exchange materials.
3. Load the exchange materials from the WUFI® database
4. To create different sections in a layer, WUFI® Passive uses subdivisions. Enter the subdivisions (horizontal and/or vertical) for a layer with an exchange material
5. Assign the exchange materials to the corresponding subdivisions by clicking in the "*2D View*" window.
6. Repeat steps 4 and 5 for all layers with exchange materials.

Now, we apply these steps to our exterior wall.

First, define all main layers (Nr. 1, 2, 3a, 4, 5a & 6) the same way as with the floor slab and the ceiling:

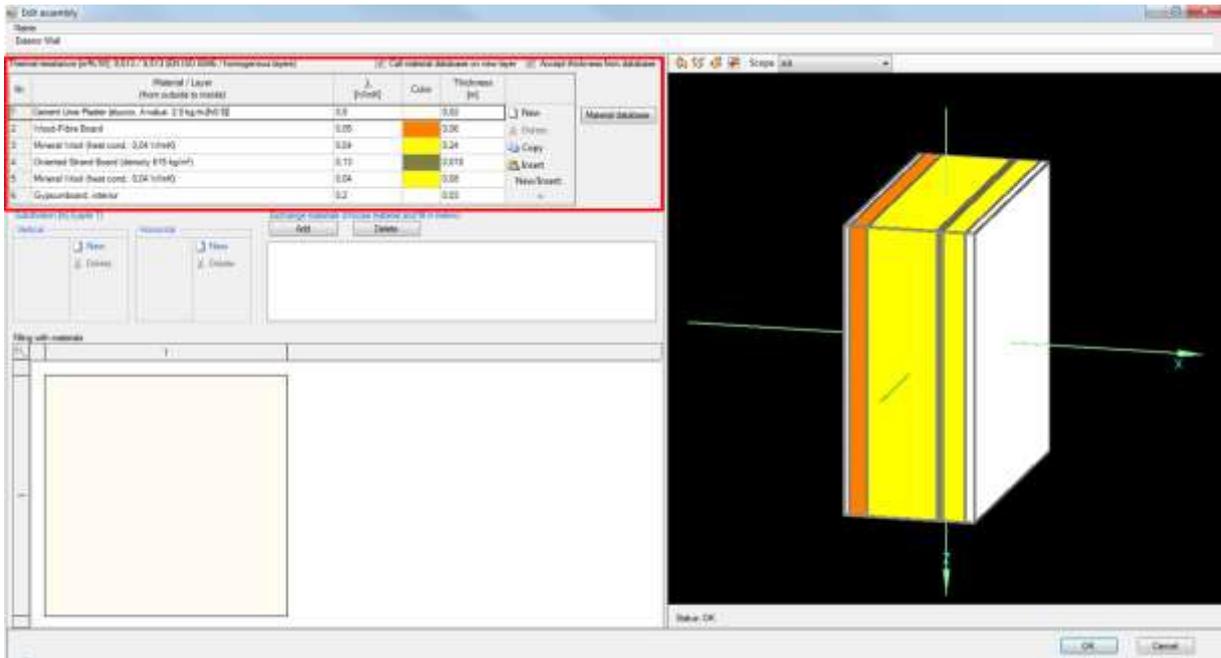


Figure 92:  
Example Case Step 07: Main layers of the inhomogeneous exterior wall component.

Second, identify the inhomogeneous layers: In this case, these are the two mineral wool layers (Nr. 3 & 5).

Third, load the exchange materials: For both layers the material "Spruce, longitudinal" is used as an exchange material. Add this material to the respective list with the "Add" button, which opens the WUFI® Material Database.

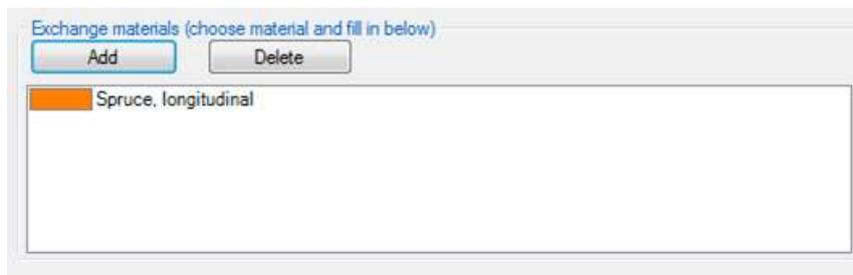


Figure 93:  
Example Case Step 07: Add the exchange material for the wood framing.

Fourth, divide the first mineral wool layer into two parts: A vertical wooden beam (10 cm) and mineral wool insulation between the beams (55 cm). To create different sections in a layer, WUFI® Passive uses "subdivisions". In this example, two horizontal subdivisions are necessary: One with 10 cm and one with 55 cm. Select layer Nr. 3 (1) and enter the measurements in the subdivisions-list (2). The "2D View" (3) visualizes the current layer and shows the subdivisions.

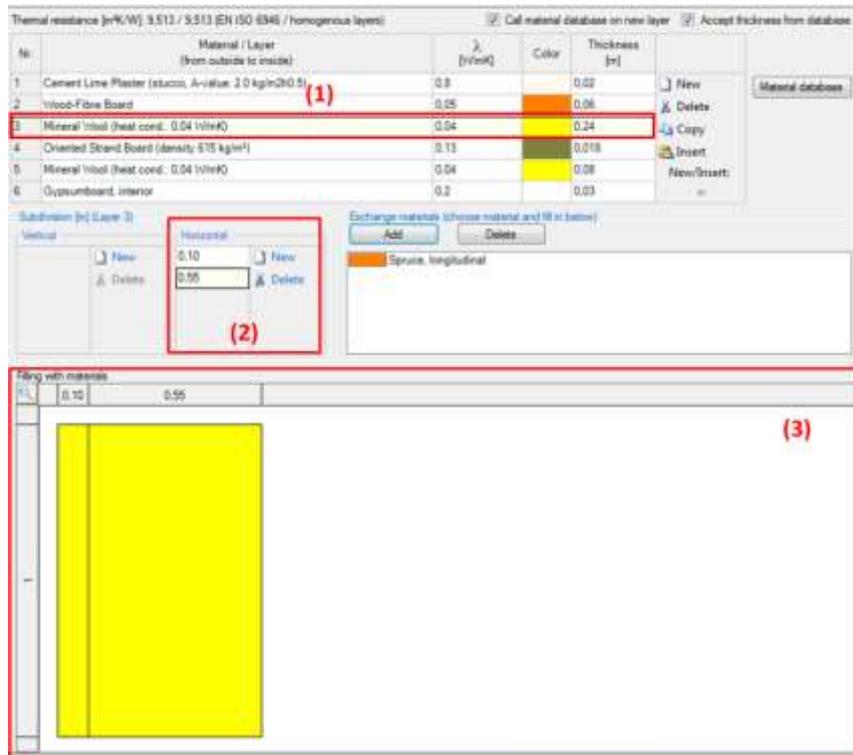


Figure 94:  
Example Case Step 07: Enter the dimensions of the subdivision.

In the fifth step, we need to assign the new subdivision as the wood framing: Click on the exchange material "Spruce, longitudinal" (1) and afterwards click on the desired subdivision in the "2D View" (2). The materials are then exchanged. The "3D Visualization" on the right side (3) helps to check if the subdivisions were entered correctly.

