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User Guide

iSBEM

An Interface for SBEM (Simplified Building Energy Model)

Part of the National Calculation Methodology: SBEM for assessing the Energy Performance of Buildings

How to use iSBEM:

(2) Compliance Assessment - UK

iSBEM version 6.1.d

12 August 2022

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Key changes and additions from previous versions of the User Guide

Changes and additions in version 6.1.d compared to the previous version:

NEW

Modified

Further guidance

Changes related to **new** or **modified functionality** in the new version as well as further explanation or clarification of **existing** parameters and functionality in iSBEM are listed below and denoted in this guide using the "NEW", "Modified" and "Further guidance" icons in the left margin.

- New delivered energy compliance metric for Scotland's 2022 Section 6 compliance assessments and no requirement for TER compliance for buildings in Scotland in certain cases (see Section 2.1: UK Building Regulations Compliance, Section 4.1.1: Building Regulations Check tab, and Section 4.2.2: BRUKL Output Document: Compliance with Building Regulations).
- Guidance on 'foundation area' parameter being required now also for Scotland's compliance calculations (see Section 3.4.2: Project tab).

This manual, together with the software tools described in it, were developed by the BRE for the Department for Levelling Up, Housing, and Communities (DLUHC).

Disclaimer

The iSBEM User Guide cannot provide legal advice or a definitive interpretation of the law. The guidance provided in this document is limited to the technical operation of the software tool. It is offered in good faith but is not binding on any person(s) or organization. The same applies to the default values in the interface, which should be viewed as conservative suggestions intended to be replaced by actual values.

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Acronyms used in iSBEM and this guide

AHU	Air Handling Unit
BER	Building Emission Rate
BDER	Building Delivered Energy Rate
BPER	Building Primary Energy Rate
BRUKL	Building Regulations United Kingdom Part L (The Building Regulations compliance checking module)
CCHP	Combined Cooling, Heat, and Power
CEN	Comité Européen de Normalisation (The European Committee for Standardisation)
CHP	Combined Heat and Power
CO_2	Carbon dioxide
ECA	Enhanced Capital Allowance
EER	Energy Efficiency Ratio
EPCgen	Energy Performance Certificate Generator (The EPC generator module)
ETL	Energy Technology List
HEPA	High Efficiency Particulate Air
HTHW	High Temperature Hot Water (boiler)
HVAC	Heating Ventilation and Air Conditioning
HWS	Hot Water System
IF	Improvement Factor
iSBEM	Interface for SBEM
LTHW	Low Temperature Hot Water (boiler)
LZC	Low or Zero Carbon
MTHW	Medium Temperature Hot Water (boiler)
NCM	National Calculation Methodology
PVS	Photovoltaic System
SBEM	Simplified Building Energy Model
SSEER	Seasonal System Energy Efficiency Ratio
SSEff	Seasonal System Efficiency
SES	Solar Energy System
SFP	Specific Fan Power
TER	Target Emission Rate
TDER	Target Delivered Energy Rate
TPER	Target Primary Energy Rate
VAV	Variable Air Volume
VRF	Variable Refrigerant Flow
WWHRS	Waste Water Heat Recovery System

1. WHAT IS IN THIS GUIDE

1.1. Scope of the guide

The objective of this document is to give step-by-step guidance on the use of iSBEM, an interface to SBEM (Simplified Building Energy Model), for the purpose of assessing compliance with the building regulations in the UK for non-domestic buildings.

This guide includes:

- How to work through the steps of the input procedure.
- How to obtain the Building Regulations compliance document.
- A tutorial with tasks spread out throughout the chapters.

This guide **does not** include:

- A detailed description of the structure of the NCM.
- A full definition of the Notional building which is used to assess compliance with Building Regulations. This can be found in England's NCM Modelling Guide which is available from the NCM website at www.uk-ncm.org.uk.
- A description of the contents of the NCM Construction, Glazing, or Activity databases.
- A detailed description of SBEM, the calculation engine to which iSBEM is an interface. This is described in the SBEM Technical Manual, available for download from the NCM website at www.uk-ncm.org.uk.
- How to set up iSBEM to operate on your computer, how to assemble the required information for your own building, how to zone your building, or how to convert files created with previous versions of iSBEM to be compatible with the current version. This can be found in the User Guide volume "**How to use iSBEM: Basics - UK**".
- Guidance related to energy calculations for the States of Jersey.

This manual is one volume in a set of documentations for the iSBEM User Guide. The other volumes in this set are as follows:

- **How to use iSBEM: (1) Basics – UK –** Contains an introduction to the use of iSBEM, an interface for SBEM (Simplified Building Energy Model) - an approach for the National Calculation Methodology (NCM) for assessing the energy performance of buildings.
- **How to use iSBEM: (3) EPC Generation – UK** - Contains step-by-step guidance on the use of iSBEM for the purpose of generating energy performance certificates for non-domestic buildings in the UK.

