

# **WUFI® Passive 3.1**

## Manual



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## Preamble

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

Using an imaginative building as an example, it also shows 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. Its advisable to follow this example when working with WUFI® Passive for the first time.

For detailed information please refer to the 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	
<b>Controls Box</b>	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.
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	Orange Attention Boxes like this one include important information about calculation settings.
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	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.
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# 1 Introduction



**If you open a project that was created with a previous version of WUFI Plus/Passive:  
With WUFI Plus/Passive 3.1.0 two changes in methodology were made that will change the final results:**

1. New approach to compute airtightness: Also components adjacent to non-simulated zones or to zones with the same inner climate are now part of the enclosure area and are taken into account for the calculation of the airtightness. So in case of an area related airtightness to those zones this will result in a difference in infiltration air change.
2. The COP of the simple heat pump model will not be reduced by 0.8 anymore in case a washing machine or a dishwasher is connected to its hot water connection

WUFI® Passive allows a double assessment of buildings to be made 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 in 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 contractors. 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 7;

Windows 10

.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.

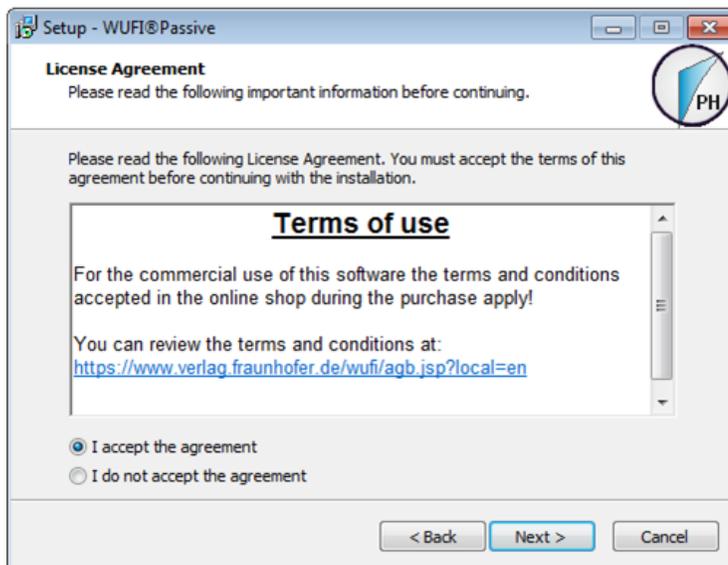


Figure 2: Installation: Terms of use

Please make sure that your computer meets the system requirements:

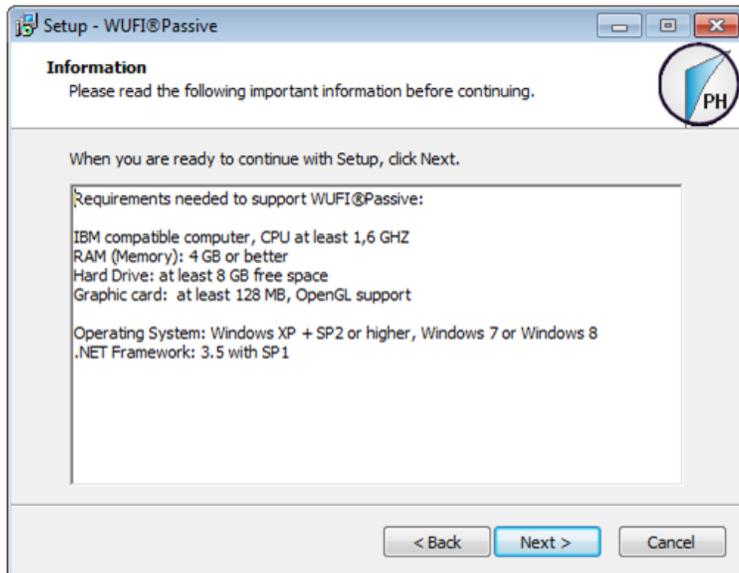


Figure 3: Installation: System requirements

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:

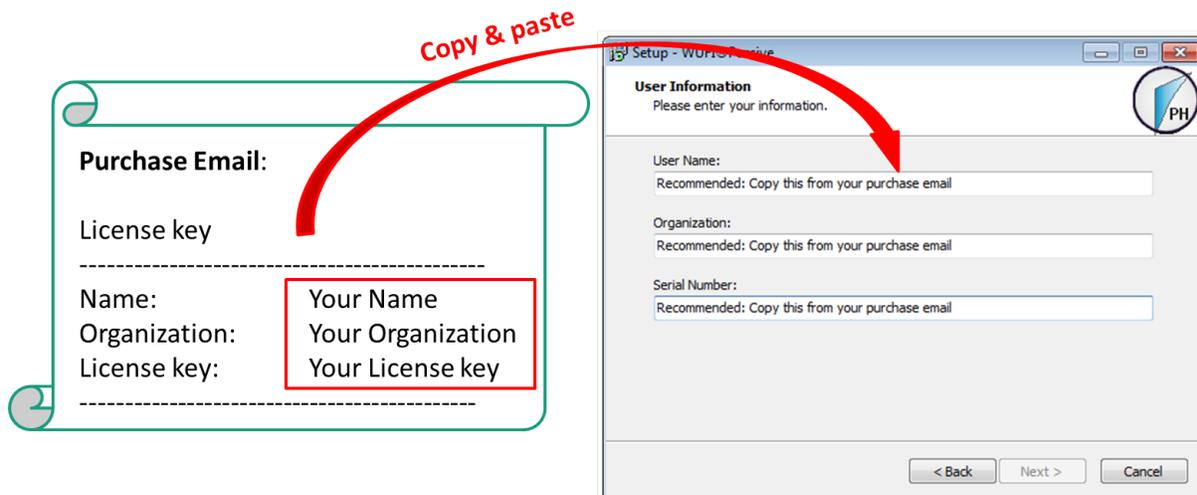


Figure 4: Installation: System requirements

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:

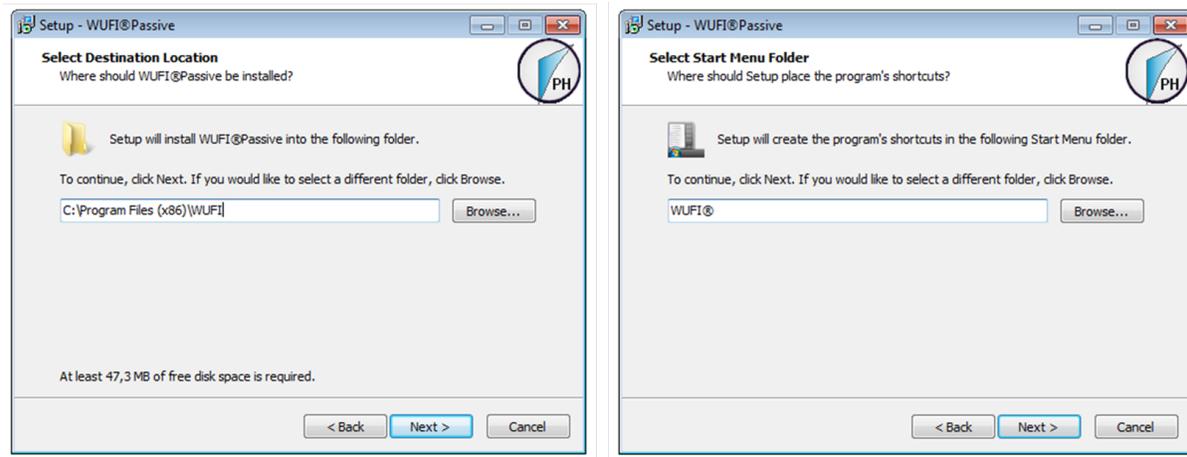


Figure 5: Installation: Select the installation folder and create an entry in the Windows Start Menu.

There is also an option to create a desktop icon:

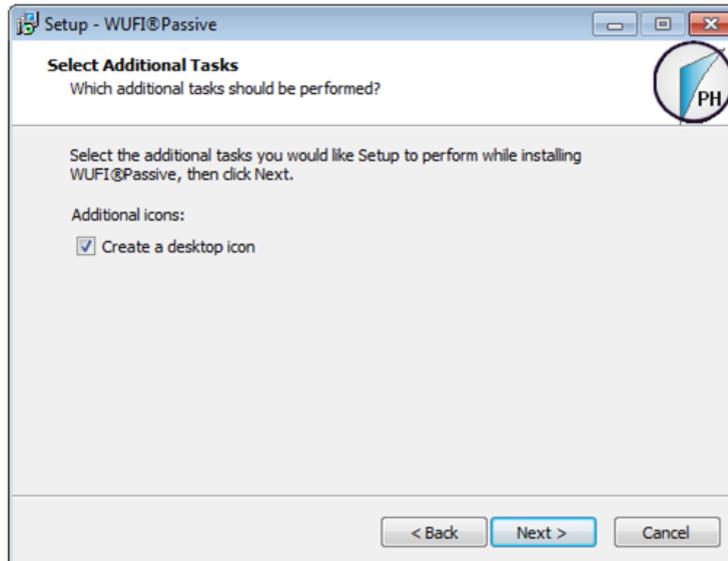


Figure 6: Installation: Create a desktop icon

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:

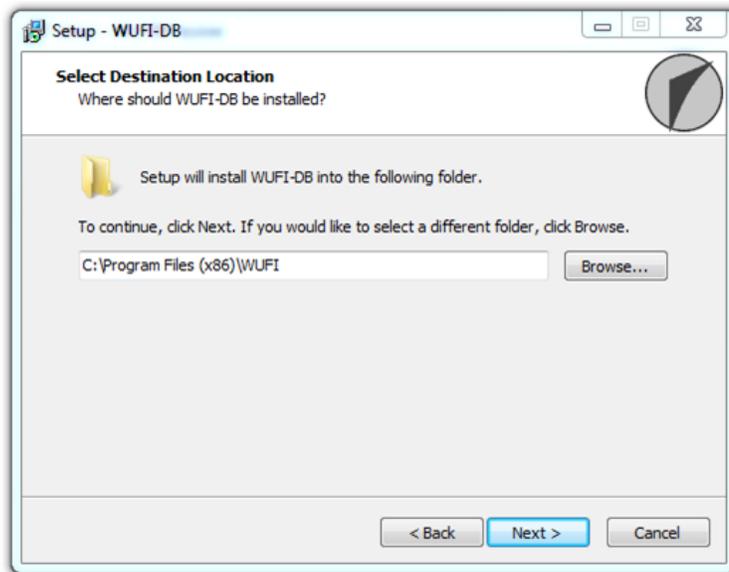


Figure 8: Installation: Select the folder for the installation of the WUFI® Database.

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: Installation: 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).

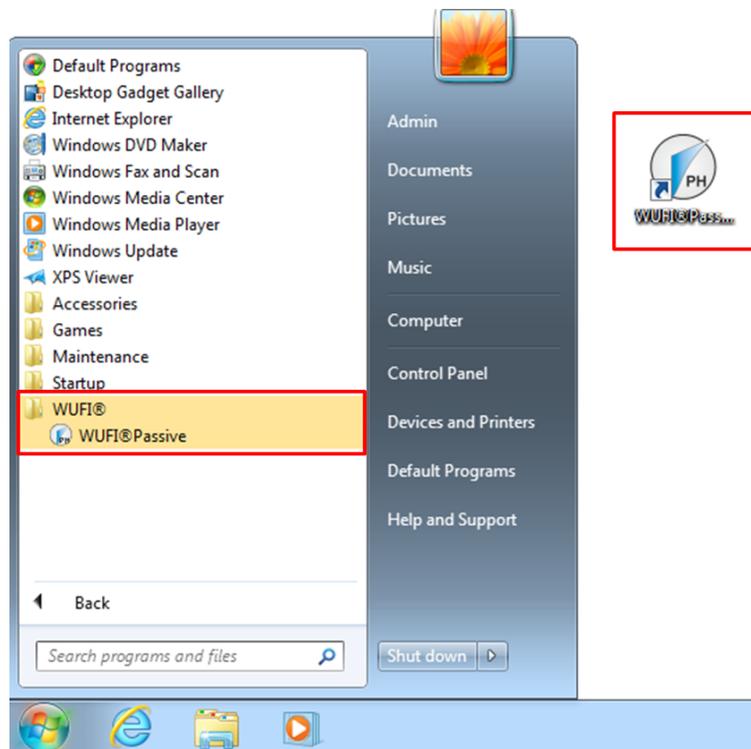


Figure 10: Installation: Starting WUFI® Passive either from the Windows Start Menu or the desktop shortcut.

### 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.

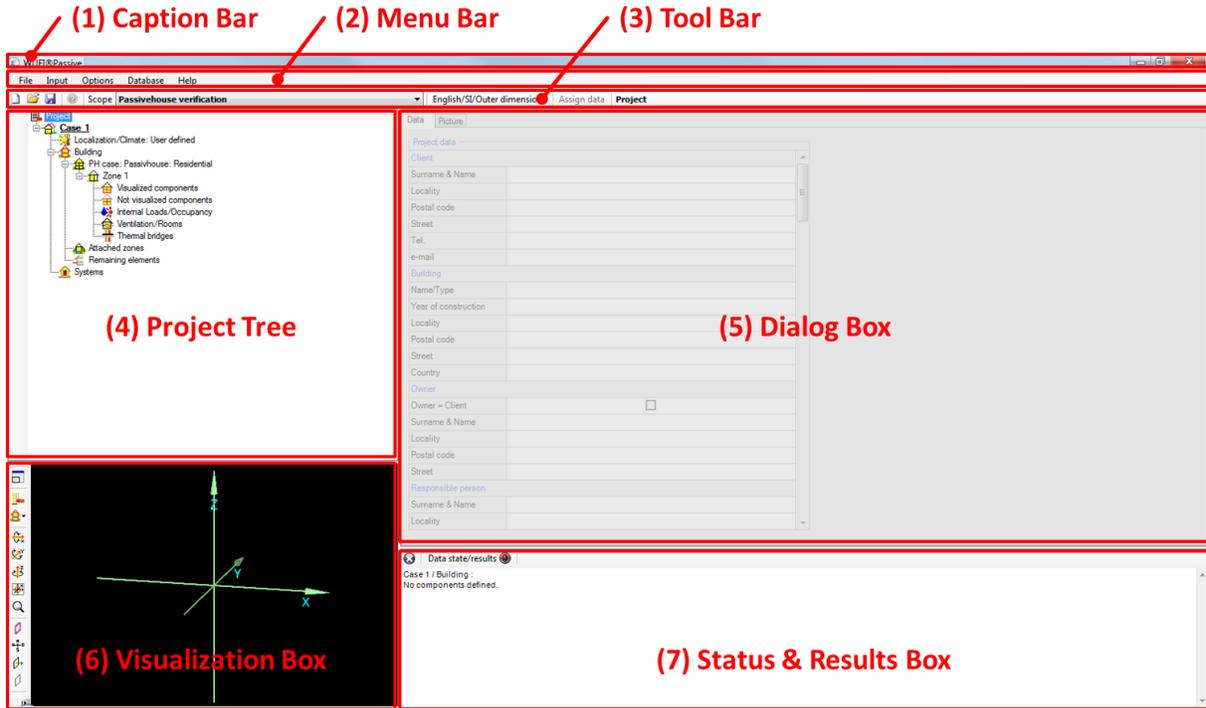


Figure 11: Main Window of WUFI® Passive.