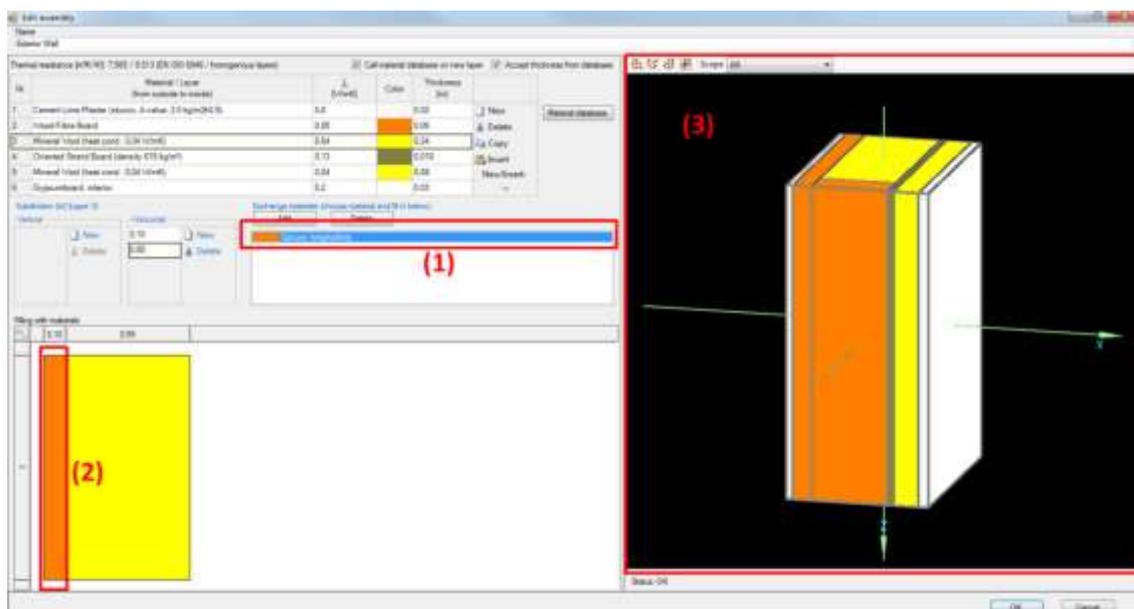


Figure 95:  
Example Case Step 07: Insert the exchange material.

Now proceed like this to enter the subdivisions for layer Nr. 5: Mineral wool panels (36 cm) between horizontal framing (4 cm):

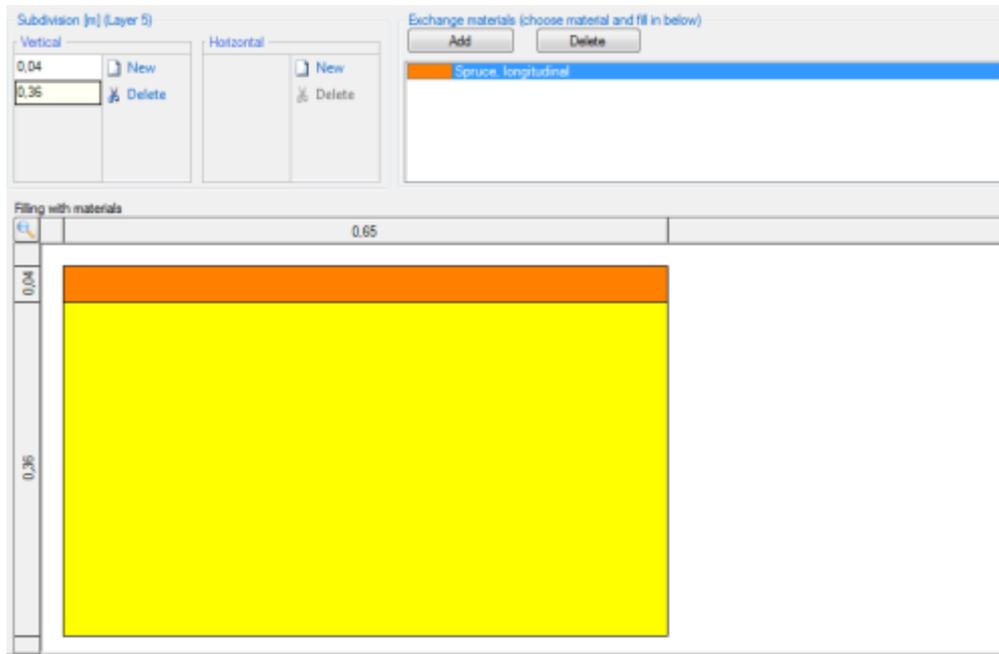


Figure 96:  
Example Case Step 07: Subdivisions for layer Nr. 5.

When complete, the assembly for the exterior walls should look like this:

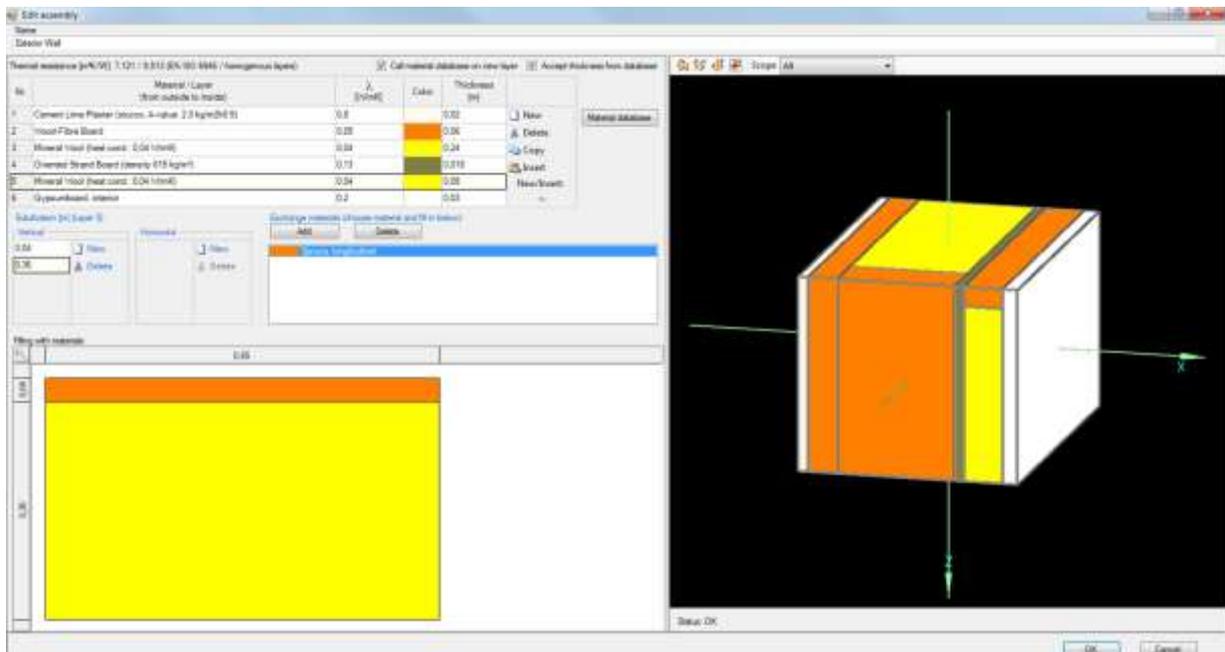


Figure 97:  
Example Case Step 07: Inhomogeneous assembly for exterior walls.



A tutorial video on our [WUFI® Wiki](#) shows how the inhomogeneous assemblies can be entered in WUFI® Passive.

The last settings for the exterior walls are for the surface. Switch to the corresponding tab. Check if the default setting for the heat transfer resistance was entered correctly. Then, change the absorption/ emission coefficients to the preset values of “Stucco, normal bright”:

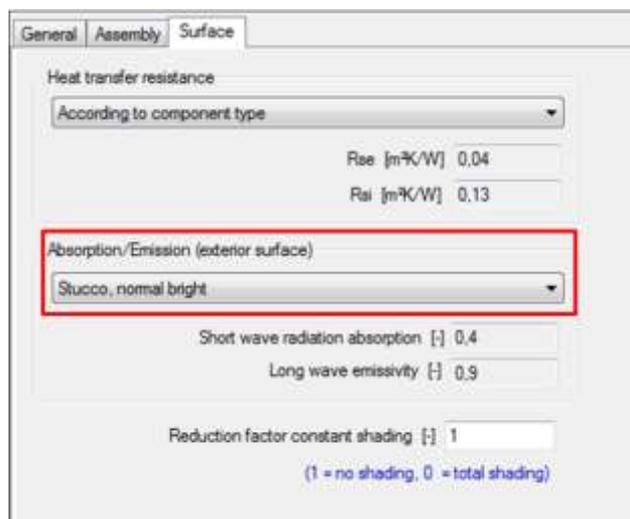


Figure 98:  
Example Case Step 07: Adjust the surface settings for the exterior walls.