TUTORIAL: The tutorial runs alongside the different chapters with a task set at each stage, starting from opening iSBEM through to printing off the Compliance document. It is recommended that you complete this tutorial before trying to enter real building data. Details on the Example building used in the tutorial are included in APPENDIX A:.

Task 1: Start the application, accept the terms and conditions, select "Open an Existing Project" and click on 'OK'. You will now be within the "Projects" sub-folder within the "iSBEM_v6.1.d" folder. When you installed iSBEM, you also automatically installed 2 project files for the Example building: the 'Example building - Complete' and the 'Example building - Tutorial' files. Double-click on the 'Example building - Complete' File. You should now be within the interface which opens in the *General* form.

Task 2*:* In the 'Example building - Complete' file, click on each of the forms and each of their tabs and sub-tabs to familiarise yourself with how to get from one location in iSBEM to another. (At present, there is a small, but unavoidable, time delay when switching between forms.)

2. CALCULATION BASICS

2.1. UK Building Regulations Compliance

The calculation procedure required by the NCM is explained more fully in the National Calculation Methodology (NCM) Modelling Guide of the relevant devolved administration. SBEM complies with the NCM. It is suitable for use with the majority of buildings, but some designs will contain features that mean that more accurate energy calculations may be obtained by more sophisticated calculation methods.

In summary, the Building Regulations compliance procedure calculates the total energy consumption of the building and its services (in kWh/m^2.annum) and compares the corresponding carbon dioxide emissions of the building being evaluated (its "Building Emission Rate" or BER) with a target value ("Target Emission Rate" or TER) derived from similar calculations for a "Notional building" (where both emission values are in $kgCO_2/m^2$.annum). For the England and Wales Building Regulations, the primary energy of the building being evaluated (its "Building Primary Energy Rate" or BPER) is also compared with a target value ("Target Primary Energy Rate" or TPER) derived from the Notional building (where both values are in kWh/m^2.annum). Similarly, for the Scotland Building Regulations, the delivered energy of the building being evaluated (its "Building Delivered Energy Rate" or BDER) is compared with a target value ("Target Delivered Energy Rate" or TDER) derived from the Notional building (where both values are in kWh/m^2.annum).

NEW

The Notional building has the following characteristics:

- The same geometry, orientation, and usage as the evaluated building.
- The amount of glazing in the Notional building is, however, not the same as that in the evaluated building. The area of glazing is a certain percentage of external walls and roofs and is dependent on the activity and building type.
- It is exposed to the same weather conditions as the evaluated building.
- Standard operating patterns (to allow consistent comparison between buildings in the same sector).
- Standardised assumptions for building fabric, glazing type, and HVAC plant efficiencies.

Detailed specifications of the 2021 England Notional building are in DLUHC's 2021 NCM Modelling Guide (available from www.uk-ncm.org.uk), and further guidance is in the Building Regulations Approved Document Part L 2021, which can be accessed from https://www.gov.uk/government/publications/conservation-of-fuel-and-power-approved-document-l.

Detailed specifications of the 2014 Welsh Notional building are in the Wales 2014 NCM Modelling Guide (available from www.uk-ncm.org.uk), and further guidance is in the Building Regulations Approved Document Part L 2014 Wales, which can be accessed from www.wales.gov.uk/docs/desh/publications/140326building-regs-approved-document-l2a-fuel-power-en.pdf.

Detailed specifications of the 2022 Scottish Notional building are in the Scotland 2022 NCM Modelling Guide, which can be accessed from https://www.gov.scot/publications/building-standards-list-of-guidance/pages/key-supporting-technical-guidance/, and further guidance is in the Scotland Building Regulations Section 6 2022, which can be accessed from https://www.gov.scot/policies/building-standards/monitoring-improving-building-regulations/.

For Northern Ireland, please refer to www.finance-ni.gov.uk/topics/building-regulations-and-energy-efficiency-buildings for further information on Northern Ireland's building regulations and published documents.

NB: Only the communal areas of apartment buildings containing self-contained flats should be assessed for compliance using SBEM, for example, circulation areas (using the "Common circulation areas" activity under the building type "Residential spaces"). The self-contained flats themselves should be assessed using SAP (for domestic buildings).

SBEM calculates the energy demands of each space in the building according to the activity within it. Different activities may have different temperatures, operating periods, lighting standards, etc. SBEM calculates heating and cooling energy demands by carrying out an energy balance based on monthly average weather conditions. This is combined with information about system efficiencies in order to determine the energy consumption. The energy used for lighting and hot water is also calculated. This requires information from the following sources:

Information	Source
Building geometry such as areas, orientation, etc.	Assessor reads from drawings or direct measurement.
Weather data	Internal database.
Selection of occupancy profiles for activity areas	For consistency, these come from an internal Activity database – assessor selects by choosing building type and activity from the database for each zone.
Activity assigned to each space	Assessor defines within iSBEM by selecting from internal database (the user should identify suitable zones for the analysis by examining the building or drawings).
Building envelope constructions	Assessor selects from internal Construction and Glazing databases or inputs parameters directly ("Inference" procedures may be used for energy certification of existing buildings). Assessor can also define their own constructions in the user-defined construction database.
HVAC systems	Assessor selects from internal databases or inputs parameters directly.
Lighting	Assessor selects from internal databases or inputs parameters directly.