## Elements of the Main Window

- |                                   |  |
|-----------------------------------|--|
| <b>(1) Caption Bar</b>            | The product name (WUFI® Passive) and its version number are shown here together with the name of the current project.  |
| <b>(2) Menu Bar</b>               | The menu bar contains different main menus. To see individual menu items and submenus, please open the main menus.   |
| <b>(3) Tool Bar</b>               | 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 Input 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 Project Tree or Input 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 and 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>Recover Data</b>	Lists the last autosaves of the project, that can be recovered. The auto-save options of WUFI® Plus are described in <a href="#">3.2.3</a> .
<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 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.



The data recovery option allows you to set the time interval after which WUFI® Passive automatically makes a copy of the current project. The maximum amount of auto saves can also be defined. When using the recover data option, see chapter 3.2.1, you can choose between the latest saves. Auto-saves will only be created when input-parameters were entered or changed by the user. The auto-saves are saved temporary in WUFI® Passive main installation folders subfolder "zres". They will be deleted when WUFI® Passive is closed.

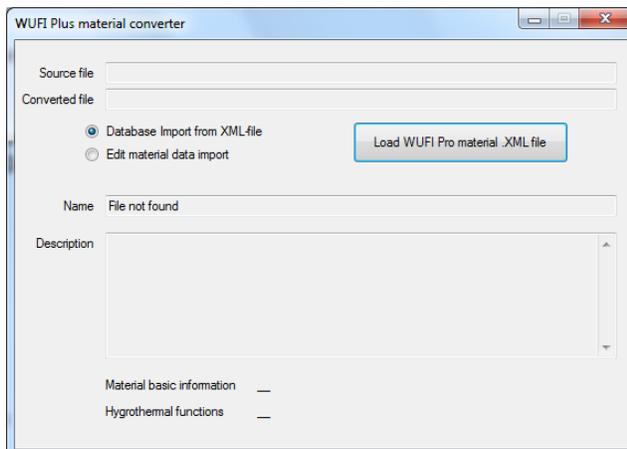


Comments can be made to every dialog of the user interface of the dialog box. The comments can be displayed at the right corner of the dialog box, at the bottom right of the dialog box and in a separate window. When choosing this option, a new "Comments" button appears next to the "Assign data" button.

### 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, or 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>Emissions 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>Export into XML-file/ Import from XML-file</b>	User-defined database entries can be exported or imported with these dialogs. This way user-defined database entries can be shared with other users or computers. WUFI® Pro Material data can also be imported with this function.



The WUFI® Plus material converter formats xml material data of WUFI® Pro to the appropriate WUFI® Plus xml format. After clicking "Load WUFI Pro material .XML file" and searching the associated file, the tool automatically creates a new xml-file according to the selected task:

1. Database import from xml-file: Creates a new xml-file with the suffix `.plusImportToDB.xml`. This file can be imported into the WUFI® Plus Material Database with the function Import from XML-file.
2. Edit material data import: Creates a new xml-file with the suffix `.xml.plusMaterial.xml`. This file can be imported into WUFI® Plus from the Edit Material dialog. See chapter [5.1.3](#) for further information.

The WUFI® Plus material converter is installed together with WUFI® Plus. It can be found in the "Tools"-folder of your WUFI® Plus installation.



Visit the WUFI® -Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about the database. Its usage is described on the Wiki-pages and a tutorial movie shows in detail 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® Plus Manual/ WUFI® Passive Manual</b>	Opens the manuals. The manuals can also be opened by pressing the F1-button on your keyboard, by clicking the Help-button in the Toolbar (see chapter 3.3) or by clicking in Help-buttons in selected menus. The latter three ways are context-sensitive, i.e. the help will automatically link the currently opened menu with the fitting help-chapter.
<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	The mean indoor temperature during the heating period. Recommended values: 20°C for residential and office buildings References: For non residential buildings with intermittent heating, this value can be calculated according to EN 13790
Internal gains setting	Default	
Internal heat gains [W/m²]	2.1	
Occupancy setting method	Verification	
Number of occupants	2.6	
Number of units [-]	1	
<a href="#">Zones</a>		

WUFI® Passive categorizes the user input:

- All inputs that are inside the 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 if a simulation has already been completed. The project should be saved before calculating to back up input data and after the calculation to save results.
 <b>Help</b>	Opens the WUFI® Help. This button is context-sensitive, i.e. the help will automatically link the currently opened menu with the fitting help-chapter. Pressing the F1-button on the keyboard does the same.
<b>Scope</b>	This dropdown-menu allows switching through different scopes of WUFI® Plus: <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> Please refer to chapter 1 for information about these scopes.
<b>Current Settings</b>	This dialog shows the current settings of language, unitsystem and if the visualization represents inner or outer dimensions. Clicking on this dialog opens the General Options, described in chapter 3.2.3.
<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 open.

### 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. The model can also be moved by clicking and holding the left mouse-button and then moving the mouse.

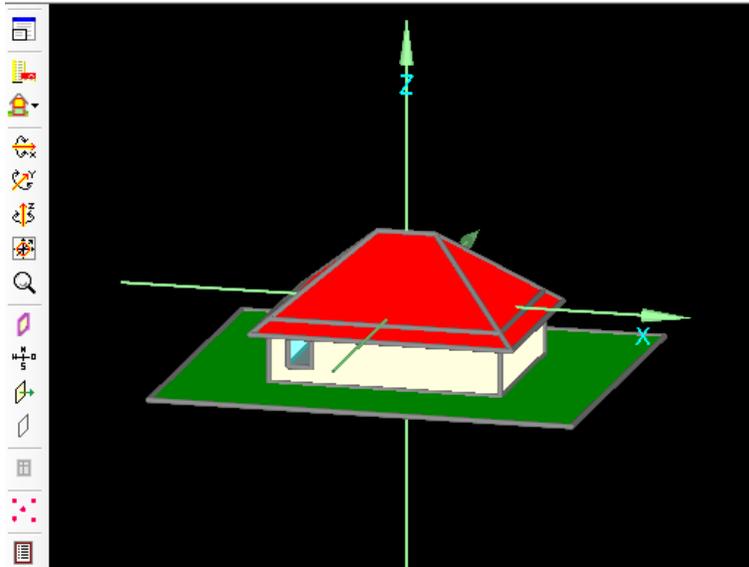


Figure 12: Visualization Box

Controls	
	<b>Expand/Shrink</b> Allows expansion of the <i>Visualization Box</i> . Its advised to use this option, as it facilitates using the <i>Visualization Box</i> .
	<b>Building Wizard</b> Clicking this button opens the <i>Building Wizard</i> . See chapter 4.4.1 for more information about this feature.
	<b>Zones</b> By clicking this button, already existing zones can be renamed 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 <i>Visualization Box</i> . For more information on zones see the chapter 4.4.2.
	<b>Rotation</b> These Buttons allow rotating the building around all three axes (X, Y & 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.

	<b>Center</b>	Centers the view of the <i>Visualization Box</i> to its original position.
	<b>Zoom</b>	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.
	<b>Transparency</b>	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.
	<b>Orientation</b>	The orientation of the building can be displayed by left clicking this button. Right clicking opens the " <i>Change orientation</i> " window, where orientation of the building can be altered.
	<b>Normal vector</b>	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.
	<b>Conditionally not visible/ selectable</b>	This button makes a component conditionally <i>not visible/ selectable</i> , for example to make 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 check-mark 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> .
	<b>Windows &amp; Openings</b>	Creates new windows and openings. See chapter 3.4.1 for further information.
	<b>Vertices</b>	Shows or hides the vertices. Chapter 3.4.2 shows how vertices can be used to create or modify a building.
	<b>Options</b>	Settings for the <i>Visualization Box</i> , as described in chapter 3.2.3.

### 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 the component 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 will appear:

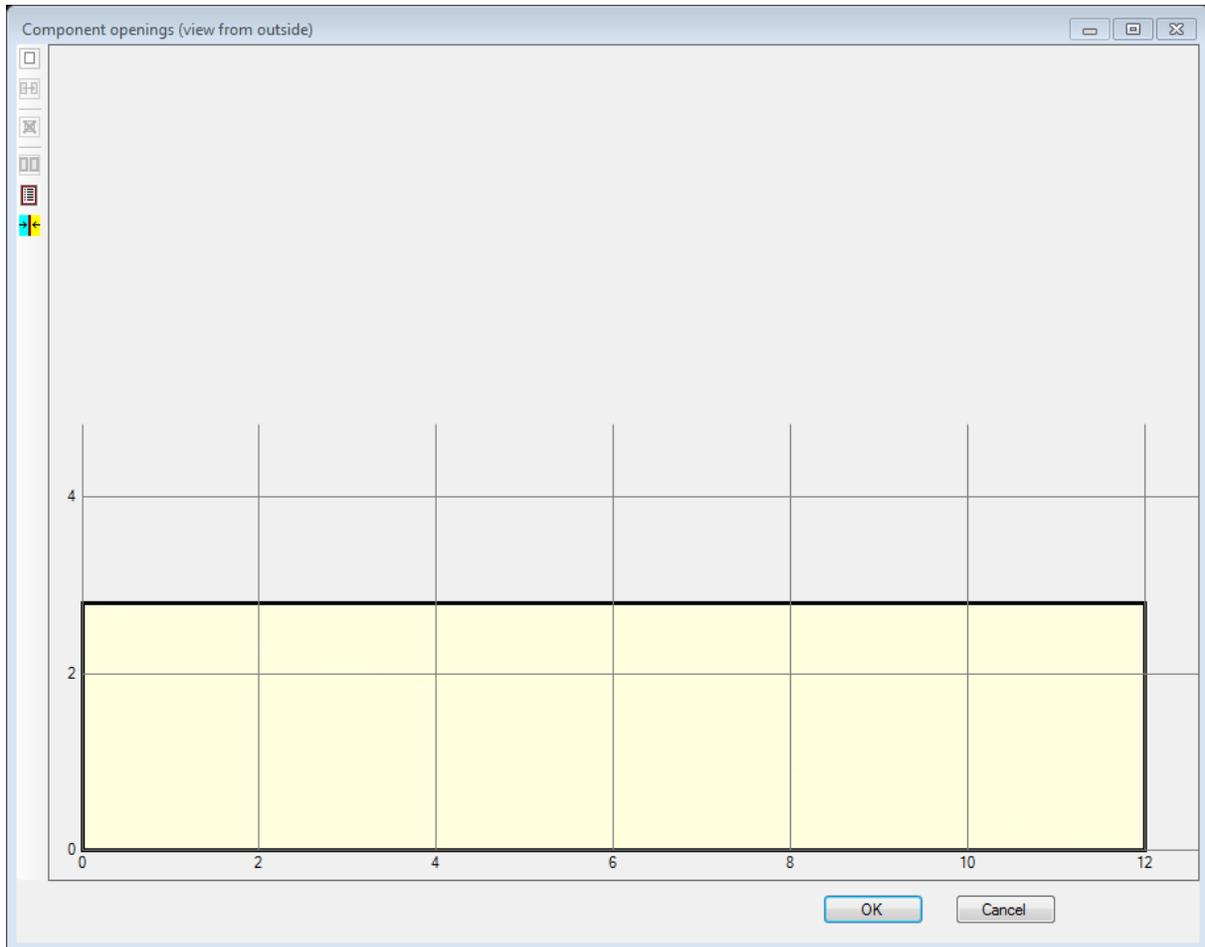


Figure 13: Component openings window

## Controls

	<b>New</b>	New windows or openings can be created with this button. The <i>Opening</i> dialog will appear. <i>Hint: New windows or openings can also be created by right-clicking on the component.</i>
	<b>New/Copy Move</b>	Allows copying or moving the selected window or opening.
	<b>Delete</b>	Delete the selected window or opening. <i>Hint: Selected windows or openings can also be deleted by pressing the Delete-Button 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:

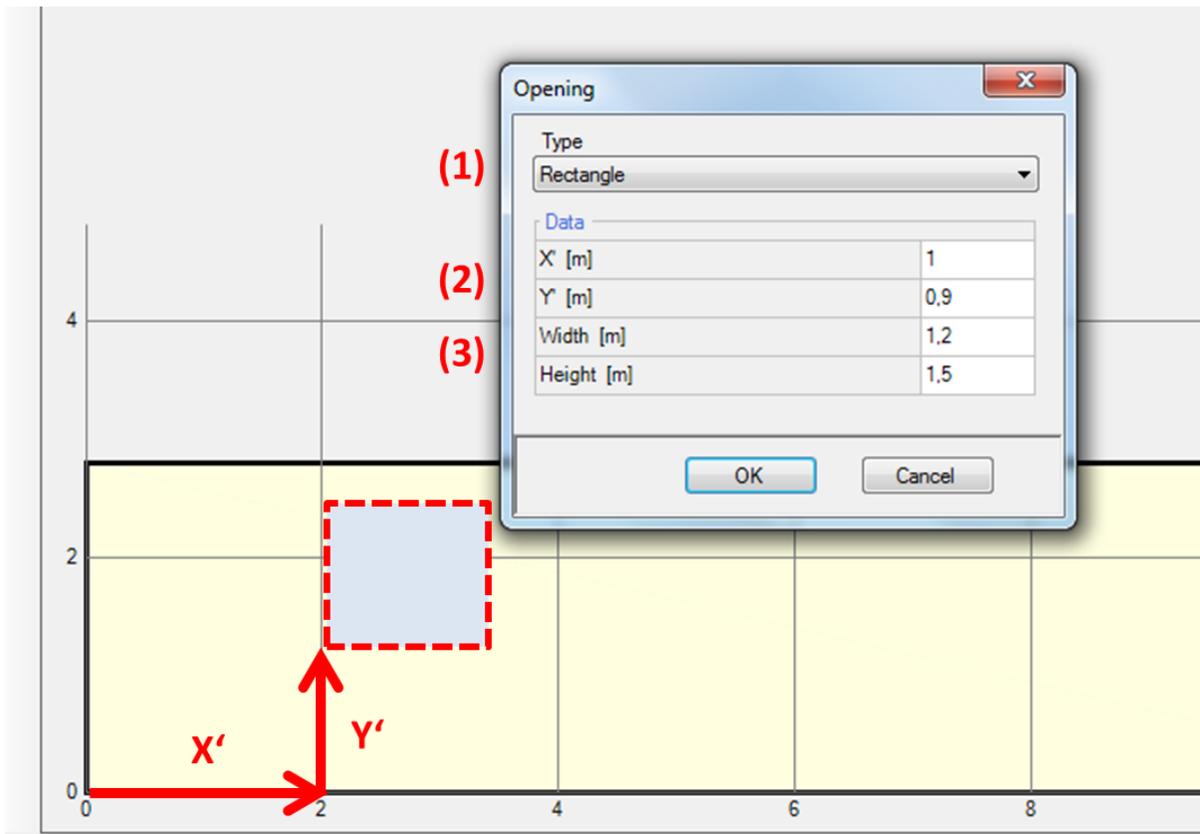


Figure 14: Creating a new window or opening.