## 11.7.4 Windows

Proceed like before: Name the component and check its general settings. Afterwards switch to the “Window parameters” tab. In this example, we load the window parameters from the WUFI® Database which can be opened by clicking on “*Select from database*”, shown below:

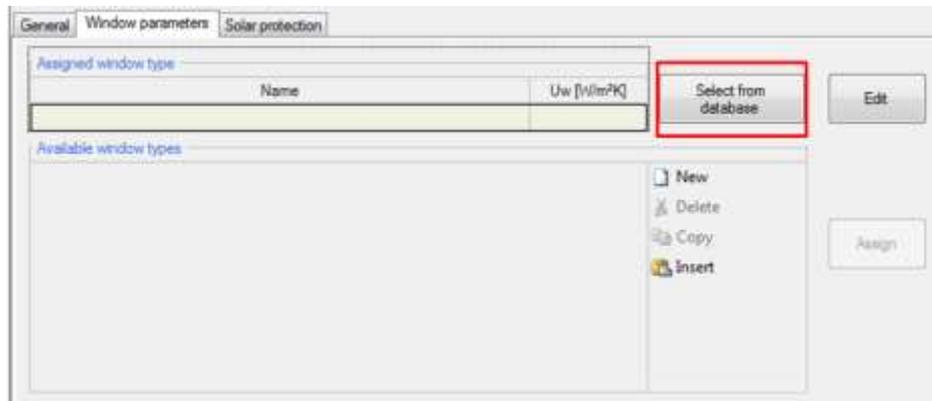


Figure 99:  
Example Case Step 07: Select window parameters from the WUFI® Database.

The “*Search pattern*”-box at the top of the database allows searching for specific windows. Type in “*Example 2*” (1), select the respective database entry (2) and press the “*Apply*” button (3) to select this window.

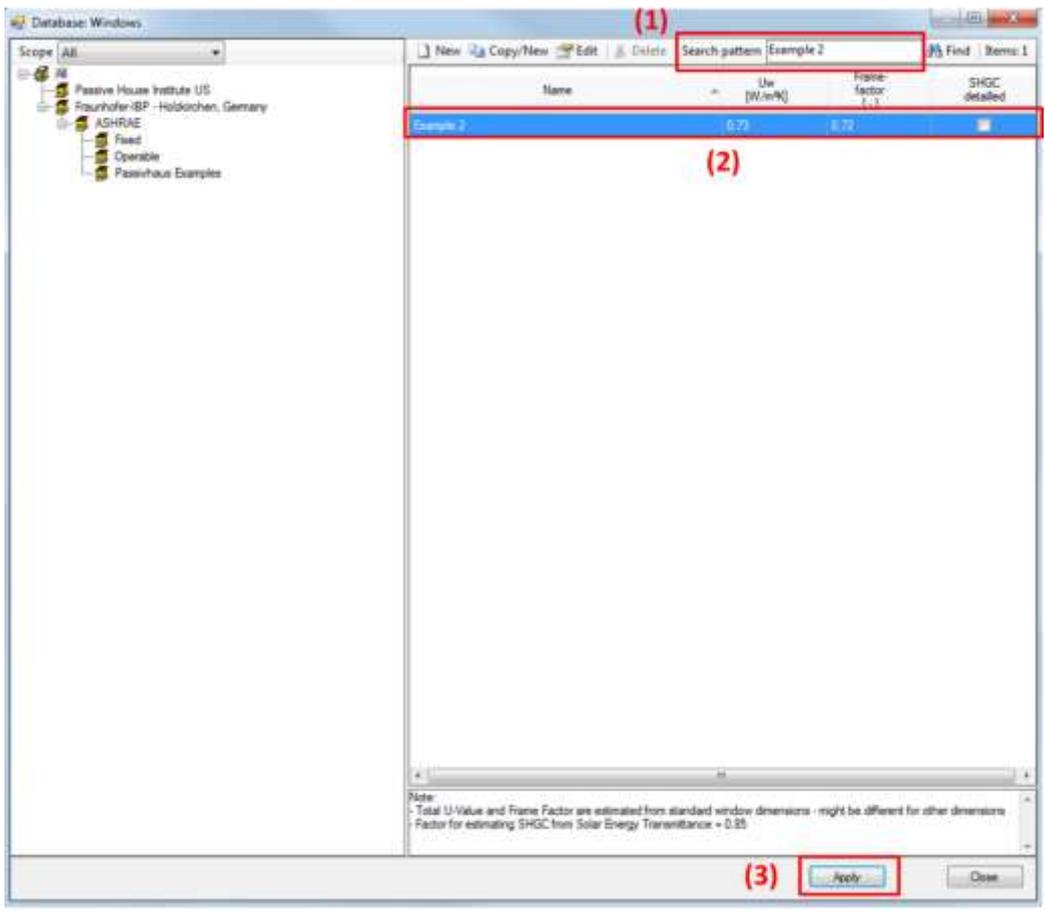
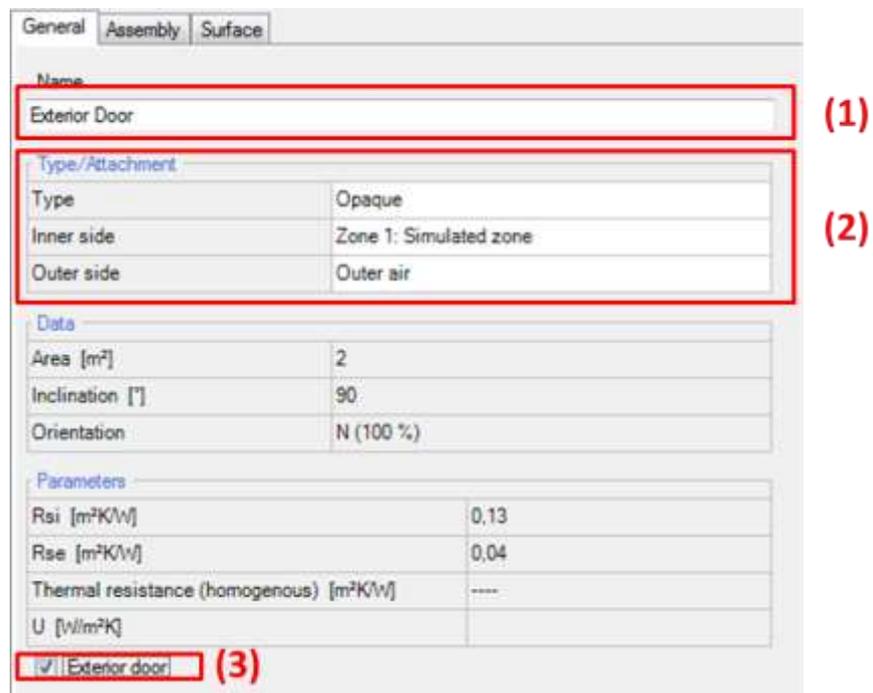


Figure 100:  
 Example Case Step 07: Opening the "Windows/ Openings"-dialog from the "Visualization Box".

In this tutorial, no solar protection is added. The general parameters for solar protection calculation will remain at their default values.

### 11.7.5 Exterior Door

Select the exterior door in the "Project Tree". Name it (1), check the general settings (2) and checkmark the "Exterior door" box (3).



General Assembly Surface

Name  
Exterior Door (1)

Type/Attachment  
Type: Opaque  
Inner side: Zone 1: Simulated zone  
Outer side: Outer air (2)

Data  
Area [m<sup>2</sup>]: 2  
Inclination [°]: 90  
Orientation: N (100%)

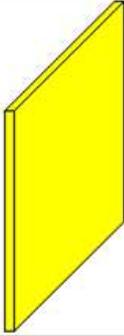
Parameters  
R<sub>si</sub> [m<sup>2</sup>K/W]: 0,13  
R<sub>se</sub> [m<sup>2</sup>K/W]: 0,04  
Thermal resistance (homogenous) [m<sup>2</sup>K/W]: ----  
U [W/m<sup>2</sup>K]:

Exterior door (3)

Figure 101:  
Example Case Step 07: General settings for the exterior door.