Table 1: Calculation parameters for SBEM

The "inference" facility in iSBEM guides the assessor through the data input procedures and directs them towards appropriate internal databases. This option is intended for use when certifying existing buildings if the drawings or construction information are not available.

3. ENTERING A BUILDING INTO iSBEM

This chapter takes you through each of the iSBEM data entry forms consecutively (the *General*, *Project Database*, *Geometry*, and *Building Services* forms), giving guidance on what information is required at each stage.

For this section of the tutorial, you will be using the 'Example building – Tutorial' file. Some of the information for the Example building has already been entered into this file, but in each step, there will be a few fields that need to be filled in.

The Example building

The Example building is a two-storey rectangular building. A coffee shop and a supermarket are located on the ground floor, separated by a passageway, while the first floor is office space. The original drawings for each floor, as well as the characteristics of the building fabric are shown in APPENDIX A:. A 3D-view of the Example building is shown in Figure 1.

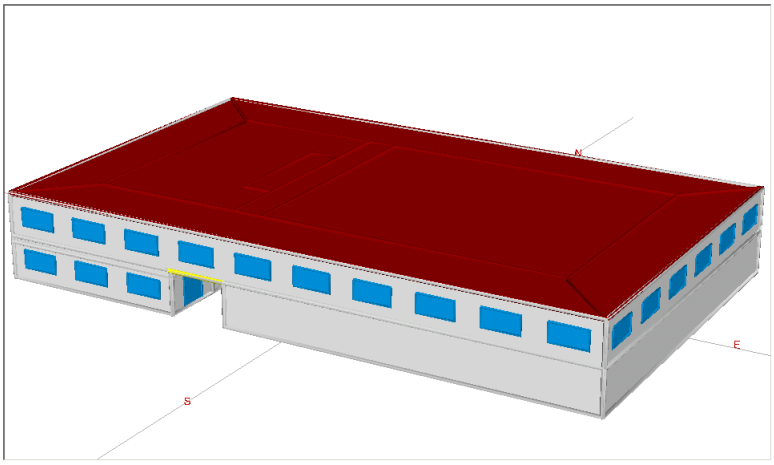


Figure 1: 3D view of the Example building

Before continuing with the tutorial, it is recommended that you have a brief read through APPENDIX A: to familiarise yourself with the building and, in particular, how the building has been zoned.

Task 3*:* Close the completed version of the example ('Example building - Complete' File), that you have been using to take a tour of the interface in Task 2, and open the tutorial version of the example, 'Example building – Tutorial' file.

To do this, go to the *File Options* tab in the *General* form and click "Open an existing project". You will then be asked if you want to save the complete version. Click on "Exit without saving". You will then be presented with the start-up options dialogue box. Click on "Select an existing project to open", and then select the 'Example building – Tutorial' File.

3.1. Important note on the default values in iSBEM

In iSBEM, there are default values included for various parameters. For example, there are default seasonal efficiencies for HVAC systems and default constructions for envelope

elements so that you can select them when defining the envelopes of a zone when learning how to use the tool. These default values are not generous (i.e., usually pessimistic), should be checked by the user, and, if appropriate, changed or added to.

NB: If none of the default values in iSBEM are changed when modelling a new building, it is very likely that the building will not comply with Building Regulations.

3.2. General form

The *General* form contains two tabs:

- **File Options** tab
- **General Information** tab

3.2.1. File Options tab

The *File Options* tab has five sub-tabs:

- **File Operations** sub-tab.
- **System Configuration** sub-tab.
- **System Configuration (cont.)** sub-tab.

File Operations sub-tab:

This sub-tab contains the options to “Save current project”, “Save As”, “Open an Existing Project”, “Create a New Project”, and “Exit iSBEM” (shown in Figure 2). It also displays in the “Current file” box the name and location of the currently open project file (“.nct” file).