With the *Opening* dialog these types of window geometry 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.

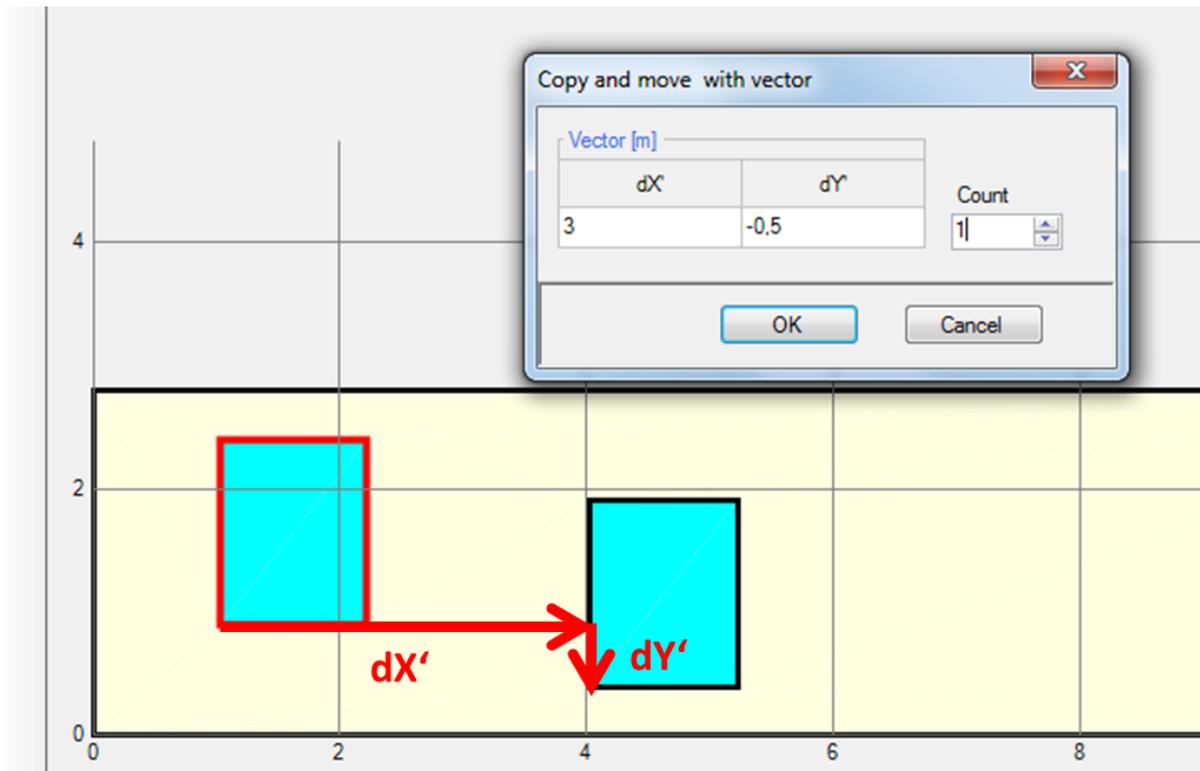


Figure 15: Copy a window or opening.

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

<div style="margin-bottom: 10px;"> <b>New</b></div> <div style="margin-bottom: 10px;"> <b>Delete</b></div> <div style="margin-bottom: 10px;"> <b>Copy</b></div> <div style="margin-bottom: 10px;"> <b>Insert</b></div> <div><b>Inner position</b></div>	<p>Create a new element in this list.</p> <p>Delete the selected element.</p> <p>Copy the selected element.</p> <p>Insert a copied element. The <i>Insert Position</i> specifies where the copied element will be positioned.</p> <p>Controls where a copied element will be inserted:</p> <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>
---	---



Visit the 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

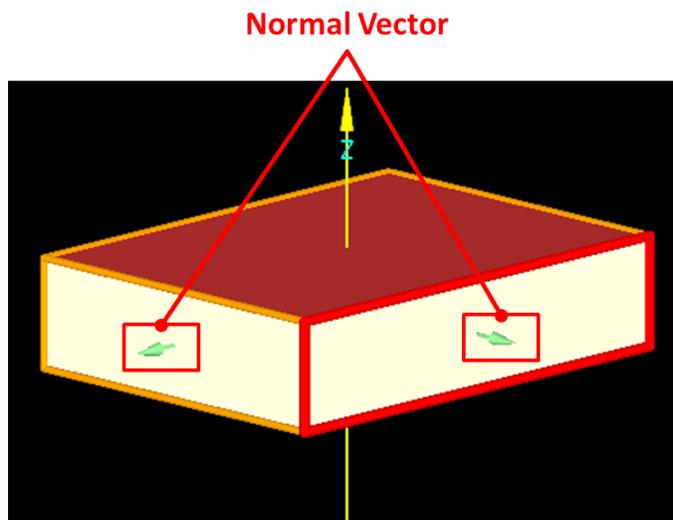
The geometry of the building can be expanded and changed in the *Visualization Box*, by using vertices and connecting them to components. This 3D editing allows the input of complex building shapes within WUFI® Passive and can also be used to create the whole building geometry.

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* becomes available, which allows for example copying and moving or making components from vertices. By selecting two vertices, the *Two Point Operations* become available, which can find intersection points or show the distance between the two vertices.

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, an incorrect 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 the 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

 	<p><b>Close/Reestablish</b>      Hides or shows the <i>Status &amp; Results Box</i>.</p> <p><b>Status Indicator</b>      The status indicator shows if all necessary inputs 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 Status &amp; Results-Box. As long as warnings are shown, the yellow symbol appears. After the Passive House Verification is successful, the green symbol appears.</p> <p><b>Warnings/ Results</b>      After all necessary data is entered, the main calculation results will be shown in the Status &amp; Results-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.</p>
--	--

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.

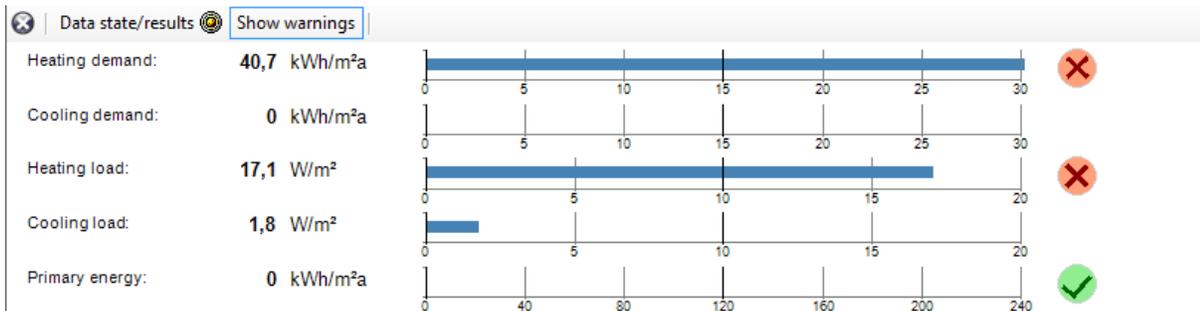


Figure 17: Summary of main calculation results in the *Status & Results Box*.

## 4 Project Tree

The *Project Tree* offers easy and quick access to all dialogs, which are necessary for defining a WUFI® Plus 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>	Selection of external and optional climates. See chapter 4.3.
	<b>Building</b>	Provides access to building geometry creation or import, settings for the <i>Air Flow Model</i> and general calculation settings. 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 4.4.5.
	<b>Visualized components</b>	Lists all visualized components in a zone. See chapter 4.4.6.
	<b>Visualized Components</b>	Definition of a visualized component. See chapter 4.4.6. 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 a 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 not visualized components in a zone. See chapter <a href="#">4.4.7</a> .
	<b>Not visualized component</b>	Definition of a not visualized component. See chapter <a href="#">4.4.7</a> .
		
		
	<b>Internal Loads / Occupancy</b>	Definition of internal loads. See chapter <a href="#">4.4.9</a> .
	<b>Ventilation/Rooms</b>	Ventilation settings. See chapter <a href="#">4.4.10</a> .
	<b>Thermal Bridges</b>	List of all thermal bridges in the building. See chapter <a href="#">4.4.11</a> .
	<b>Attached zones</b>	List of all attached zones. See chapter <a href="#">4.4.8</a> .
	<b>Attached Zone</b>	General settings and information about an attached zone. See chapter <a href="#">4.4.8</a> . Available types:
		<ul style="list-style-type: none"> <li>• Unheated Space</li> <li>• Unheated Cellar</li> <li>• Space under suspended floor(crawlspace)</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 <a href="#">4.4.12</a> .
	<b>Remaining Component</b>	Properties of a remaining component. See chapter <a href="#">4.4.12</a> .
	<b>HVAC</b>	List of all HVAC systems. See chapter <a href="#">4.5</a> .
	<b>System</b>	Settings for a specific HVAC system. See chapter <a href="#">4.5</a> .



## Device

Settings for a specific HVAC device. See chapter 6. Available devices:

- User defined. Allows a combination of space heating and cooling as well as air humidification and dehumidification
- Mechanical ventilation
- Electric Heating / DHW
- Boiler
- Combined Heat and Power (CHP)
- District Heating
- Heat Pump
- Solar Collector
- Water Storage
- Photovoltaics



## 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.

## 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 ?? 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.

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



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 the 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 ?? for further information.

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

(1) Localization (2) Climate

Localization Climate Primary energy/CO2-factor

Selection **Standard** (3) Selection

Name Reference climate Gemary (DIN 4108-6)

**(4) Parameters**

Parameters	
Latitude [°]	51.3
Longitude [°]	9.4
Altitude weather station [m]	112
Altitude building [m]	112
Daily temperature swing summer [K]	11.7
Average wind speed [m/s]	4
Length of heating period [days/a]	

**(5) Ground**

Ground	
Ground thermal conductivity [W/mK]	2
Ground heat capacity [J/kgK]	1000
Ground density [kg/m³]	2000
Depth below grade of groundwater [m]	3
Flow rate of groundwater [m/d]	0.05

\*optional

**(6) PHIUS performance targets**

Space conditioning targed data - Select from climate data	
Annual heating demand [kWh/m²a]	
Annual cooling demand [kWh/m²a]	
Peak heating load [W/m²]	
Peak cooling load [W/m²]	

Figure 18: Localization dialog.

## Controls Box

- (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 (Microsoft Excel must be installed)) 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 ??.

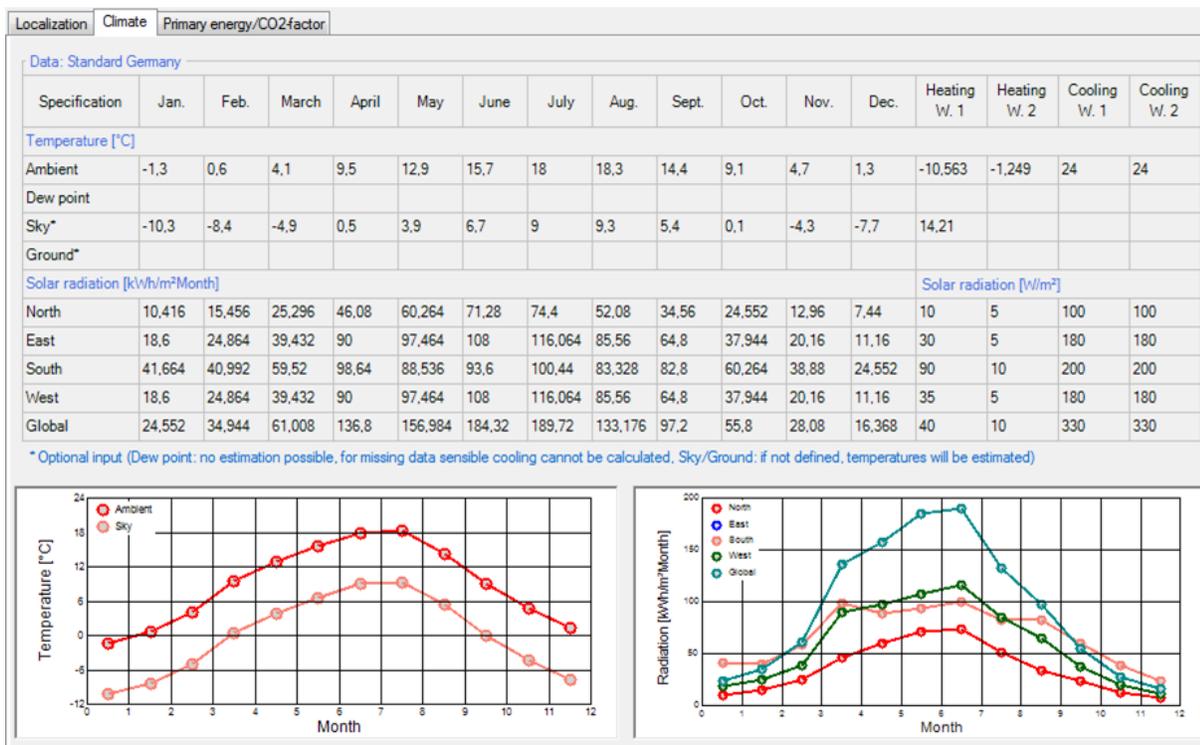


Figure 19: Climate Dialog.