Create this assembly:

Homogenous layers  
Thermal resistance: 1 m<sup>2</sup>K/W  
Heat transfer coefficient (U-value): 0,85 W/m<sup>2</sup>K  
Thickness: 0,04 m



Nr.	Material/Layer (from outside to inside)	ρ [kg/m <sup>3</sup> ]	c [J/kgK]	λ [W/mK]	Thickness [m]	Color
1	EPS (heat cond.: 0.04 W/mK - density: 30kg/m <sup>3</sup> )	30	1500	0,04	0,04	

Figure 102:  
Example Case Step 07: Assembly for the exterior door.

Check if the surface settings are entered correctly. All settings should remain at their default values in this example.

## 11.8 Step 08: Setting internal loads and occupancy schedule

The next step is the implementation of inner loads. Click on the "*Internal Loads/Occupancy*" branch in the "*Project Tree*" and add the following devices with the given settings into the list:

Device	Quantity	Energy demand	Additional info
Kitchen dishwasher	1	1.10 kWh/Use	DHW connection
Kitchen fridge/ freeze combo	1	1.20 kWh/d	
Kitchen cooktop	1	0.22 kWh/Use	Cooking with electricity
Laundry – washer	1	1.10 kWh/Use	DHW connection; Utilization factor 1.00
Laundry – dryer	1	1.10 kWh/Use	Condensation dryer; Remaining dampness 0.6

New devices can be added with the "New" button (1). The settings for a device can be entered in the "*Additional data*" section (2). When complete, the internal loads should look like this:

The screenshot shows a software interface for defining internal loads. At the top, there is a field for 'Humidity sources [g/m³h]' with the value '2'. Below this is a 'Device list' table with columns: 'Device/End use', 'Reference quantity', 'Quantity', 'In conditioned space', and 'Additional info'. A 'Set standard dataset' button is located to the right of the table. A red box labeled '(1)' highlights the 'New' button in the right-hand column of the table. Below the table is an 'Additional data' section for the selected 'Kitchen dishwasher' device, with a red box labeled '(2)' around it. This section includes fields for 'Choice' (set to 'DHW connection'), 'Energy demand (norm) [kWh/Use]' (set to '1.1'), and 'Comment'.

Device/End use	Reference quantity	Quantity	In conditioned space	Additional info
Kitchen dishwasher	PH case occupants	2.6	<input checked="" type="checkbox"/>	DHW connection
Kitchen fridge/freeze combo	PH case Units	1	<input checked="" type="checkbox"/>	
Kitchen cooktop	PH case occupants	2.6	<input checked="" type="checkbox"/>	Cooking with electricity
Laundry - washer	PH case occupants	2.6	<input checked="" type="checkbox"/>	DHW connection; Utilization factor 1
Laundry - dryer	PH case occupants	2.6	<input checked="" type="checkbox"/>	Condensation dryer; Remaining dampness 0.6

Additional data: Kitchen dishwasher

Choice	DHW connection
Energy demand (norm) [kWh/Use]	1.1
Comment	

Figure 103:  
Example Case Step 08: Defining internal loads.

## 11.9 Step 09: Ventilation settings

Select the "Ventilation/ Rooms" branch in the "Project Tree". The "Utilization Pattern" tab shows up first. In this tab, different utilization patterns are defined. They will be assigned to the rooms of the building later. To simplify this example, only one utilization pattern is defined and then used for every room.

Click on the "New" button (1) to create a new utilization pattern. In this example, we define the operation days and weeks so that it covers the whole year (2). Finally, enter the daily operation schedule (3) as shown in the figure below:

Utilization pattern Rooms ventilation Summer ventilation Exhaust ventilation

Name	Operating days per week [d/week]	Operating weeks per year [week/a]	(1)
Example	7	52	New

(2)

Intermediate results

Supply air due to persons [m³/h]	0
Total extract air demand [m³/h]	0
Volumetric requirement [m³/h]	89,7
Design air flow rate [m³/h]	
Average air flow rate [m³/h]	0
Average air change rate [1/h]	0

Additional data. Example

Specification	Daily operation schedule [h]	Fraction of design air flow [-]	(3)
Maximum	0	1	
Standard	3	0.8	
Basic	21	0.5	
Minimum	0	0.5	

Figure 104:  
Example Case Step 09: Ventilation settings – Utilization pattern.

In the next step, the ventilation rates for each room will be defined. Switch to the "Rooms ventilation" tab. In this example, we add a kitchen, bathroom and living room. Add those rooms with the "New" button in the Rooms list (1). Now, assign the previously defined utilization pattern to each room (2). In addition, you can define the geometry of each room in the "Additional data" section (3). It is used to calculate the average air change rate for each room, which is only an informative value. The room geometries are summarized in the table below. Enter the supply and exhaust air volume flow rates as shown in the figure below (4):

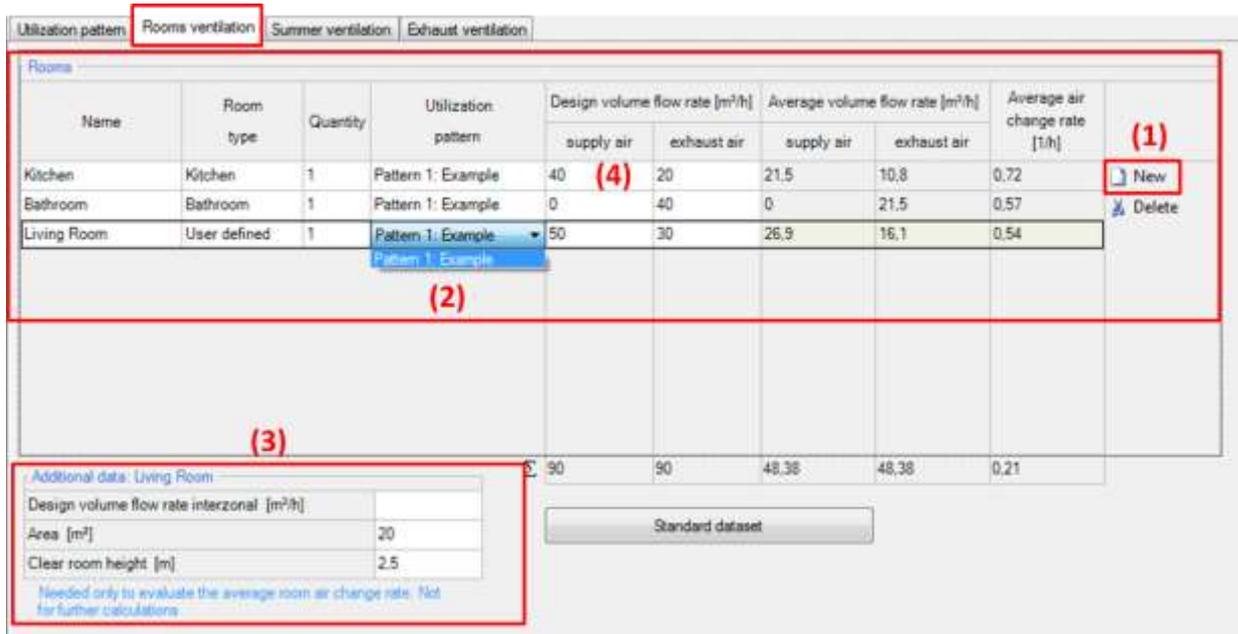


Figure 105:  
Example Case Step 09: Ventilation settings – Rooms

	Kitchen	Bathroom	Living Room
<b>Area [m²]</b>	12.00	15.00	20.00
<b>Clear room height [m]</b>	2.50	2.50	2.50

Now, switch to the “Summer ventilation” tab. Enter the necessary data (1) as in the figure below:

Utilization pattern	Rooms ventilation	Summer ventilation	Exhaust ventilation
Summer ventilation			
Summer HRV/humidity recovery	None		
ACH via mechanical ventilation exhaust air [1/h]	0		
Specific power consumption [Wh/m <sup>2</sup> ]	0		
ACH via natural ventilation (day) [1/h]	0,4455		<input type="button" value="..."/>
Additional ventilative cooling (optional data)			
ACH via mechanical ventilation [1/h]			
Mechanical automatic controlled ventilation [1/h]			
Specific power consumption [Wh/m <sup>2</sup> ]			
Automatic control system via	Temperature difference		
ACH via natural ventilation (night) [1/h]			

Figure 106:  
Example Case Step 09: Ventilation settings – Summer ventilation.