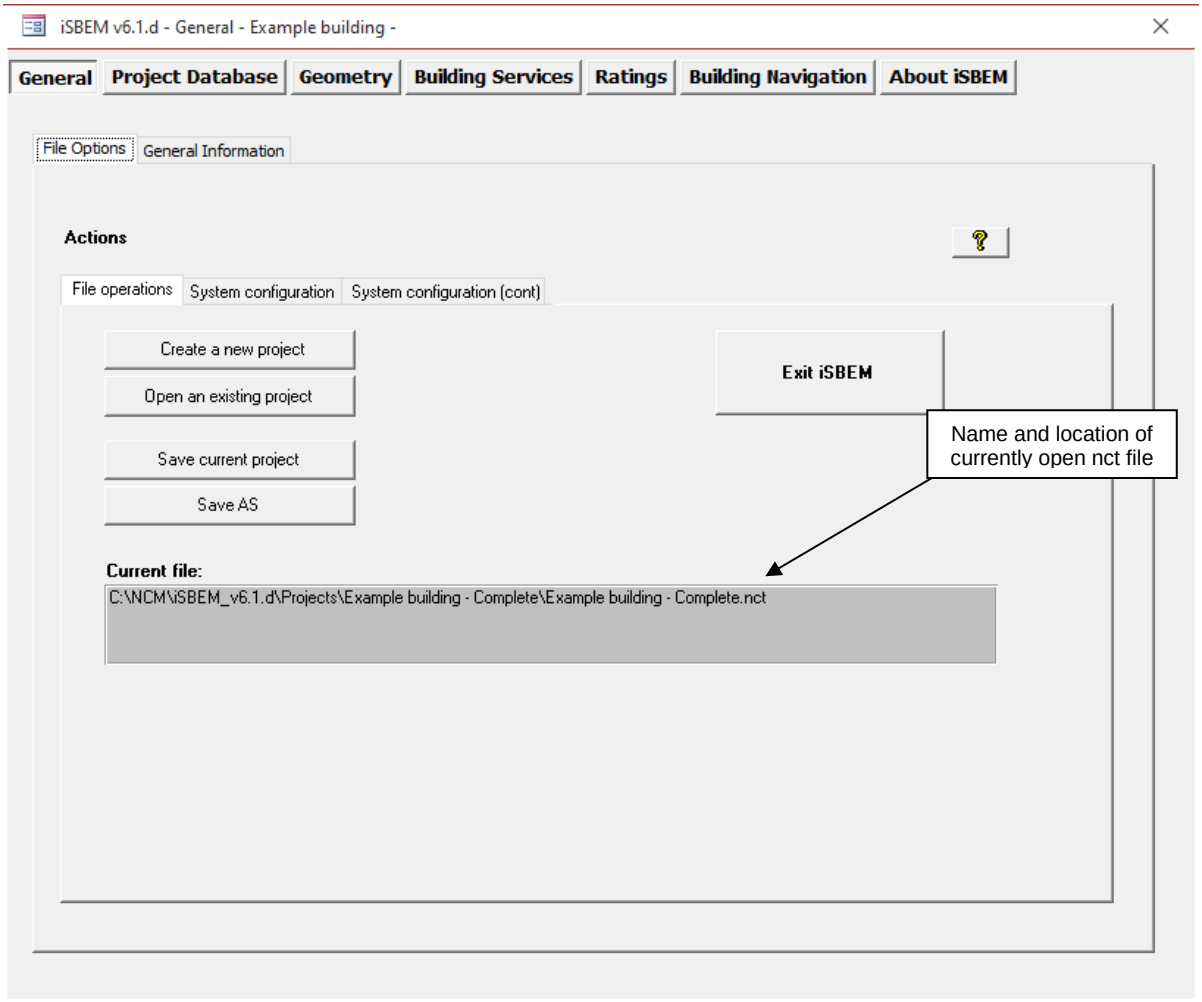


Figure 2: The File Options tab in the General form

System Configuration sub-tab:

iSBEM creates different output reports (more details can be found in Chapter 4). Several of these reports have the file extension 'pdf" and '.htm', i.e., they are in pdf and html formats, respectively. In order for the pdf and html files to be opened by iSBEM for you to view (by accessing your default web browser on your computer, e.g., Microsoft Edge), iSBEM needs to know the *Program Files* folder path on your computer. The default path (C:\Program Files (x86)\), shown in Figure 3, should be fine for most systems. If, however, you have a different configuration on your computer, and the reports are not created or cannot be opened from the *Ratings* form, you will need to manually edit the configuration in this tab to reflect the settings on your computer. When you tick the box "Tick to edit current configuration", the "Program Files folder" box will become active and you will be able to input the location appropriate for your computer configuration. If in doubt about what this configuration is, contact your IT Department.

iSBEM also needs to know the folder where the projects and the iSBEM output reports will be saved. This is specified by the location of the *Projects* folder. The default path, shown in Figure 3, should be fine for most systems, where [App-Path] is the path where the application iSBEM has been installed on your computer (by default, C:\NCM\iSBEM_v6.1.d). If, however, the reports are not created, or you have changed the location where iSBEM is installed by default, you will need to manually edit the configuration in this box "Project Files folder".