### 4.3.2 Primary Energy/ CO2-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 CO2-Factor allows the conversion of the energy use into an equivalent amount of CO2.

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 ?? 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](#).

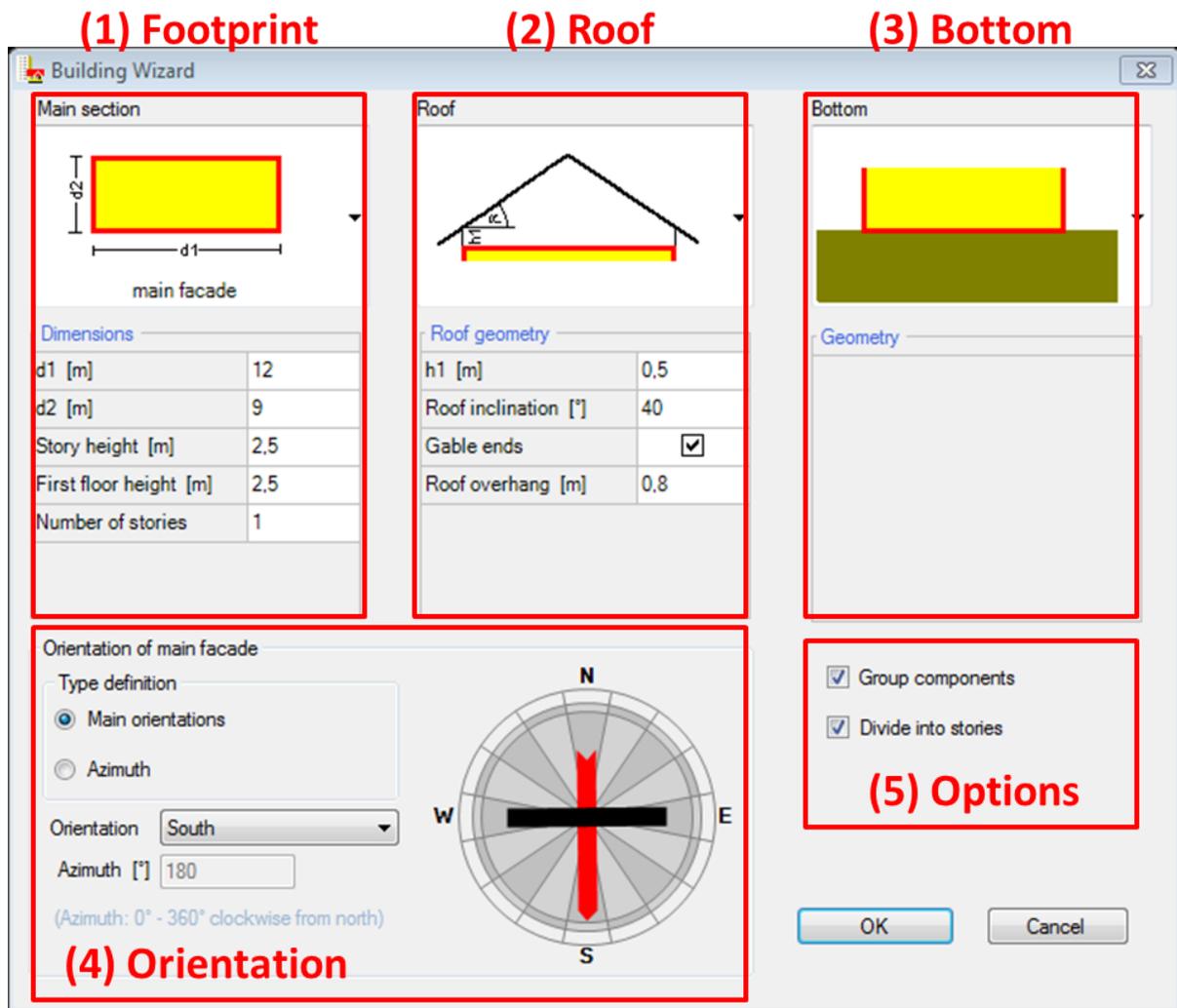


Figure 20: Building Wizard.



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

#### 4.4.2 PH Case: General & Additional data

WUFI® Passive uses PH Cases to differ between different usage types inside a single building model. For example, if a building consists of an office on the first floor and flats on 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 4.4.5 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.

The screenshot shows the 'Additional data' tab of the PH Case dialog. It is divided into two main sections:

**(1) Parameters**

Building category	Residential
Occupancy type	Residential
Building status	In planning
Type	New construction
Indoor temperature [°C]	20
Internal gains setting	Default
Internal heat gains [W/m²]	2.1
Occupancy setting method	Verification
Number of occupants	2.6
Number of units [-]	1

**(2) Zones**

Nr.	Name	Floor area [m²]	
1	Simulated zone	92	New Delete
		Σ 92	

Figure 21: PH Case: General Settings.

Controls	
<b>(1) Parameters</b>	These parameters describe the buildings usage and occupancy type.
<b>(2) Zones</b>	List of all zones of a case.
<b>New</b>	Creates a new zone.
<b>Delete</b>	Deletes the selected zone

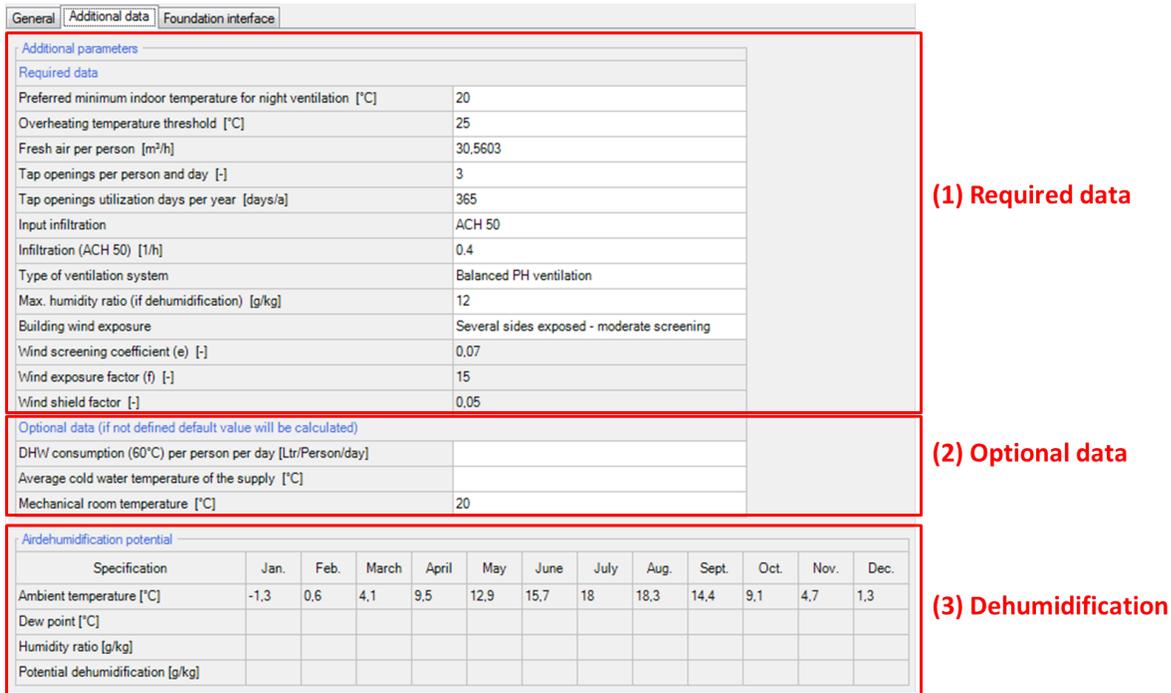


Figure 22: PH Case: Additional data.



**If you open a project that was created with a previous version of WUFI Plus/Passive:**

**With WUFI Plus/Passive 3.1.0 two changes in methodology were made that will change the final results:**

New approach to compute airtightness: Also components adjacent to non-simulated zones or to zones with the same inner climate are now part of the enclosure area and are taken into account for the calculation of the airtightness. So in case of an area related airtightness to those zones this will result in a difference in infiltration air change.

Please note: The airtightness at 50 Pa per envelope area regard the thermal building envelope area including walls and floors to the ground and walls and ceilings to attached neighbor spaces.

### 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.

### 4.4.3 PH Case: Foundation Interface

Up to three foundation interfaces can be defined and are used for calculation of the entire foundation's ground temperature.

(1) Foundation interfaces

(2) Setting/ Type

(3) General Parameters

(4) Additional Parameters

(5) Optional data

(6) Ground temperatures

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.

**Inner 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).

**(3) General Parameters**

These parameters describe the geometry of the foundation and physical properties.

**(4) Additional Parameters**

Additional parameters that were not defined in (2) or (3).

**(5) Optional Data**

Optional parameters that describe the ground.

**(6) Ground temperatures**

Ground temperatures are shown in this table. These temperatures are calculated depending on the user input in this tab and the outdoor climate. The entire foundation ground temperature is calculated from the winter and summer temperatures.

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. This table is only informative. No direct user input is possible.

#### 4.4.4 PH Case: Manual J

The Manual J-dialog allows the calculation of the cooling load for residential buildings according to the 8th Edition of the ACCA Manual J.

General | Additional data | Foundation interface | Manual J

Manual J-residential cooling load calculation **(1) Manual J**

**Climate / ventilation**

Outdoor design temperature [°C]	33.8889
Indoor design temperature (optional) [°C]	23.8889
Outdoor - Indoor moisture difference [%]	46
Air changes per hour [1/h] <b>(2) Climate &amp; Ventilation</b>	0.2
Altitude correction factor [-]	0.87

**Loads**

Nr.	Internal load	Quantity
1	Small Plant	1

**(3) Internal loads**

**Components**

Nr.	Name	Cooling load temperature difference [-]	Heat transfer multiplier [-]	Shade line multiplier [-]	Orientation	Area [m²]	U-value [W/m²K]
1	Z.1. C. 1: Floor Slab	15			Horizontal (100 %)	108	0.1207
2	Z.1. C. 2: Ceiling	35			Horizontal (100 %)	108	0.1279
3	Z.1. C. 3: Exterior Wall	15,6			S (29 %), E (23 %), W (23 %), N 95,8		0.0921
4	Z.1. C. 4: Windows		46	1,41	N (100 %)	7,2	0,7906
5	Z.1. C. 5: Exterior Door	31			S (100 %)	2	0,8547

**(4) Components**

**Results**

Name	Sensible Cooling [W]	Latent cooling load [W]
Opaque components	483,1	0
Fenestration	261,2	0
Ventilation <b>(5) Results</b>	424,4	670,4
Internal loads	0	0
Infiltration	80,5	127,1
<b>Total</b>	<b>1249,2</b>	<b>797,6</b>

**Interim results**

Cooling temperature difference [°C]	10
Average air change rate [1/h]	0.5
Altitude building [m]	112

Status: OK **(6) Intermediate results**

Figure 24: PH case: Manual J.

## Controls

- (1) Manual J** Select this option to perform a Manual J residential cooling load calculation.
- (2) Climate & Ventilation** Information about the Outdoor Climate (See Manual J: Table 1A) and the ventilation conditions (See Manual J: Table 5A or 5B and table 10A).
- (3) Internal loads** The internal loads can be entered here. WUFI® Passive provides a list with the following loads: plant, coffee maker, cooking range, crock pot, toaster, dishwasher, microwave, vented clothes dryer, clothes washing machine, color television, stereo, radio, computer, laser printer, water bed, light fixture, refrigerator or freezer and ceiling fan.
-  **New** Create a new element in this list.
-  **Delete** Delete the selected element.
- Inner 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) Components** List of all entered components in WUFI® Passive. The cooling load temperature difference needs to be entered for the opaque components (See Manual J: Table 4A and 4B). For the transparent components the Heat transfer multiplier needs to be entered (See Manual J: Table 3A, 3B and 3C). If a window overhang is being considered (Described in chapter 5.2.3) a coefficient for the Shade line multiplier is required (See Manual J: Table 3E). The orientation, area and U-value of each component is shown for information.
- (5) Results** After all necessary data is entered the results are displayed in this section immediately.
- (6) Intermediate results** The result of the difference between the outdoor and the indoor cooling temperature is shown. The average air change rate and the building altitude are displayed for information. They are automatically transferred from other tabs (See chapter 4.4.10 and chapter 4.3.1) and.



For further information see the 8th version of the ACCA Manual J Cooling load calculation.

#### 4.4.5 Simulated Zones



There are different inputs for the net volume depending on the certification criteria (Default or PHIUS+ 2015). Please refer to chapter ?? 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 those zones and must be defined precisely. See chapter 4.4.8 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.

The screenshot shows the 'Foundation interface' settings for 'Slab on grade'. The dialog is divided into several sections, each highlighted with a red box and labeled on the right:

- (1) Foundation interfaces:** A list containing '1 | Slab on grade' with 'New' and 'Delete' buttons.
- (2) Setting/ Type:** 'Setting' is set to 'User defined' and 'Type' is 'Slab on grade'.
- (3) General Parameters:** A table with columns 'Specification', 'Setting', and 'Value'.
 

Specification	Setting	Value
Floor slab area [m <sup>2</sup> ]	User defined	
U-Value of slab on grade [W/m <sup>2</sup> K]	User defined	
Floor slab perimeter (P) [m]	User defined	
- (4) Additional Parameters:** A table with columns 'Specification' and 'Value'.
 

Specification	Value
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
- (5) Optional data (if not defined default value will be calculated):** A table with columns 'Specification' and 'Value'.
 

Specification	Value
Phase shift months [months]	
Harmonic fraction [W/K]	
- (6) Ground temperatures [°C]:** A table with columns 'Specification' and months 'Jan.' through 'Dec.'.
 

Specification	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Foundation interface 1: winter												
Foundation interface 1: summer												
Entire foundation												

Figure 25: Simulated Zone Settings.