To calculate the air exchange rate due to daily window ventilation and infiltration, we use the internal calculator in WUFI® Passive. It can be opened by clicking on the calculator symbol  (2). In the calculator, enter the values shown in the figure below. We assume, that the windows are opened during one hour per day ( $1/24 \sim 0.04$ ). The temperature difference between indoor and outdoor and the average wind speed are set to recommended values for daily ventilation. The window geometries are taken from the four windows we added in Step 04.

Calculator summer ventilation, day

Zone net volume: 230 m<sup>3</sup>

Calculator

Column relevant for calculation	<input checked="" type="checkbox"/>	<input type="checkbox"/>				
Fraction of opening duration [-]	0,04					
Temperature difference interior - exterior [K]	4					
Wind velocity [m/s]	2					

Window group 1

Tilting windows	<input type="checkbox"/>					
Count	4	1	1	1	1	1
Clear width [m]	1,2					
Clear height [m]	1,5					
Opening width [m]	0,9					

Window group 2

Tilting windows	<input type="checkbox"/>					
Count	1	1	1	1	1	1
Clear width [m]						
Clear height [m]						
Opening width [m]						
Difference in height to window group 1 [m]						
Contribution to air change rate [1/h]	0,445	----	----	----	----	----

Total air change rate: 0,4455 1/h

OK Cancel

Figure 107:  
Example Case Step 09: Ventilation settings – Calculator summer ventilation

The ACH via mechanical ventilation in summer should be equal to the winter ventilation ACH, which is can be seen with the utilization pattern under “Average air change rate [1/h]”. No additional ventilative cooling devices are used, so we enter no data for the remaining inputs.

No exhaust ventilation devices are used in this example, so no user input is necessary in the “Exhaust Ventilation” tab.

The ventilation input in this dialog is finished. However, we still need to define a mechanical ventilation device in the HVAC system which is able to facilitate these ventilation settings. This will be done in Step 12.

## 11.10 Step 10: Thermal bridges

Thermal bridges must be listed in this dialog. To simplify our example building, we assume that only one exists. To add it, click on the "Thermal bridges" branch in the "Project Tree" and then on the "New" button on the right side. The thermal bridge has a linear thermal transmittance of 0,03 W/mK and is 42 meters long. This is a wall to roof thermal bridge, so the attachment is "Ambient".



Figure 108:  
Example Case Step 10: Input a thermal bridge.

## 11.11 Step 11: Connection with attached zone

To simplify this example, the attic is unheated and non-ventilated. Only the temperature difference reduction factor must be entered. Set this value to 0.75:

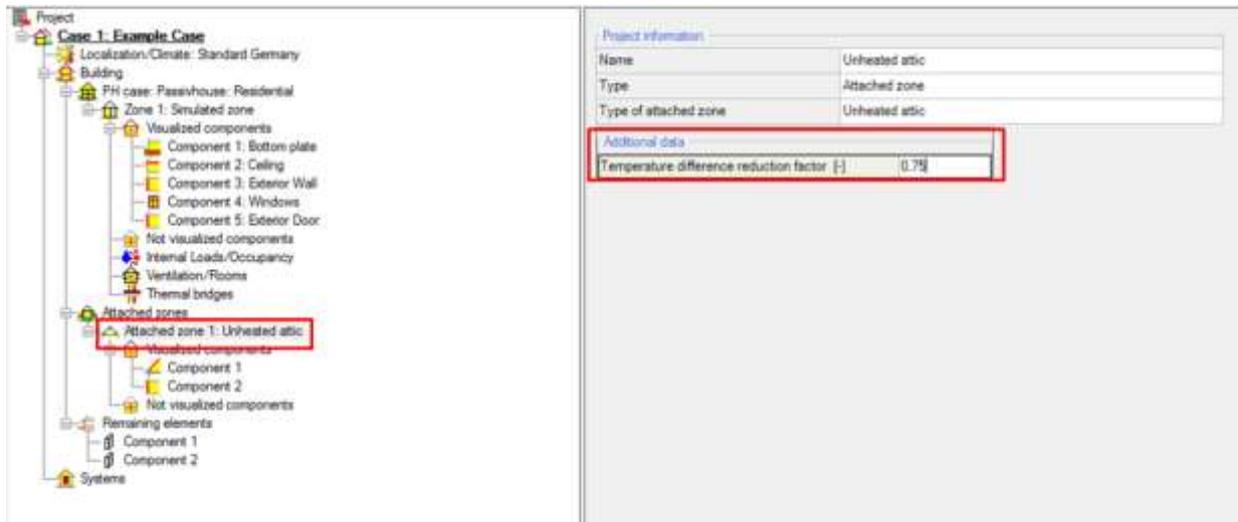


Figure 109:  
Example Case Step 11: Connection with unheated attic.

## 11.12 Step 12: Including HVAC

Now, the HVAC system is added to our building. It consists of a heat pump, which is used for heating and DHW, and continuous mechanical ventilation.

### 11.12.1 Creating a HVAC system and its devices

Select the “Systems” branch in the “Project Tree” (1), create a new system with the “New” button (2) and select an “User defined (ideal system)” HVAC system (3).

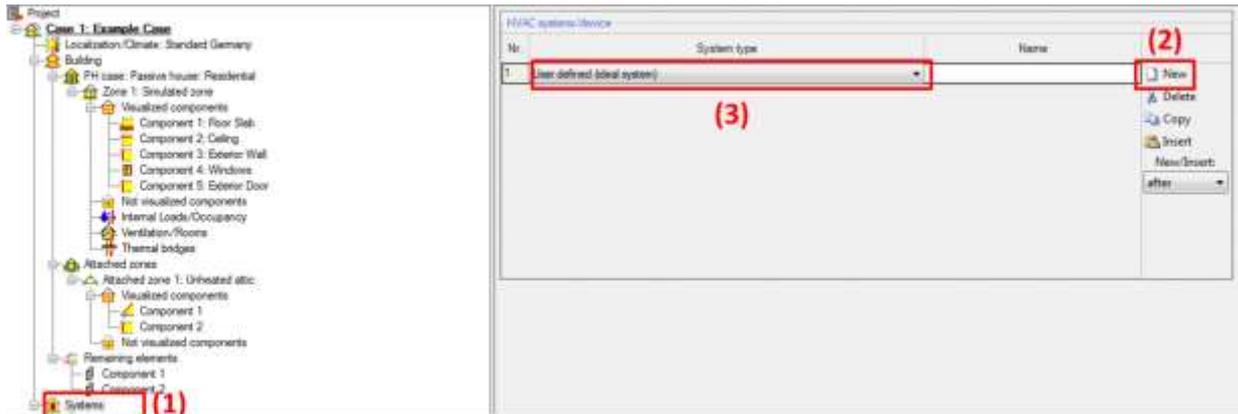


Figure 110:  
Example Case Step 12: Creating a HVAC system.

Now that the system is created, its devices and their usage must be defined. To do this, click on the created system in the “Project Tree” (1). Add two devices with the “New” button (2) and define their types as “Heat pump” and “Mechanical ventilation” (3). Now, the usage of the devices must be assigned. To do this, select the appropriate checkboxes in the devices list (4). The heat pump should be used for “Space heating” and “DHW”. Mechanical ventilation devices are always predefined with the usage type “Space ventilation”.