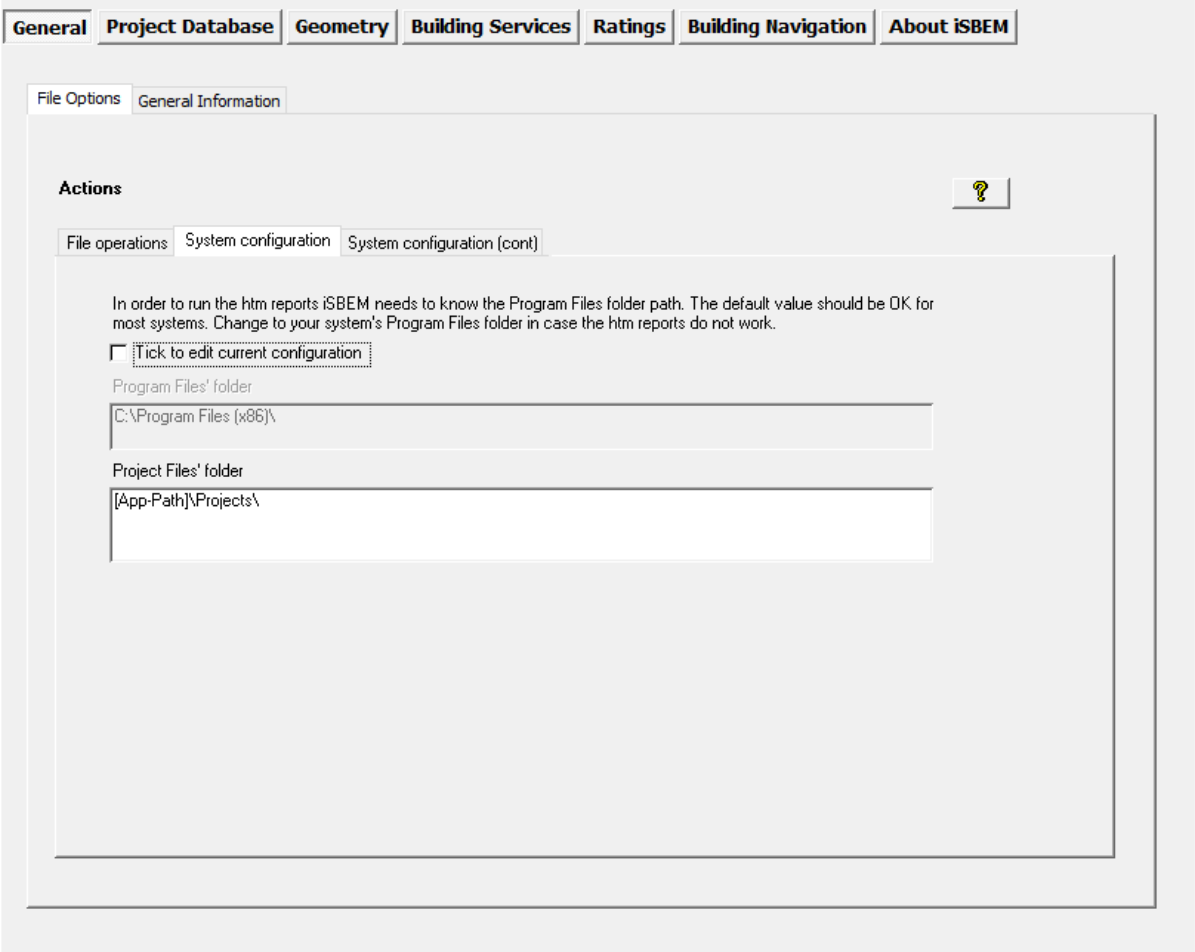


Figure 3: The System Configuration sub-tab

System Configuration (cont.) sub-tab:

This sub-tab (Figure 4) contains tick boxes which users can modify to reflect their preferences while using iSBEM:

1. Tick box which is unticked by default. You need to tick it if you would like iSBEM to generate the *Data Reflection* reports (for the Actual and Notional buildings) in html format (as well as csv format which is always done) during the calculation, and the relevant access button will appear in the *Ratings* form. If the box remains unticked, then these reports will be generated in csv format only (see Section 4.2.3: Data Reflection Report – Actual Building and 4.2.3: Data Reflection Report – Actual Building), and the relevant access button in the *Ratings* form will remain invisible.
2. Tick box, which is ticked by default, and should remain ticked if you wish for the contents of the *Building Navigation* form to be refreshed automatically with any changes in the objects properties that might have been performed since the form was last accessed. If you do not wish for the *Building Navigation* form to be refreshed automatically, you should untick this box. There is a button in the *Building Navigation* form which you can click in order to initiate the “refresh” function manually (see Section 3.6: Building Navigation form).
3. Tick box, which is ticked by default, to automatically clear the contents of the *Quick Envelopes* tab once the envelopes have been created (i.e., once the “create envelopes” button has been pressed). You can untick this box if you do not wish for the contents of

the tab to be cleared (see Section 3.4.8: Quick Envelopes tab: Short cut to creating envelopes and windows).