## Controls Box

- |                            |  |
|----------------------------|--|
| <b>(1) Information</b>     | Information about the zone: Name, type, PH-Case.   |
| <b>(2) Geometry</b>        | Information about the zones geometry and its specific heat capacity, which depends on the construction type of the building. |
| <b>(3) Additional Data</b> | 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.

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

#### 4.4.7 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. The <i>Edit file</i> dialog will open.
	<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>Inner 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 input the area of *Not Visualized Components* or they will not be taken into account in the simulation.

#### 4.4.8 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 those zone and must be defined precisely. The adjacent zones can be named and the type of zone can be selected in the dropdown 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.

#### 4.4.9 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.

Occupant quantity [-]	4
Humidity sources [g/m²h]	2

**(1) General**

Device list Set standard dataset

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

**(2) Device List**

Additional data: Kitchen dishwasher

Choice	DHW connection
Energy demand (norm) [kWh/Use]	1,1
Comment	

**(3) Additional Data**

Figure 26: 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. The *Edit file* dialog will open.
-  **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.
- Inner 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 ?? 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 is 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, etc) 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.

**(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"/>	DHW 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"/>	DHW connection; Utilization factor 1	Insert
Laundry - dryer	PH case occupants		<input checked="" type="checkbox"/>	Condensation dryer; Remaining dampness 0	New/Insert: after

**(3) Additional Data**

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

Figure 27: 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. The *Edit file* dialog will open.



#### 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.

#### Inner 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

Utilization pattern	Occupancy	Office equipment	Kitchen equipment	Lighting
Occupant quantity [-]	4			
Number of Bedrooms [-]	4			
Humidity sources [g/m²h]	2			

**(1) General**

Name	Utilization pattern	Activity of persons	Occupant quantity	Floor area of utilization zone [m²]	
	Pattern 1: Example	Adult, standing or light work			<ul style="list-style-type: none"> <li>New</li> <li>Delete</li> <li>Copy</li> <li>Insert</li> <li>New/Insert: after</li> </ul>
		<ul style="list-style-type: none"> <li>Kid, 0 - 10 years</li> <li>Adult, sitting</li> <li>Adult, standing or light work</li> </ul>			

**(2) Occupancy list**

Additional data	
Heat loss due to evaporation (per person) [W]	
Heat loss due to flushing WC (coldwater)	<input checked="" type="checkbox"/>
Number of flush toilets [-]	1
Toilet utilization pattern	
Use default values for school	<input type="checkbox"/>

**(3) Additional data**

Hint: Input of occupant quantity and floor area of utilization zone is alternative. Only one of them should be defined.

Figure 28: Internal Loads/ Occupancy dialog for residential buildings

**(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. The *Edit file* dialog will open.



**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.

**Inner 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

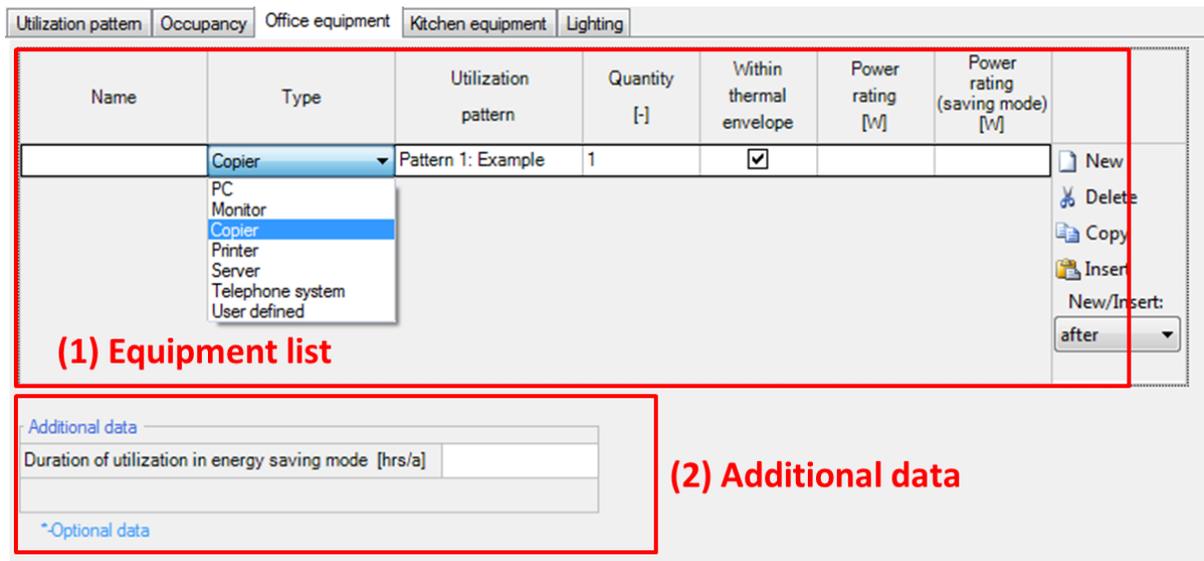


Figure 29: Internal Loads/ Occupancy dialog for residential buildings

## Controls

<b>(1) Equipment list</b>	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.
<b>(2) Additional data</b>	For some office devices additional data can be provided here. This box only shows up if additional information can be added.
<b>New</b>	Create a new element in this list. The <i>Edit file</i> dialog will open.
<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>Inner 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>

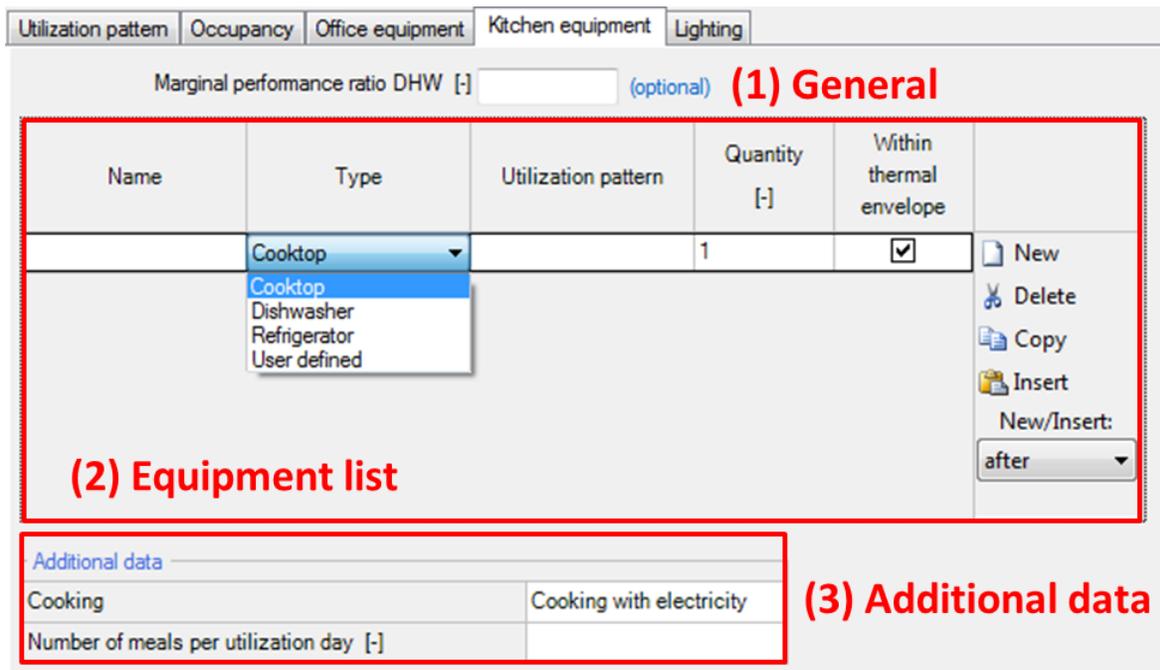


Figure 30: Internal Loads/ Occupancy dialog for residential buildings

## Controls

<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. The <i>Edit file</i> dialog will open.
 <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>Inner 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>

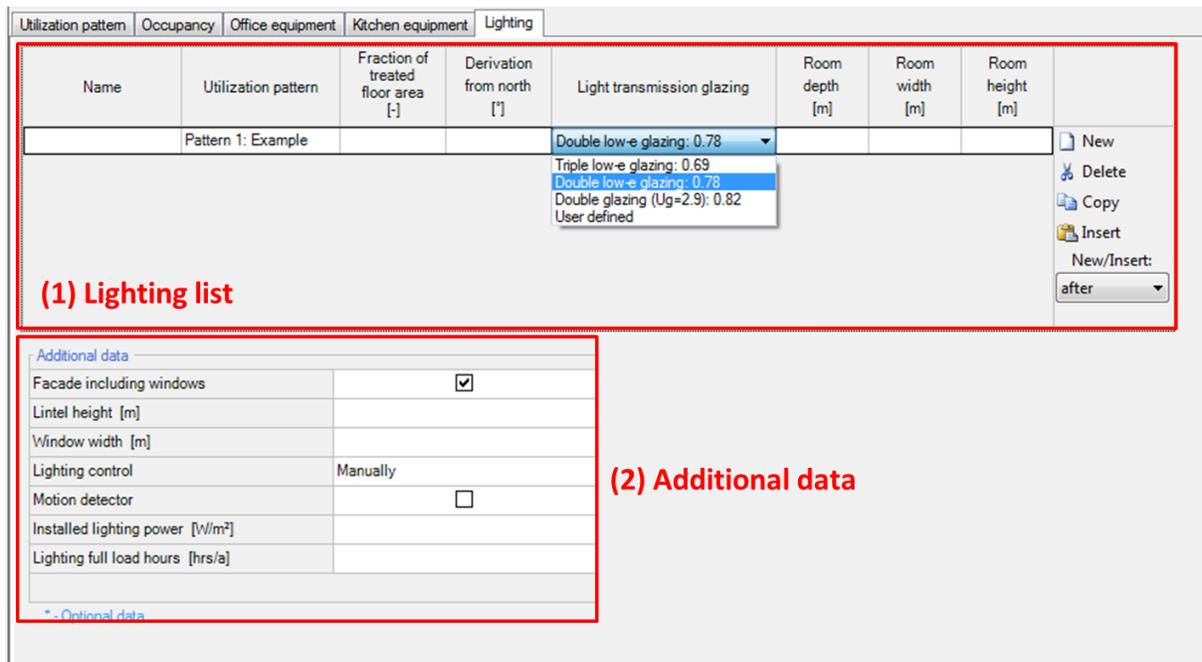


Figure 31: Internal Loads/ Occupancy dialog for residential buildings

## Controls

<b>(1) Lighting list</b>	The required lighting is estimated depending on the amount of daylighting. Therefore data on room geometry, glass transparency and occupancy (utilization pattern) is needed.
<b>(2) Additional data</b>	Additional data can be provided for the lighting calculation.
<b>New</b>	Create a new element in this list. The <i>Edit file</i> dialog will open.
<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>Inner 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>

#### 4.4.10 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 inputs of these tabs are explained on the following pages.

Utilization pattern:

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

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

**(1) Utilization list**

**(2) Intermediate results**

**(3) Additional data**

Figure 32: Ventilation dialog: Utilization pattern.

**(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. The *Edit file* dialog will open.



**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.

**Inner 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:

Utilization pattern: Rooms ventilation | Summer ventilation | Exhaust ventilation

Rooms

Name	Room type	Quantity	Utilization pattern	Design volume flow rate [m³/h]		Average volume flow rate [m³/h]		Average air change rate [1/h]	
				supply air	exhaust air	supply air	exhaust air		
	Kitchen	1	Pattern 1: Example	0	60	0	2,5	0,05	New
	Bathroom	1	Pattern 1: Example	0	40	0	1,7	0,06	Delete
	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

**(1) Rooms list**

Additional data:

Design volume flow rate interzonal [m³/h]	
Area [m²]	20
Clear room height [m]	2,5

Needed only to evaluate the average room air change rate. Not for further calculations

Standard dataset

**(3) Standard dataset**

**(2) Additional data**

Figure 33: 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 inputted 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. The *Edit file* dialog will open.

 **Delete** Delete the selected element.

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 [W/h/m <sup>2</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 [W/h/m <sup>2</sup> ]			
Automatic control system via	Temperature difference		
ACH via natural ventilation (night) [1/h]			

**(1) General**

**(2) Additional data**

Figure 34: Ventilation dialog: Summer ventilation.

### Controls

<b>(1) General</b>	General settings which specify the ventilation during the cooling period.
<b>(2) Additional data</b>	Additional and optional settings for cooling via ventilation.

Exhaust ventilation:

Utilization pattern	Rooms ventilation	Summer ventilation	Exhaust ventilation			
Name	Type	Exhaust volume flow rate [m <sup>3</sup> /h]	Run time per use [min]	Run time per year [min]	Run time per day [min]	<ul style="list-style-type: none"> <li>New</li> <li>Delete</li> <li>Copy</li> <li>Insert</li> <li>New/Insert:</li> <li>after</li> </ul>
<b>(1) Exhaust list</b>						

Figure 35: 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. The *Edit file* dialog will open.



#### 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.

#### Inner 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

#### 4.4.11 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).

Nr	Name	Linear thermal transmittance [W/mK]	Length [m]	Attachment	
1	Example Thermal Bridge	0.04	42	Ambient	New Delete Copy Insert New/Insert: after

Figure 36: Thermal bridges dialog

### Controls

	<b>New</b>	Create a new element in this list. The <i>Edit file</i> dialog will open.
	<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>Inner 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>

#### 4.4.12 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 (1). With "New"(2), a new HVAC-System is created and its System Type can be selected from a dropdown-menu, see figure below (3). 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.