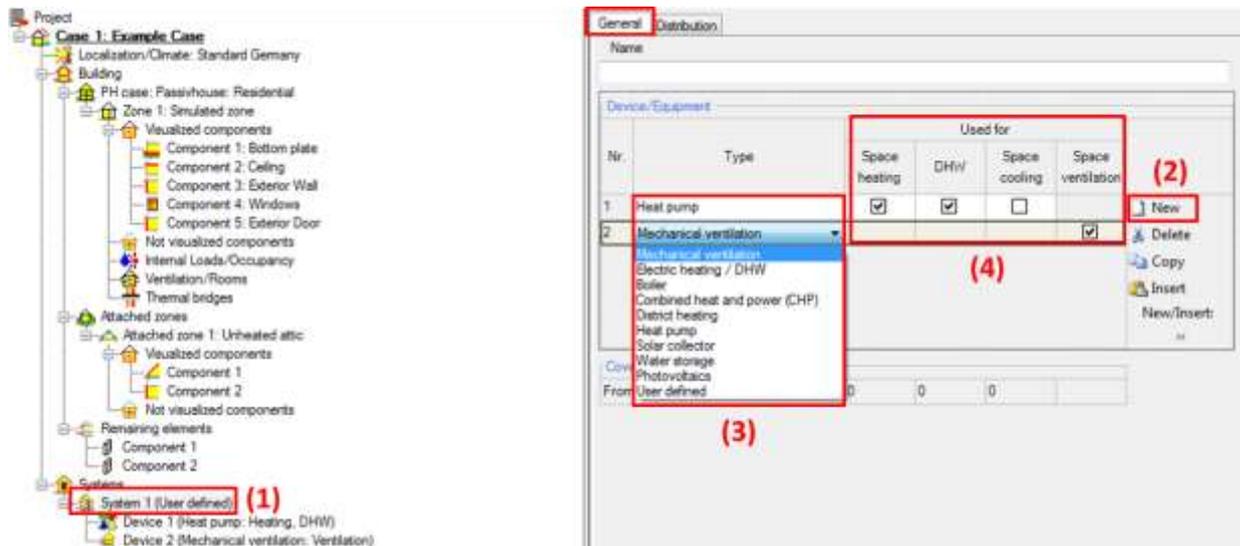


Figure 111:  
Example Case Step 12: Include HVAC devices and assign their usage.

## 11.12.2 Distribution

The distribution has to be defined for hydronic heating, DHW and ventilation.

For hydronic heating, a design flow temperature of 35°C is used. The length of distribution pipes shall be 12 m and the heat loss coefficient is assumed to be 0.13 W/mK. The design system heat load is left empty. WUFI® Passive will use the calculated heating load of the building if left blank.

Specification	Warm region	Cold region 1	Cold region 2
Design flow temperature [°C]	35		
Length of distribution pipes [m]	12		
Heat loss coefficient per meter pipe [W/mK]	0,13		
Temperature of the room the pipes pass through [°C]			
Design system heating load [kW]			
Flow temperature controlled	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 112:  
Example Case Step 12: Distribution of hydronic heating

Switch to the DHW tab. For DHW, a design flow temperature of 55°C is used. The length of the circulation pipes is 20 m and the heat loss coefficient is assumed to 0.15 W/mK. The Daily running hours of the circulation shall be 10 h, an average value for a single family dwelling. The length of individual pipes is 12 m and the exterior pipe diameter is 25.4 mm.

Specification	Warm region	Cold region 1	Cold region 2
<b>Circulation pipes</b>			
Design flow temperature [°C]	55		
Length of circulation pipes [m]	20		
Heat loss coefficient per meter pipe [W/mK]	0,15		
Temperature of the room the pipes pass through [°C]			
Daily running hours of the circulation [h]	10		
<b>Individual pipes</b>			
Length of individual pipes [m]	12		
Exterior pipe diameter [mm]	25,4		

Figure 113:  
Example Case Step 12: Distribution of DHW

The ventilation tab requires the input of both exhaust and supply ducts and they both have to be defined. To add these ducts click the "New" button (1) twice and define a exhaust and a supply duct (2). The duct shape of both is "Round" (3) and the supply duct length is 1 meter while the exhaust duct length is 3 meters (4). Both ducts then need to be assigned to a ventilation unit (5). This is the mechanical ventilation device we created previously. Next, define the duct width (160 mm), insulation thickness (60 mm) and thermal conductivity (0.04 W/mK) in the "Additional data" section (6) for both the exhaust and supply duct.

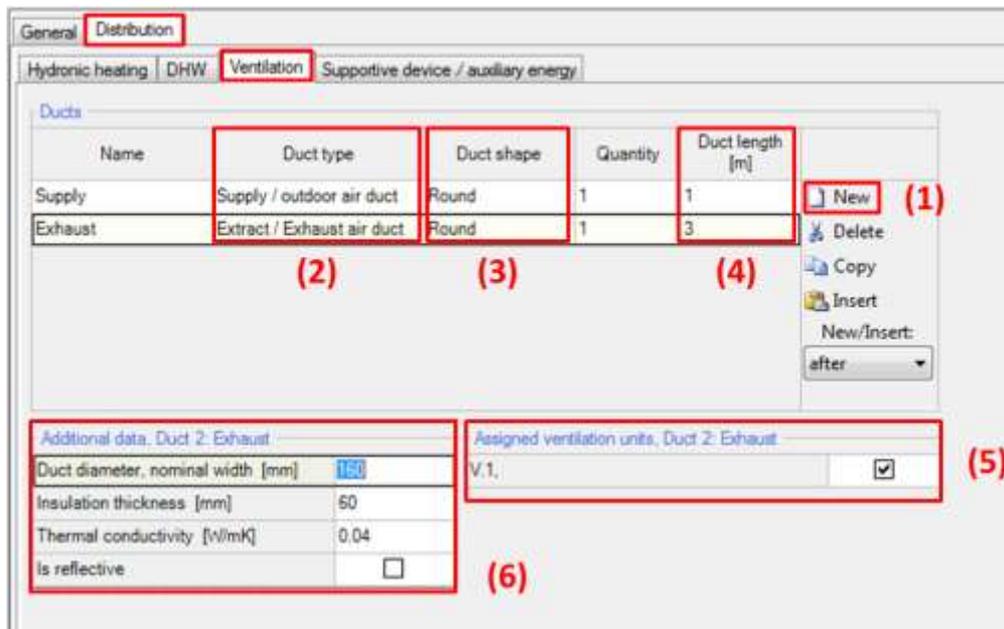


Figure 114:  
Example Case Step 12: Distribution of ventilation.

For the supportive devices/ auxiliary energy, default values will be used so, no user input is necessary in this tab.

### 11.12.3 Heat Pump

Now, the settings for the heat pump device must be entered. Select the heat pump device in the "Project Tree" (1). Switch its type to "Heat pump" (2). Two parameters must be entered: The COP (3.5) and the total system performance ratio of heat generator (0.28).