4. Tick box, which is ticked by default, to allow the definition of the areas of glazing within envelopes to be input as areas, in m^2, rather than percentages in the *Quick Envelopes* tab. If you wish to define glazing areas using percentages, then you can untick the box (see Section 3.4.8: Quick Envelopes tab: Short cut to creating envelopes and windows).

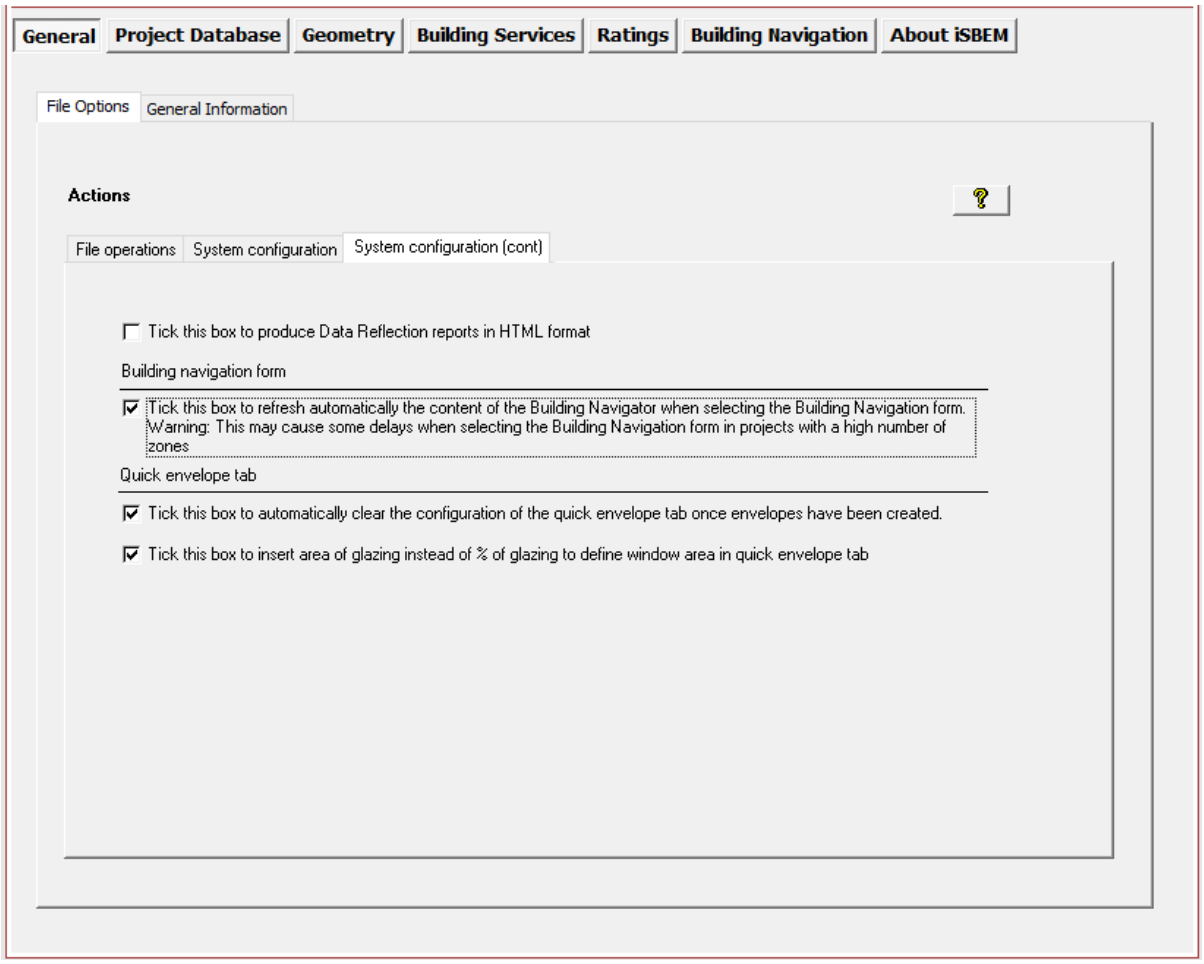


Figure 4: The System Configuration (cont.) sub-tab

3.2.2. General Information tab

The *General Information* tab contains a few sub-tabs, as described below, where you can enter as much or as little background information about the project. However, there are also essential parameters to be selected, such as the weather location for the project and the purpose of the analysis. These details can be entered and edited in their respective tabs (see Figure 5). Some of this information may have already been entered when the project was first created (see the User Guide volume "**How to use iSBEM: Basics - UK**"), but they can be edited here.

The *General Information* tab contains the following sub-tabs:

- **Project Details** sub-tab.
- **Additional Project Details** sub-tab.

- **Special Considerations** sub-tab.
- **Regulation 25A** sub-tab.
- **Building Details** sub-tab.
- **Certifier Details** OR **Agent Details** sub-tab.