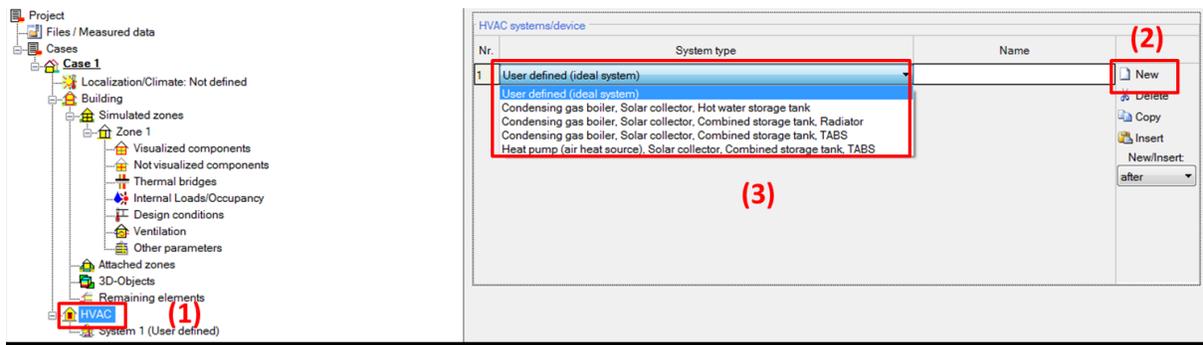


Figure 37: HVAC dialog

**(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. The *Edit file* dialog will open.



**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.

**Inner 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 inputted. 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**

Name  
Example System

**(2) Devices**

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

**(3) Coverage**

Coverage		From other systems			
	From other systems	0	0	0	
1	Photovoltaics				
2	Heat pump	1	0.5	1	

Figure 38: 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. The <i>Edit file</i> dialog will open.
 <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>Inner 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>

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 the 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
- Heat pump (air heat source), 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 systems 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 the 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 39: 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:

General		Distribution		
Hydronic heating		DHW	Ventilation	Supportive device / auxiliary energy
DHW distribution				
Specification	Warm region	Cold region 1	Cold region 2	
Design flow temperature [°C]	55			
Circulation pipes				
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			
Individual pipes				
Length of individual pipes [m]	12			
Exterior pipe diameter [mm]	25.4			
* Optional input				

Figure 40: 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 and the lengths calculated from the hot water tank/ source to each individual tapping point should be entered.

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:

Cooling 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"/>

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 [-]	
Pannel cooling COP [-]	

**(1) Distribution**

**(2) Additional Data**

Figure 41: 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 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:

Name	Duct type	Duct shape	Quantity	Duct length [m]
	Supply / outdoor air duct	Round	1	

**(1) Duct List**

Additional data, Duct 1	
Duct diameter, nominal width [mm]	
Insulation thickness [mm]	
Thermal conductivity [W/mK]	
Is reflective	<input type="checkbox"/>

**(2) Additional Data**

Assigned ventilation units, Duct 1	
V.1.	<input type="checkbox"/>

**(3) Assigned ventilation units**

Figure 42: 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:

General Distribution

Hydronic heating DHW Cooling Ventilation Supportive device / auxiliary energy

Use default values **(1) Default Values**

Name	Device type	Quantity	In conditioned space	Energy demand (norm) [W]	Additional info	
	Heating circulating pump	1	<input checked="" type="checkbox"/>		Controlled	New
	DHW circulating pump	1	<input checked="" type="checkbox"/>			Delete
	DHW storage load pump	1	<input checked="" type="checkbox"/>			

**(2) Device List**

Standard dataset

**(3) System Devices**

Devices in the system	
1	User defined: Heating, DHW, Cooling
2	Mechanical ventilation: Ventilation

**(4) Additional Data**

Additional data: Heating circulating pump

Controlled

Figure 43: 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 the 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	
Rsi [m <sup>2</sup> K/W]	0,13
Rse [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	

(1) Name

(2) Type

(3) Data

(4) Parameters

(5) Exterior Door

Figure 44: 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 <a href="#">5.1.5</a> 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**

Name	R [m²K/W]
Lightweight timber framed wall	3,784

**(2) Available assemblies**

**(3) Summary**

Inhomogenous layers  
 Thermal resistance: 3,784 / 4,17 m²K/W (EN ISO 6946 / homogenous layers)  
 Heat transfer coefficient (U-value): 0,25 W/m²K  
 Thickness: 0,206 m

Nr.	Material/Layer (from outside to inside)	ρ [kg/m³]	c [J/kgK]	λ [W/mK]	Thickness [m]	Color
1	Spruce, radial	455	1500	0,09	0,019	Orange
2	Air Layer 25 mm	1,3	1000	0,155	0,023	Cyan
3	60 minute Building Paper	280	1500	12	0,001	Dark Red
4	Mineral Wool (heat cond.: 0,04 W/mK)	60	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	White

Figure 45: Opaque Components Assembly Selection.

Assemblies that were created in a project can't be saved in the database. So, if you want to reuse 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 the WUFI® -Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about the data-base.

### 5.1.3 Assembly - Editing

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

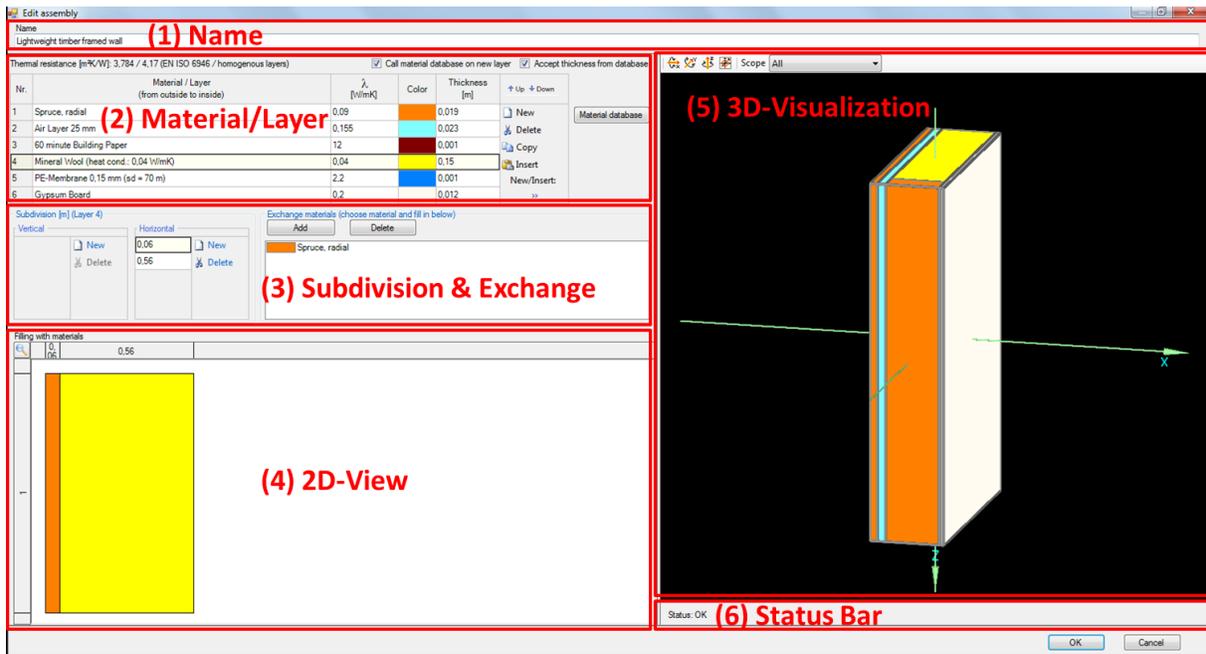


Figure 46: Opaque Components Edit Assembly.

## 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 can-not be transferred! Only the main layers, without subdivisions, are transferred.
- (4) 2D-View** 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 Exchange materials-list (3) and then clicking the desired subdivision in the 2D-View to assign that material to the subdivision.
- (5) 3D-Visualization** This window shows a 3D-visualization of the assembly. The controls for this 3D-view are similar to the 3D-Visualization Box described in chapter 3.4.
- (6) Status Bar** This status bar helps to identify potential errors.



-  **New** Create a new element in this list. The *Edit file* dialog will open.
-  **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.
- Inner 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



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.

#### 5.1.4 Surface

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

General Assembly **Surface**

Heat transfer resistance

According to component type

Rse [m<sup>2</sup>K/W] 0,04

Rsi [m<sup>2</sup>K/W] 0,13

Absorption/Emission (exterior surface)

User defined

Short wave radiation absorption [-] 0,4

Long wave emissivity [-] 0,9

Reduction factor constant shading [-] 1

(1 = no shading, 0 = total shading)

**(1) Heat transfer resistance**

**(2) Absorption/ Emission**

**(3) Constant shading factor**

Figure 47: Opaque Components Thermal surface settings.

## Controls

- |                                     |  |
|-------------------------------------|--|
| <b>(1) Heat Transfer Resistance</b> | The Heat Transfer Resistance can either be entered user-defined or it can be assigned automatically according to the component type.   |
| <b>(2) Absorption/ emission</b>     | 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. |
| <b>(3) Constant shading factor</b>  | 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](#).

## 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® Passive.

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

Figure 48: 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 checkbox is selected, these values are taken from the Window parameters-tab described in chapter 5.2.2. If a window is not mounted to a wall and, for example 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:

**(1) Name**

**(2) General settings**

**(3) Window parameters**

**(4) Frame parameters**

Specification	Left	Right	Top	Bottom
Frame width [m]	0,1	0,1	0,1	0,1
Installation U-value [W/m <sup>2</sup> K]	0,8	0,8	0,8	0,8
Psi-Spacer [W/mK]	0,05	0,05	0,05	0,05
Frame-Wall Psi-value [W/mK]	0,03	0,03	0,03	0,03

Figure 49: Edit Window Parameters.

<b>(1) Name</b>	Naming the window parameter.
<b>(2) General Settings</b>	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.
<b>(3) Window Parameters</b>	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.
<b>(4) Frame Parameters</b>	Here, detailed about the window frame is entered. These values are used for calculation of $U_w$ in (3).
 <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>Inner 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>

### 5.2.3 Solar Protection

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

The screenshot shows the 'Solar protection - General' tab in a software interface. It is divided into two main sections, both highlighted with red boxes and labeled on the right:

**(1) Parameters**

Parameters	
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**

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 50: 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:

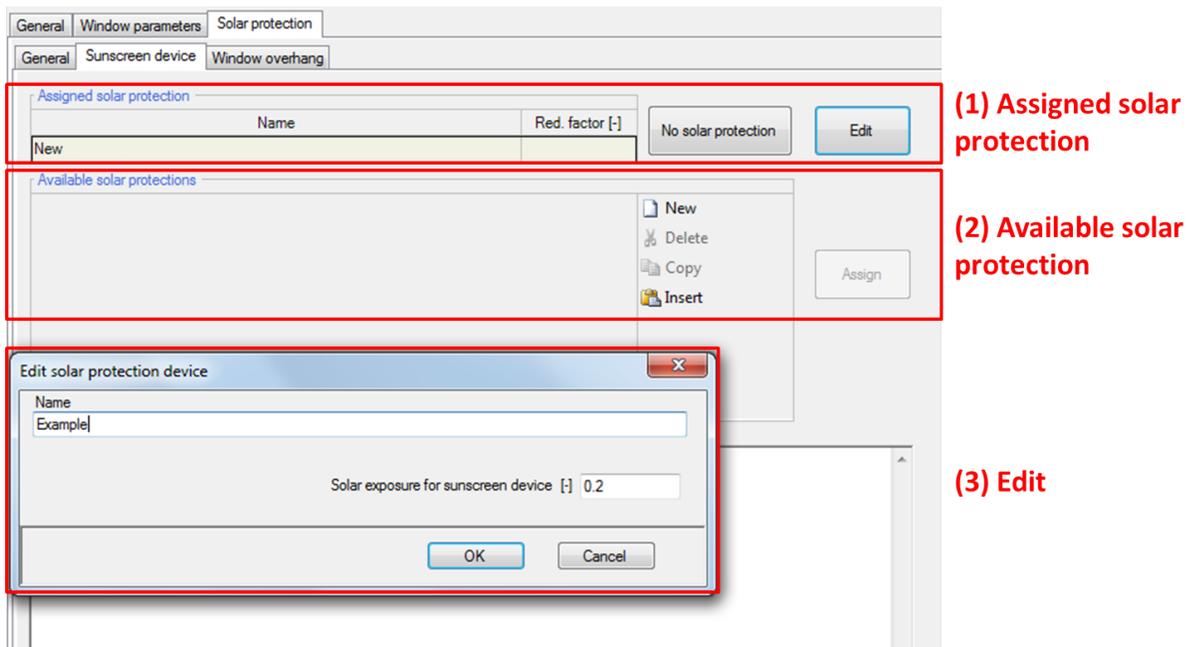


Figure 51: Solar protection of transparent components: Settings for sunscreens devices.

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

## Controls

- |  |  |
|--|--|
| <p><b>(1) Assigned solar protection</b></p>  | <p>The currently assigned sunsreen device. Clicking the Edit-button opens the respective dialog (3). The No solar protection-button dismisses the currently assigned sun-sreen device.</p> |
| <p><b>(2) Available solar protection</b></p> | <p>This list shows all of the sunsreen devices that are currently used in this project.</p>  |
| <p><b>(3) Edit</b></p>                       | <p>In this dialog, the sunsreen device can be named and its shading factor can be entered.</p>   |

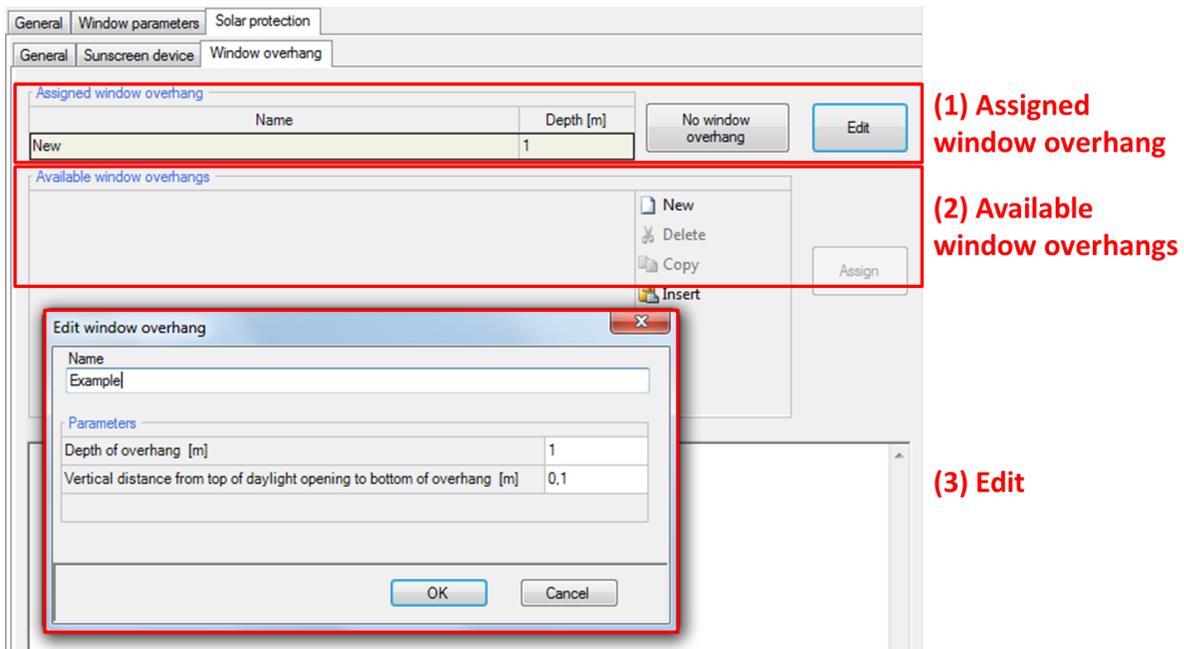


Figure 52: Solar protection of transparent components: Settings for window overhang.