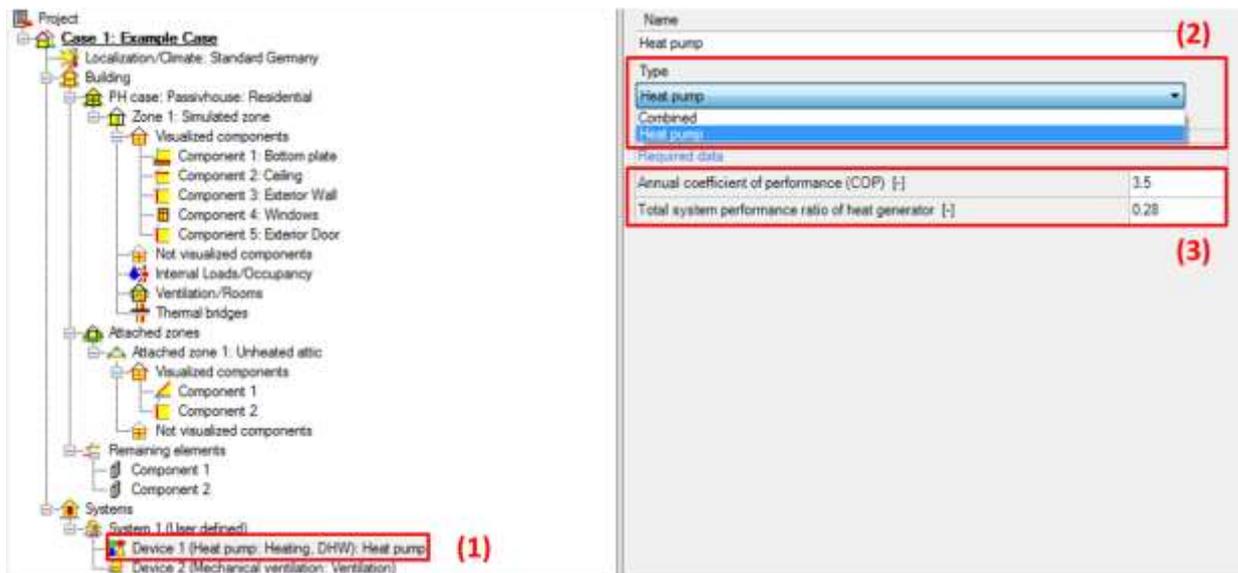


Figure 115:  
Example Case Step 12: Settings for the heat pump device

## 11.12.4 Mechanical Ventilation

Now switch to the mechanical ventilation device (1). It requires more data than the heat pump device. WUFI® Passive comes with a database that also includes settings for HVAC devices. We will use this feature to load the mechanical ventilation device from the WUFI® Database. Click the "Assign from database" button (2) to open the database. Then, select the "Example ventilation unit" and press the assign button to load the preset values for the mechanical ventilation unit. These values are automatically filled in (3). The individual rooms that the ventilation device is used for should be assigned. This device needs to be connected to the rooms created in Step 09. To do this, activate the checkboxes in the respective section (4).



Figure 116:  
Example Case Step 12: Settings for the mechanical ventilation device

### 11.13 Step 13: Viewing the results and adjusting the building

As soon as all necessary data is entered, the main results for the Passive House verification are shown in the "Status & Results Box":

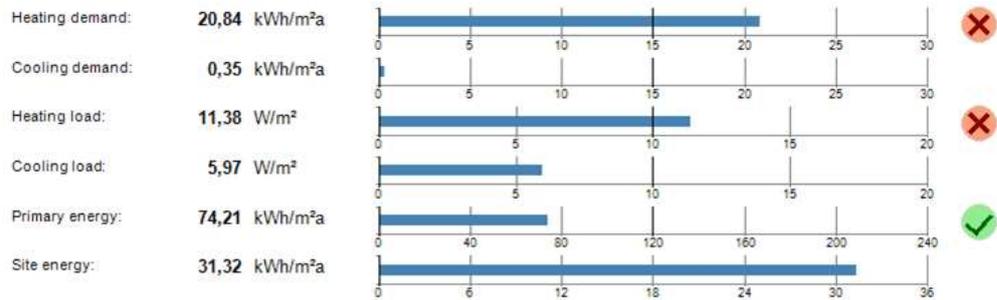


Figure 117:

Example Case Step 13: Main results in "Status & Results Box".

Unfortunately, our building doesn't meet the criteria for heating demand and heating load. To fulfill the Passive House criteria, we will replace the assembly of the exterior wall with the construction described in the table below.

Nr.	Material (as named in WUFI® Database)	Thickness [m]
1	Cement lime plaster	0.020
2	EPS (heat cond. 0.04 W/mK – density: 15 kg/m³)	0.340
3	Aerated Clay Brick (density: 600 kg/m³)	0.240
4	Interior Plaster (Gypsum Plaster)	0.015

Now, our example building meets the Passive House criteria:

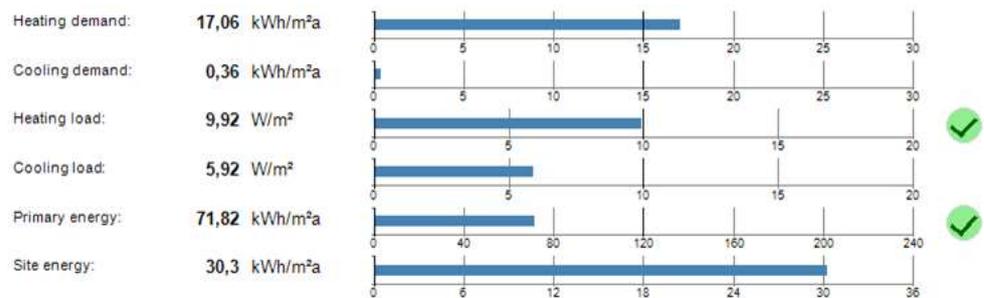


Figure 118:

Example Case Step 13: Main results in "Status & Results Box" for the adjusted building.

## 11.14 Step 14: Passive House Verification Report

The example building meets the passive house certification criteria. Now it's time to view the verification report, which can be accessed by clicking on the "Case" branch in the "Project Tree" (1) and then on the "Report: Data & results" tab (2). The verification report can be selected from a dropdown menu (3):



Figure 119:  
Example Case Step 14: Passive house verification report.

Scroll through the report and view the results.

The full version of WUFI® Passive allows extended functionality for the reports: They are not watermarked and can be exported to Microsoft Word (4) for further usage. Also, the reports can be printed directly from WUFI® Passive. To do this, switch to the "Print layout" (5) and print the report by clicking the respective button (6).



The different sections of the Passive House Verification report are explained in detail on our [WUFI® Wiki](#).

## 11.15 Step 15: Switching to dynamic hygrothermal simulations

As soon as the building meets the certification criteria, dynamic hygrothermal simulations become available through the WUFI® Plus calculation scope. The applicable data from the Passive house verification scope is transferred to this scope where possible. Chapter 9.1 describes this transfer in detail.

Now, let's switch to the WUFI® Plus calculation scope by selecting it in the tool bar:

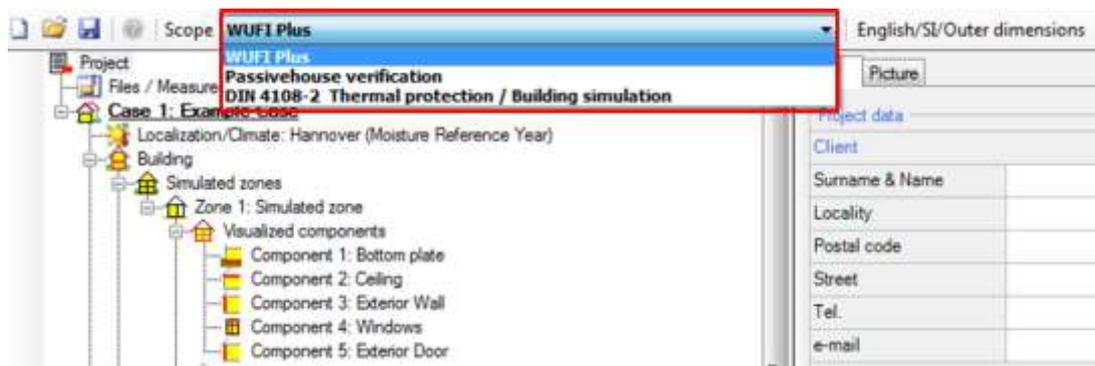


Figure 120:

Example Case Step 15: Switch to the WUFI® Plus calculation scope.

After that, check the "Status & Results Box": It indicates that some inputs are still missing. Double clicking the "Status & Results Box" will guide you automatically to the screen, where the input is missing. Please refer to the WUFI® Plus manual for further information about the necessary input.

As soon as the necessary data was entered, WUFI® Passive allows to start the simulation. Click the "Start" button in the "Status & Results Box".



This chapter only gives a very short explanation on transferring data from Passive House calculations to the dynamic hygrothermal building simulations of WUFI® Plus. Please refer to the WUFI® Plus manual to learn about the possibilities that arise with dynamic hygrothermal simulations and how to work with its results.