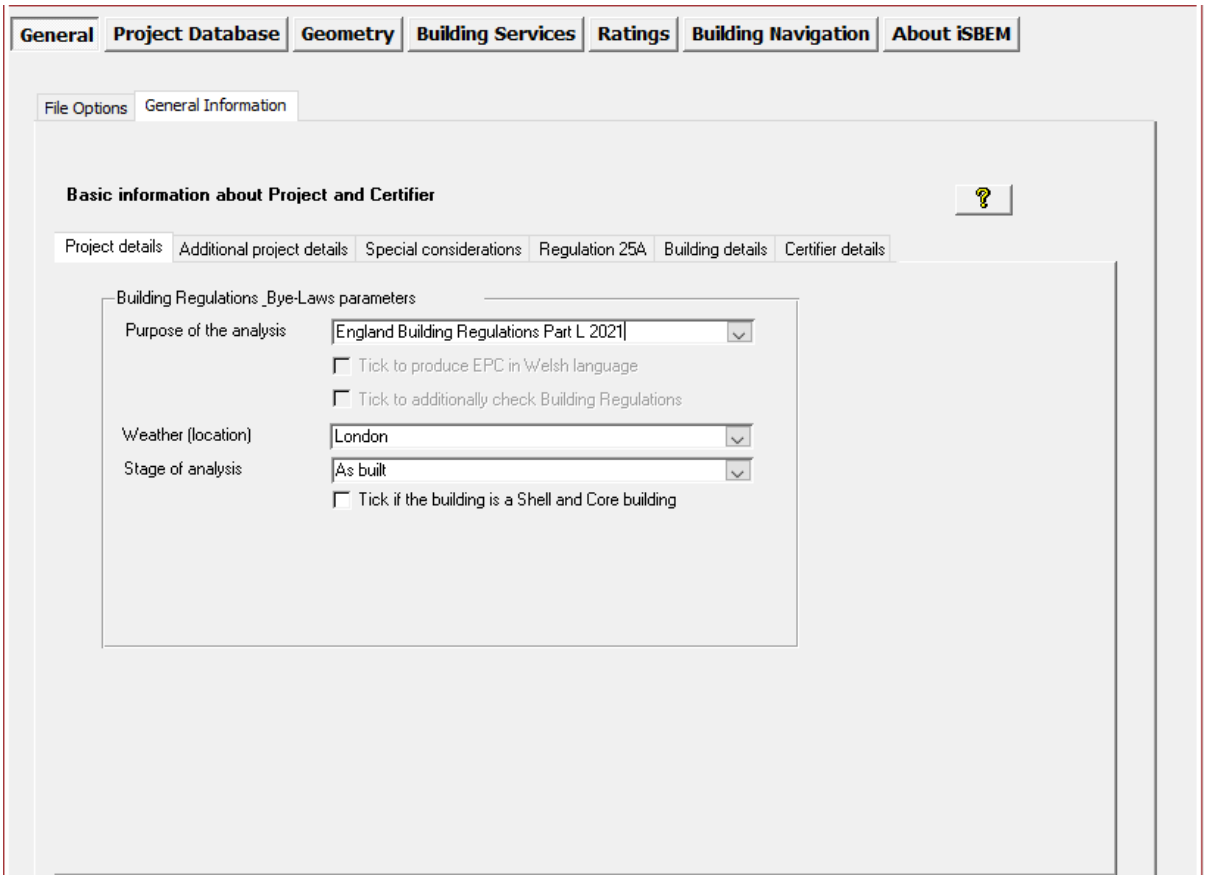


Figure 5: The General Information tab in the General form if England compliance is selected as the purpose of analysis

Project Details sub-tab:

In this sub-tab, the following information can be entered (Figure 5):

Building Regulations & Bye-Laws Parameters

1. Purpose of the analysis – purpose for carrying out a calculation using iSBEM, whether it is to check compliance with Building Regulations in England or any other country in the UK, e.g., England Building Regulations Part L 2021.
2. Weather location (pick the closest to your site from the available locations) – there are 14 locations available for England, 1 for Wales (Cardiff), 1 for Scotland, and 1 for Northern Ireland (Belfast).
3. Stage of analysis – whether “as designed” or “as built”. This parameter is not enabled if the Scottish Regulations are selected in the “Purpose of the Analysis” parameter above.
4. Tick box to indicate whether this is a ‘shell and core’ building. This parameter is active only if the purpose of analysis is checking compliance with building regulations for England, Wales, or Northern Ireland.

5. S6 type of building – type of building according to Section 6 of the Scottish Building Regulations, i.e., this parameter is active only if the calculation is for Scotland.

   NB: For details of the Section 6 types of buildings, please refer to the Scotland Building Regulations Section 6 document for 2015[i] (for further guidance on 'Shell buildings', 'Extensions to the insulation envelope', and 'Other buildings').