## 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 sunscreen devices and window overhang are multiplied with these values to determine the overall shading reduction factor for each transparent component.

## 6 HVAC-Deviess

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.

The screenshot shows the settings for a mechanical ventilation device. It is divided into four main sections:

- (1) Name:** A text field containing "Mechanical Ventilation".
- (2) Database relevant data:** A section with a table of required data and an "Assign from database" button.
 

Required data	
HRV/ERV efficiency [-]	0,84
Electric efficiency [Wh/m³]	0,37
Equipped with frost protection	<input checked="" type="checkbox"/>
- (3) Ventilated Rooms:** A table listing rooms with checkboxes.
 

Rooms ventilated by this unit	
Z.1. R.1, Kitchen	<input checked="" type="checkbox"/>
Z.1. R.2, Bathroom	<input checked="" type="checkbox"/>
Z.1. R.3, Shower	<input checked="" type="checkbox"/>
Z.1. R.4, WC	<input type="checkbox"/>
- (4) Remaining Parameters:** A section with a table of required data and optional data.
 

Required data	
Quantity	1
Humidity recovery efficiency [-]	0
HRV/ERV in conditioned space	<input checked="" type="checkbox"/>
No summer bypass feature (summer ventilation with HRV/ERV)	<input type="checkbox"/>
Defrost active	<input checked="" type="checkbox"/>
Temperature below which defrost must be used [°C]	-2
Optional data (if not defined default value will be calculated)	
Subsoil heat exchanger efficiency [-]	0

Figure 53: 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 4.4.10. 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 several 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 lists various parameters with their values or checkboxes.

Required data	
Condensing boiler	<input checked="" type="checkbox"/>
Boiler efficiency at 30 % load [-]	0.98
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
Average boiler temperature at design 35°C/28°C [°C]	24
Optional data (if not defined default value will be calculated)	
Maximal heating power [kW]	
Standby heat loss boiler at 70°C [-]	
Auxiliary energy (electric power) [W]	
Auxiliary energy DHW (electric power) [W]	
- (4) Remaining Parameters:** A section for additional settings, including a checkbox for "Within thermal envelope" (unchecked) and a field for "Solar fraction for space heating [-]" (empty).

Figure 54: 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>	<p>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).</p> <p>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.</p>
<b>(4) Remaining Parameters</b>	<p>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).</p> <p>This input is specific for each building, so no entries from the database can be imported.</p>

### 6.4 Compined 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 55: 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 its 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.



**If you open a project that was created with a previous version of WUFI Plus/Passive:**

**With WUFI Plus/Passive 3.1.0 two changes in methodology were made that will change the final results:**

The COP of the simple heat pump model will not be reduced by 0.8 anymore in case a washing machine or a dishwasher is connected to its hot water connection.

Name Heat pump	<b>(1) Name</b>
Type Heat pump	<b>(2) Type</b>
Parameters Required data Annual coefficient of performance (COP) [-] Total system performance ratio of heat generator [-] Annual cooling COP [-]	<b>(3) Parameters</b>

Figure 56: 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 Heat pump is described here, the input for a Combined heat pump 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.  |

**(1) Name**  
Heat Pump - Combined Unit

**(2) Type**  
Combined

**(3) Database relevant data**

Required data	Value
Specific heat loss storage incl. connections [W/K]	1,8
Average storage temperature in standby mode [°C]	50
Flow rate of added exhaust air (0 if not applicable) [m³/h]	0
Effective heat recovery efficiency [-]	0,83
Electric efficiency [W/h/m²]	0,41
Frost protection hydronic	<input checked="" type="checkbox"/>
Optional data (if not defined default value will be calculated)	
Efficiency SHX exhaust air mixing [-]	

**(4) Remaining Parameters**

Required data	Value
Annual cooling COP [-]	
Optional data (if not defined default value will be calculated)	
Solar fraction for space heating [-]	
Efficiency SHX exhaust air mixing [-]	

**(5) Measured values**

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 reload [kW]	0,8	1,4	1	
Measured COP DHW storage heating-up [-]	3,5	3,7	3,5	
Measured COP DHW storage reload [-]	3	3,5	3	
<b>Standby*</b>				
Ambient air temperature [°C]				
Measured thermal power heat pump standby [kW]				
Measured COP standby [-]				

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

Figure 57: 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.

Name  
 Example Solar Collector

Collector type  
 Vacuum tube collector (VTC)

**(3) Database relevant data**

Assign form database

Required data

Total efficiency [-]	0.8
Heat loss coefficient k1 [W/m <sup>2</sup> K]	3.4
Temperature dependence of heat loss coefficient k2 [W/m <sup>2</sup> K]	0.015
Effective thermal capacity [kJ/m <sup>2</sup> K]	5.2
Incidence angle modifier (kdir50°) [-]	0.93
Incidence angle modifier (kdfu) [-]	0.9
Solar thermal yield [kWh/m <sup>2</sup> a]	475
Area of module [m <sup>2</sup> ]	2.2
Optional data (if not defined default value will be calculated)	
Auxiliary energy (electric power) [W]	

**(4) Remaining parameters**

Required data

Area of solar thermal array [m <sup>2</sup> ]	
Orientation of array (positive east from north) [°]	180
Inclination angle of array [°]	30
DHW priority	<input checked="" type="checkbox"/>
Auxiliary energy used in conditioned space	<input type="checkbox"/>
Optional data (if not defined default value will be calculated)	
Vertical distance between upper and lower edge of module(s) [m]	
Vertical distance between shading obstruction and lower edge of module(s) [m]	0
Horizontal distance between shading obstruction and array [m]	
Other shading fraction of solar exposure (1=full exposure, 0=total shading) [-]	1

Optional data: external heat gain calculation

Specification	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Solar gain DHW [kWh]												
Solar gain heating [kWh]												

(1) Name

(2) Type

(3) Database relevant data

(4) Remaining parameters

(5) External heat gain calculation

Figure 58: 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>         | <p>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 its not entered, WUFI® Passive estimates standard values.</p> <p>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.</p> |
| <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> | <p>Data from an external heat gain calculation or from measurements can be entered here.</p> <p>However, this entry is optional and WUFI® Passive calculates these values internally if left blank.</p>  |

## 6.8 Water Storage

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

The screenshot shows the configuration interface for a water storage device. It is divided into five main 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 table of required data:
 

Required data	Value
Storage capacity [Liter]	400
Specific storage losses standby part only [W/K]	0.68

 There is an "Assign from database" button next to this section.
- (4) Connected solar collector:** A list of solar collectors with checkboxes. One collector, "SC.1.: Solar Collector 1", is checked.
- (5) Remaining parameters:** A section with a table of optional data:
 

Optional data (if not defined default value will be calculated)	Value
Within thermal envelope	<input type="checkbox"/>
Storage ambient temperature [°C]	
Quantity	1
Typical storage water temperature [°C]	

Figure 59: 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 60: 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 couldnt 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 reuse 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 the WUFI® -Wiki ([www.wufi-wiki.com](http://www.wufi-wiki.com)) to learn more about the data-base.

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

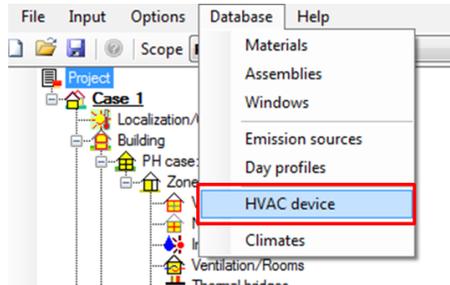


Figure 61: Open the WUFI® HVAC database.

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):

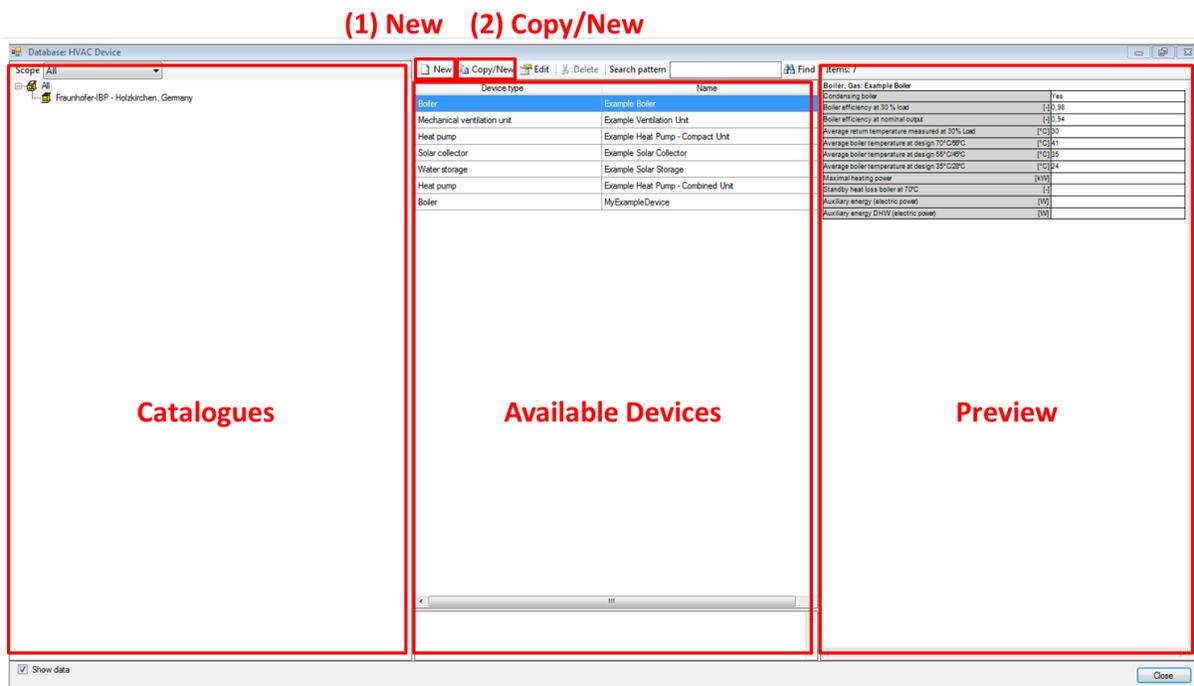


Figure 62: Structure of the WUFI® HVAC database.

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.

The screenshot shows a dialog box titled "Database: HVAC device (New EI.)" with the following fields and annotations:

- (1) Name:** A text input field containing "Example Device".
- (2) Type:** A dropdown menu showing "Mechanical ventilation unit".
- (3) Additional Data:** A table with the following entries:
 

Database relevant data	
Required data	
HRV/ERV efficiency [-]	0.80
Electric efficiency [Wh/m <sup>2</sup> ]	0.30
Equipped with frost protection	<input checked="" type="checkbox"/>
- (4) Catalogues:** A tab labeled "Catalogues" is selected.
- (5) Description:** A tab labeled "Description" is visible.

At the bottom of the dialog box are "OK" and "Cancel" buttons.

Figure 63: 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® Passive.
- 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 *MenuBar > Options > WUFIplusSketchUpplugin*, as described in chapter 3.2.3. The following dialog appears:

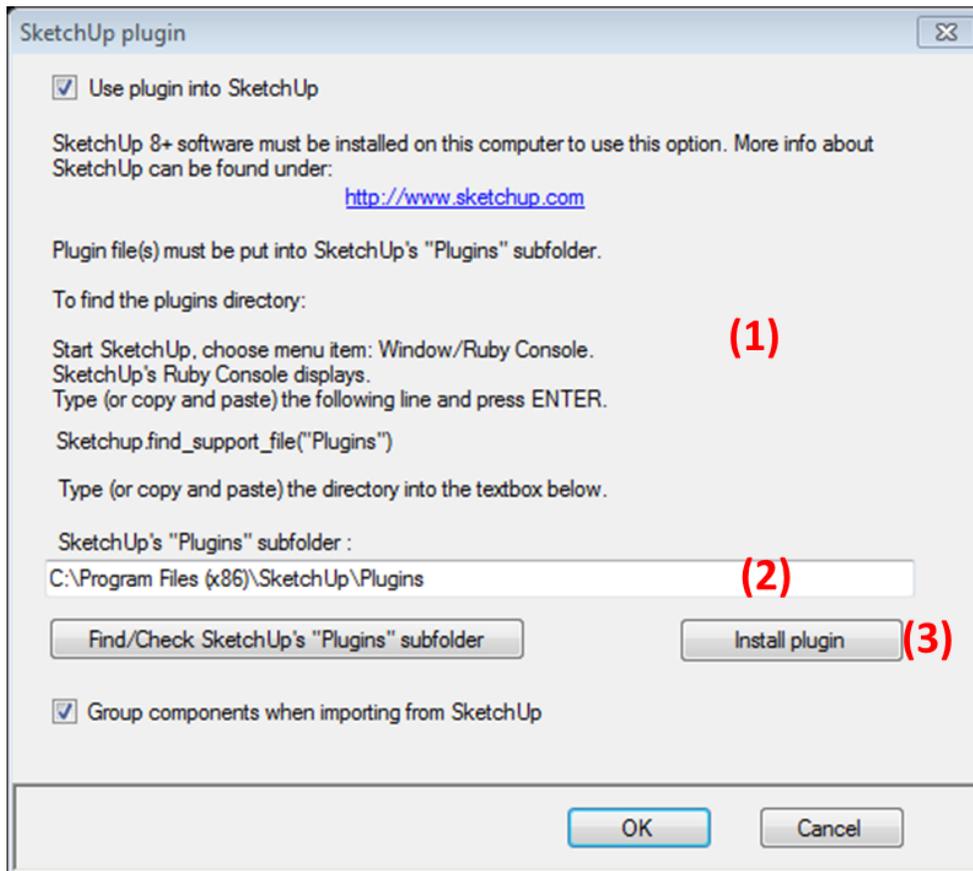


Figure 64: Options for the WUFI® Passive SketchUp Plugin.