## List of figures

Figure 1:	Installation: Start the setup.	10
Figure 2:	Installation: Terms of use.	10
Figure 3:	Installation: System requirements.	11
Figure 4:	Installation: Enter your license data.	11
Figure 5:	Installation: Select the installation folder and create an entry in the Windows Start Menu.	12
Figure 6:	Installation: Create a desktop icon.	12
Figure 7:	Installation: Start the installation of the WUFI® Database.	13
Figure 8:	Installation: Select the folder for the installation of the WUFI® Database.	13
Figure 9:	Finish the installation of WUFI® Passive and the WUFI® Database.	14
Figure 10:	Starting WUFI® Passive either from the Windows Start Menu or the desktop shortcut.	15
Figure 11:	Main Window of WUFI® Passive.	16
Figure 12:	Visualization Box.	24
Figure 13:	Component openings window.	26
Figure 14:	Creating a new window or opening.	27
Figure 15:	Copy a window or opening.	28
Figure 16:	Error Messages in the " <i>Status &amp; Results Box</i> ".	32
Figure 17:	Summary of main calculation results in the " <i>Status &amp; Results Box</i> ".	33
Figure 18:	Localization dialog.	41
Figure 19:	Climate Dialog.	42
Figure 20:	Building Wizard.	46
Figure 21:	PH Case: General Settings.	47
Figure 22:	PH Case: Additional Data.	48
Figure 23:	PH Case: Foundation Interface.	49

Figure 24: Simulated Zone Settings.	51
Figure 25: Internal Loads/ Occupancy dialog for residential buildings	56
Figure 26: Internal Loads/ Occupancy dialog for residential buildings	58
Figure 27: Internal Loads/ Occupancy dialog for residential buildings	60
Figure 28: Internal Loads/ Occupancy dialog for residential buildings	62
Figure 29: Internal Loads/ Occupancy dialog for residential buildings	63
Figure 30: Internal Loads/ Occupancy dialog for residential buildings	64
Figure 31: Ventilation dialog: Utilization pattern	65
Figure 32: Ventilation dialog: Rooms ventilation	67
Figure 33: Ventilation dialog: Summer ventilation	69
Figure 34: Ventilation dialog: Exhaust ventilation	70
Figure 35: Thermal bridges dialog	71
Figure 36: HVAC dialog	73
Figure 37: List of HVAC Devices	75
Figure 38: HVAC Distribution – Hydronic heating.	78
Figure 39: HVAC Distribution – DHW.	79
Figure 40: HVAC Distribution – Cooling.	80
Figure 41: HVAC Distribution – Ventilation.	81
Figure 42: HVAC Distribution – Supportive device/ auxiliary energy.	82
Figure 43: Opaque Component – General Settings.	84
Figure 44: Opaque Components – Assembly Selection	85
Figure 45: Opaque Component – Edit Assembly	86
Figure 46: Opaque Component – Thermal surface settings	88
Figure 47: Transparent Component – General Settings.	91
Figure 48: Edit Window Parameters.	92
Figure 49: General settings for solar protection of a transparent component.	94
Figure 50: Solar protection of transparent components: Settings for sunscreen devices.	95

Figure 51: Solar protection of transparent components: Settings for window overhang.	96
Figure 52: Settings for mechanical ventilation device.	97
Figure 53: Settings for a boiler device.	98
Figure 54: Settings for a district-heating-device.	99
Figure 55: Settings for a heat pump device.	100
Figure 56: Settings for a combined heat pump device.	101
Figure 57: Settings for a solar collector device.	102
Figure 58: Settings for water-storage device.	104
Figure 59: Settings for photovoltaics device.	105
Figure 60: Open the WUFI® HVAC database.	107
Figure 61: Structure of the WUFI® HVAC database.	107
Figure 62: Creating a new device for the WUFI® HVAC database.	108
Figure 63: Options for the WUFI® Passive SketchUp Plugin.	109
Figure 64: Dialogs in SketchUp for the WUFI® Passive SketchUp Plugin.	110
Figure 65: Setting the properties of an object in the WUFI® Passive SketchUp Plugin.	111
Figure 66: External program for gbXML-import.	112
Figure 67: Report dialog.	116
Figure 68: Opening the Passive House verification report.	118
Figure 70: Report for a calculation according to DIN 4108-2.	122
Figure 71: Example Case: View of the Example Building.	123
Figure 72: Example Case: Create a new project.	125
Figure 73: Example Case: Define climatic conditions	126
Figure 74: Example Case: Climate-Tab.	127
Figure 75: Example Case: Set Primary Energy & CO <sub>2</sub> -Factors.	127
Figure 76: Example Case: Creating building geometry with the " <i>Building Wizard</i> ".	128

Figure 77: Example Case Step 04: Opening the “ <i>Windows/ Openings</i> ”-dialog from the “ <i>Visualization Box</i> ”.	130
Figure 78: Example Case Step 04: Adding a window.	131
Figure 79: Example Case Step 04: Copying the existing window.	132
Figure 80: Example Case Step 04: Inserting the exterior door.	133
Figure 81: Example Case Step 04: Defining the exterior door as an opaque component.	133
Figure 82: Example Case Step 05: General Passive House settings.	134
Figure 83: Example Case Step 05: Natural ventilation settings.	135
Figure 84: Example Case Step 05: Foundation interface.	136
Figure 85: Example Case Step 06: Zonal settings.	137
Figure 86: Example Case Step 07: General settings for the floor slab.	138
Figure 87: Example Case Step 07: Open the “ <i>Edit assembly</i> ” window.	138
Figure 88: Example Case Step 07: Editing the assembly of the bottom plate.	139
Figure 89: Example Case Step 07: Select a material from the WUFI® database.	140
Figure 90: Example Case Step 07: Assembly for the bottom plate.	140
Figure 91: Example Case Step 07: Heat transfer resistance for the floor slab.	141
Figure 92: Example Case Step 07: Assembly for the ceiling.	142
Figure 93: Example Case Step 07: Main layers of the inhomogeneous exterior wall component.	144
Figure 94: Example Case Step 07: Add the exchange material for the wood framing.	144
Figure 95: Example Case Step 07: Enter the dimensions of the subdivision.	145
Figure 96: Example Case Step 07: Insert the exchange material.	145
Figure 97: Example Case Step 07: Subdivisions for layer Nr. 5.	146
Figure 98: Example Case Step 07: Inhomogeneous assembly for exterior walls.	146

Figure 99: Example Case Step 07: Adjust the surface settings for the exterior walls.	147
Figure 100: Example Case Step 07: Select window parameters from the WUFI® Database.	148
Figure 101: Example Case Step 07: Opening the "Windows/ Openings"-dialog from the "Visualization Box".	149
Figure 102: Example Case Step 07: General settings for the exterior door.	150
Figure 103: Example Case Step 07: Assembly for the exterior door.	150
Figure 104: Example Case Step 08: Defining internal loads.	151
Figure 105: Example Case Step 09: Ventilation settings – Utilization pattern.	152
Figure 106: Example Case Step 09: Ventilation settings – Rooms	153
Figure 107: Example Case Step 09: Ventilation settings – Summer ventilation.	154
Figure 108: Example Case Step 09: Ventilation settings – Calculator summer ventilation	155
Figure 109: Example Case Step 10: Input a thermal bridge.	156
Figure 110: Example Case Step 11: Connection with unheated attic.	157
Figure 111: Example Case Step 12: Creating a HVAC system.	158
Figure 112: Example Case Step 12: Include HVAC devices and assign their usage.	159
Figure 113: Example Case Step 12: Distribution of hydronic heating	160
Figure 114: Example Case Step 12: Distribution of DHW	160
Figure 115: Example Case Step 12: Distribution of ventilation.	161
Figure 116: Example Case Step 12: Settings for the heat pump device	162
Figure 117: Example Case Step 12: Settings for the mechanical ventilation device	163
Figure 118: Example Case Step 13: Main results in "Status & Results Box".	164
Figure 119: Example Case Step 13: Main results in "Status & Results Box" for the adjusted building.	164
Figure 120: Example Case Step 14: Passive house verification report.	165

Figure 121: Example Case Step 15: Switch to the WUFI® Plus calculation scope. 166