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. With SketchUp 2016, the installation requires further steps,

which are described at the end of this chapter. Afterwards it can be found in Sketch-Ups Menu Bar under *Plugins*, 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 Sketch-Up 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 isnt 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. Its recommended to use this function instead of the direct export (2).

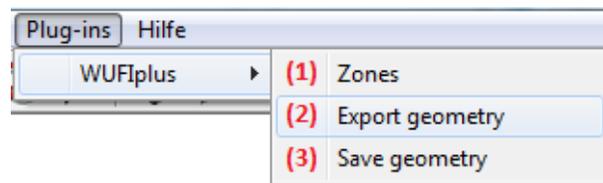


Figure 65: Dialogs in SketchUp for the WUFI® Passive SketchUp Plugin.

The properties of all objects which are imported into WUFI® Passive have to be defined. 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.

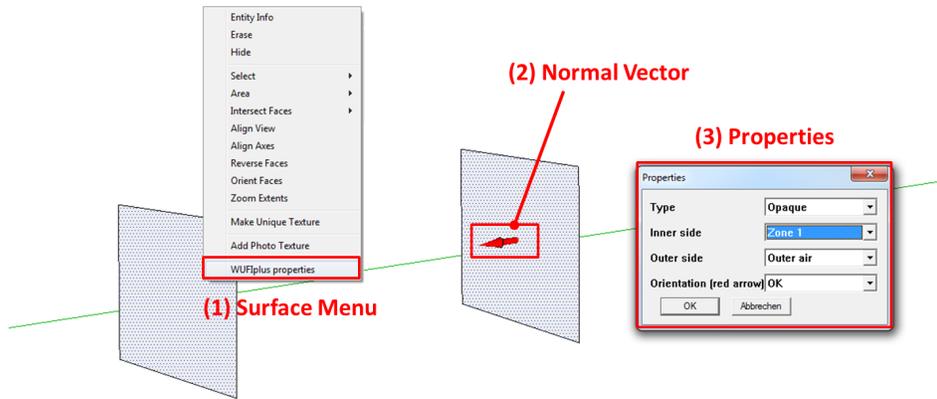


Figure 66: Setting the properties of an object in the WUFI® Passive SketchUp Plugin.



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 the 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 geometries of a building from SketchUp to WUFI® Passive.



#### SketchUp 2016:

The installation in SketchUp 2016 differs because the Plug-Ins have to be set separately in this version:

1. Install the WUFI Passive SketchUp Plug-In in WUFI Passive as described above.
2. The open SketchUp 2016 and choose the menu item Window/ Preferences.
3. A list of preferences appears. There, click on Extensions and select Wufi from the list.

## 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 cannot import a usable model.

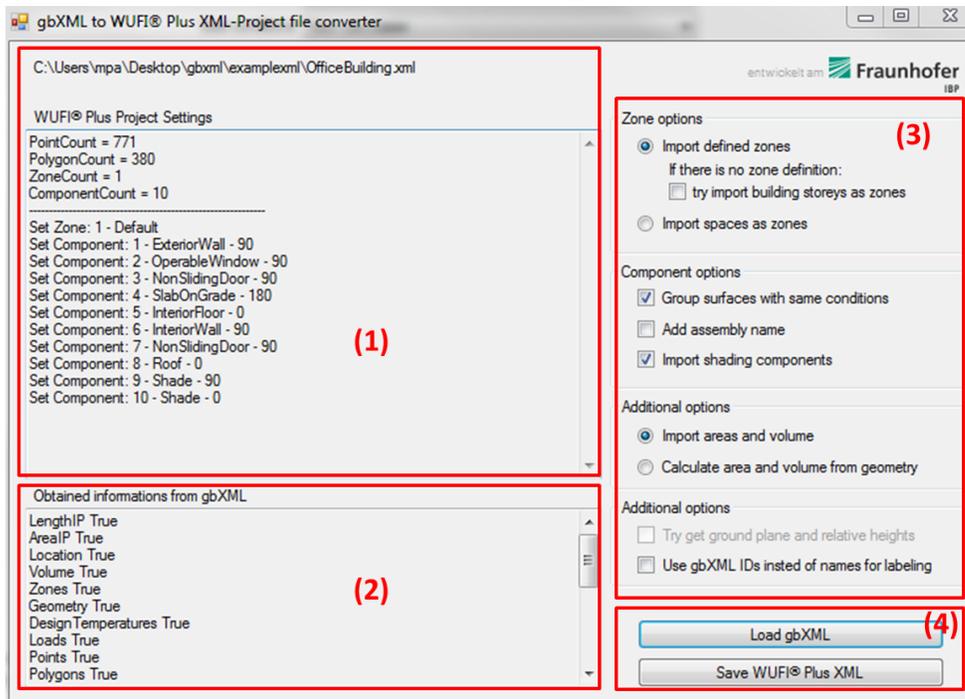


Figure 67: External program for gbXML-import.

## Controls Box

- |                                 |   |
|---------------------------------|---|
| <b>(1) Results screen</b>       | General information about imported zones and components.  |
| <b>(2) Information</b>          | Information about obtained data from the gbXML Project translated to the WUFI® Passive Project.   |
| <b>(3) Import options</b>       | General settings concerning the import of the gbXML geometry, zone definition, and additional data. Further information about these options is provided below the box.  |
| <b>(4) Load and Save option</b> | Two functions are available: <ul style="list-style-type: none"><li>• <i>Load gbXML</i>: Choose the gbXML file you want to use with WUFI® Passive.</li><li>• <i>Save WUFI® Passive XML Project</i>: Saves the loaded gbXML Project with the defined import options, as WUFI® Passive XML Project, openable in WUFI® Passive.</li></ul> |

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 else the building 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 be 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*: ordinarily 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 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 search for 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.

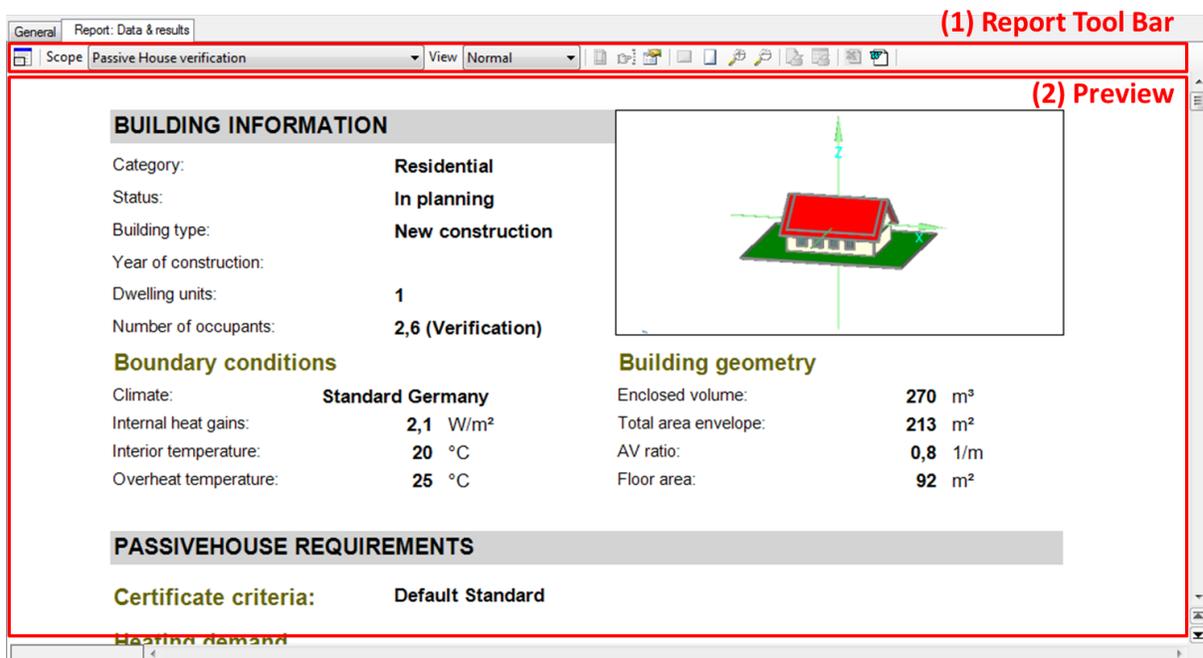


Figure 68: Report dialog.

## Controls

**(1) Report Tool Bar** This tool bar allows selecting, modifying, printing and exporting individual reports. The buttons in this tool bar are explained below.



**Expand/ Shrink Window**

Allows expanding the Report Box.

**Scope**

Allows switching through different types of reports. The table at the end of this chapter lists all available reports.

**View**

Allows changing between two options:

- *Normal*: The standard report viewer in WUFI® Plus.
- *Print layout* shows how the report will look, when its 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).



**Whole page**

Shows the whole page in the Preview Box (2).



**Zoom in/ out**

Zooming in or out in the Preview Box (2).



**Print all**

Prints the current report with the default printer. Only available if View is set to Print Layout.



**Print dialog**

Opens a standard Windows printer-dialog, where the printer and its properties can be selected.  
Only available if *View* is set to *Print Layout*.



**Word Export**

Saves the report as an Microsoft Office (2007+) .docx-file. A standard Windows save-dialog opens and the file can be named.

**(2) Preview**

Shows how the selected report looks like.

## 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:

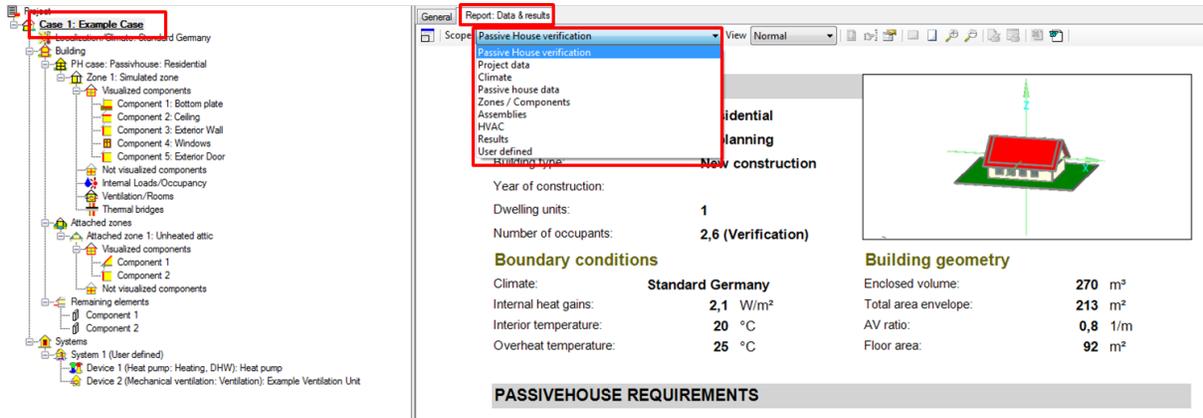


Figure 69: Opening the Passive House verification report.

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.

Next, the different sections of the Passive House Verification report are shown. There will be a short description of the output parameters for each section as well as a screenshot. Please note the terminology used in the report:

### Source Energy:

Site energy plus the energy consumed in the extraction, processing and transport of primary fuels such as coal, oil and natural gas; energy losses in thermal combustion in power generation plants; and energy losses in transmission and distribution to the building site.

### Site Energy:

Energy consumed at the building site as measured at the site boundary. At minimum, this includes heating, cooling, ventilation, domestic hot water, indoor and outdoor lighting, plug loads, process energy, elevators and conveying systems, and intra-building transportation systems.

## 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 from external climate files.
- 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.
- Primary energy is not calculated in WUFI® Plus.
- DHW is not calculated in WUFI® Plus.

### 9.2 Prepopulate Boundary Conditions

Certain input parameters can be carried over from WUFI® Passive to WUFI® Plus mode. To simplify this step new a function "Prepopulate Boundary Conditions" has been introduced. This option will set reasonable values (e.g. Internal Loads, Design Conditions, Ventilation, Ground Climate, SHGC, ...) for the dynamic simulation mode for better comparison of the results.

This function can be accessed from the "Case > General" - Tab in WUFI® Plus Scope.

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

WUFI® Plus comes with a special calculation mode for simulations used in context of the German thermal protection standard DIN 4108-2:2013. 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 cant 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 cant be changed.
- *Internal Loads* are predefined and cant be changed.
- *Design Conditions* are predefined and cant 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*. This report sums up the most relevant input data and evaluates if the simulation results fulfill criteria of DIN 4108-2. A seperate report is created for each simulated zone. The figure below shows an example of this report.
- In order to create a full documentation of your project according to DIN 4108-2 we recoman further add at least the reports "Conditioned Zones", "Assemblies / window types / solar protection" and "HVAC" (if a mechanical ventilation system was used). You can use the "User defined"-Report to combine multiple reports.

## GENERAL INFORMATION

Software: **WUFI® Plus**  
Calculation method: **Thermal building simulation according DIN4108-2**  
Overheating Degree Hours: **1813,4 kWh/a (> 500 demand value)**

## BUILDING INFORMATION

### General information

Type: **Non-residential**

Year of construction:

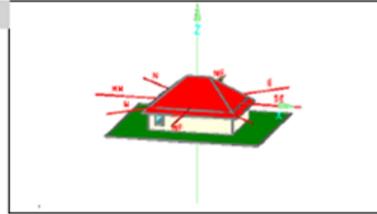
### Building geometry

Enclosed volume: **385** m<sup>3</sup>

Total area envelope: **334** m<sup>2</sup>

AV ratio: **0,87**

Treated floor area: **108** m<sup>2</sup>



## BOUNDARY CONDITIONS

### Boundary conditions

Internal heat gains: **13,1** W/m<sup>2</sup>

Interior temperature: **21** °C

Overheat temperature: **26** °C

### Ventilation

#### Natural

During residence time: **0,2** 1/h (No increased day ventilation)

Outer 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 NN: **81** m

Timezone: **+1** h

Ground reflectance short: **0,2**

Ground reflectance long: **0,1**

Ground emission: **0,9**

Figure 70: Report for a calculation according to DIN 4108-2.

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