Additional Project Details sub-tab:

When modelling a building for the purpose of assessing compliance with building regulations, you can disregard the parameters in this sub-tab.

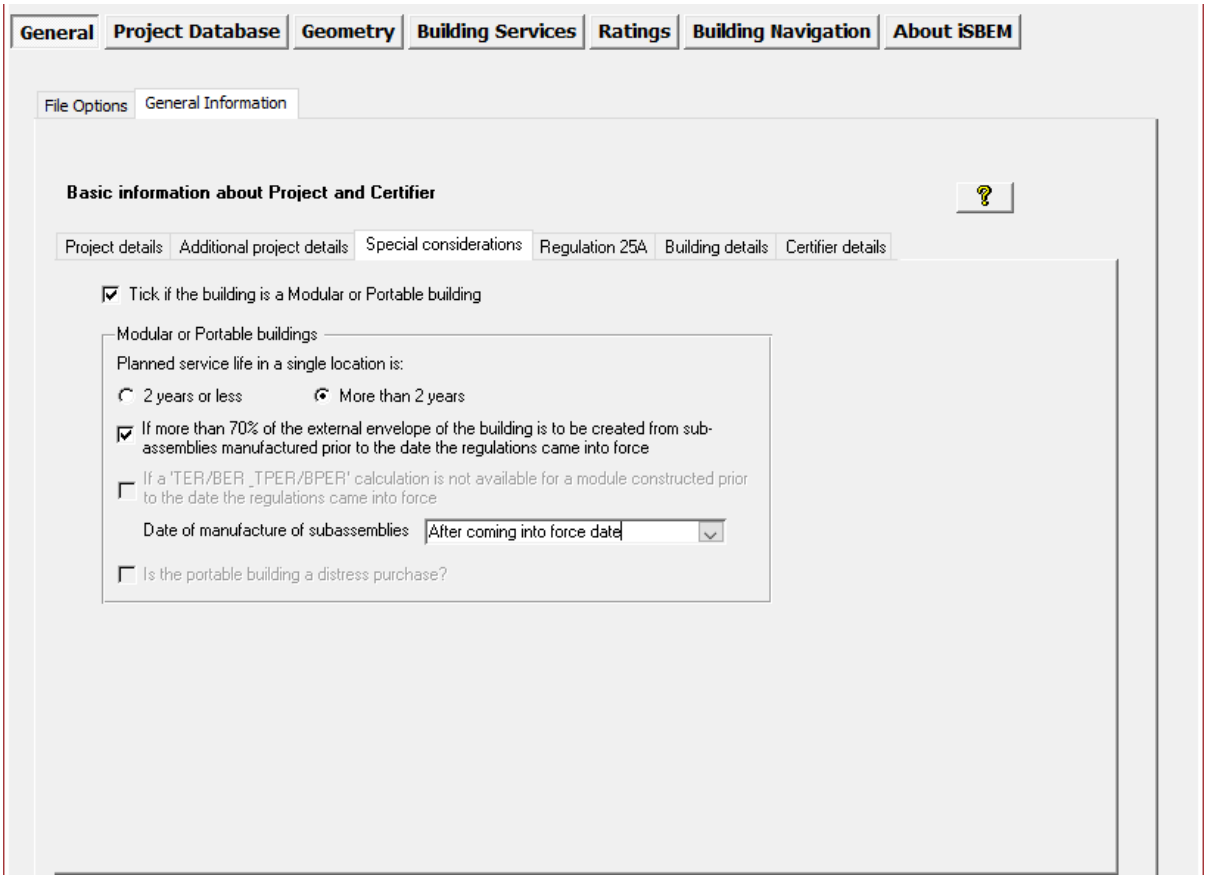


Figure 6: The Special Considerations sub-tab of the General Information tab in the General form

Special Considerations sub-tab:

In this sub-tab (Figure 6), the following information can be entered:

1. Tick box to indicate if this is a modular or portable building (with a total planned service life of more than 2 years), as defined in the building regulations. If the box is ticked, the following parameters become active, if relevant for the purpose of analysis selected:
   a. A radio button to indicate that the planned time of use in a single location is either:

[i] Available from http://www.gov.scot/Topics/Built-Environment/Building/Building-standards/techbooks/techhandbooks/th2015nondom6.

i. 2 years or less

ii. More than 2 years

b. Depending on your selection in the above parameter, one or more of the following parameters will become active:

i. A tick box to indicate if more than 70% of the external envelope of the building is to be created from sub-assemblies manufactured prior to the date on which the regulations came into force.

ii. A tick box to indicate if a “TER/BER & TPER/BPER” calculation is not available for a module constructed prior to the date the regulations came into force.

iii. Date of manufacture of sub-assemblies.

iv. A tick box to indicate whether this portable building is a “distress purchase” (as defined in the building regulations).

NB: Refer to, for e.g., England’s 2021 ADL2 for more information on the above parameters related to modular and portable buildings and the associated requirements.

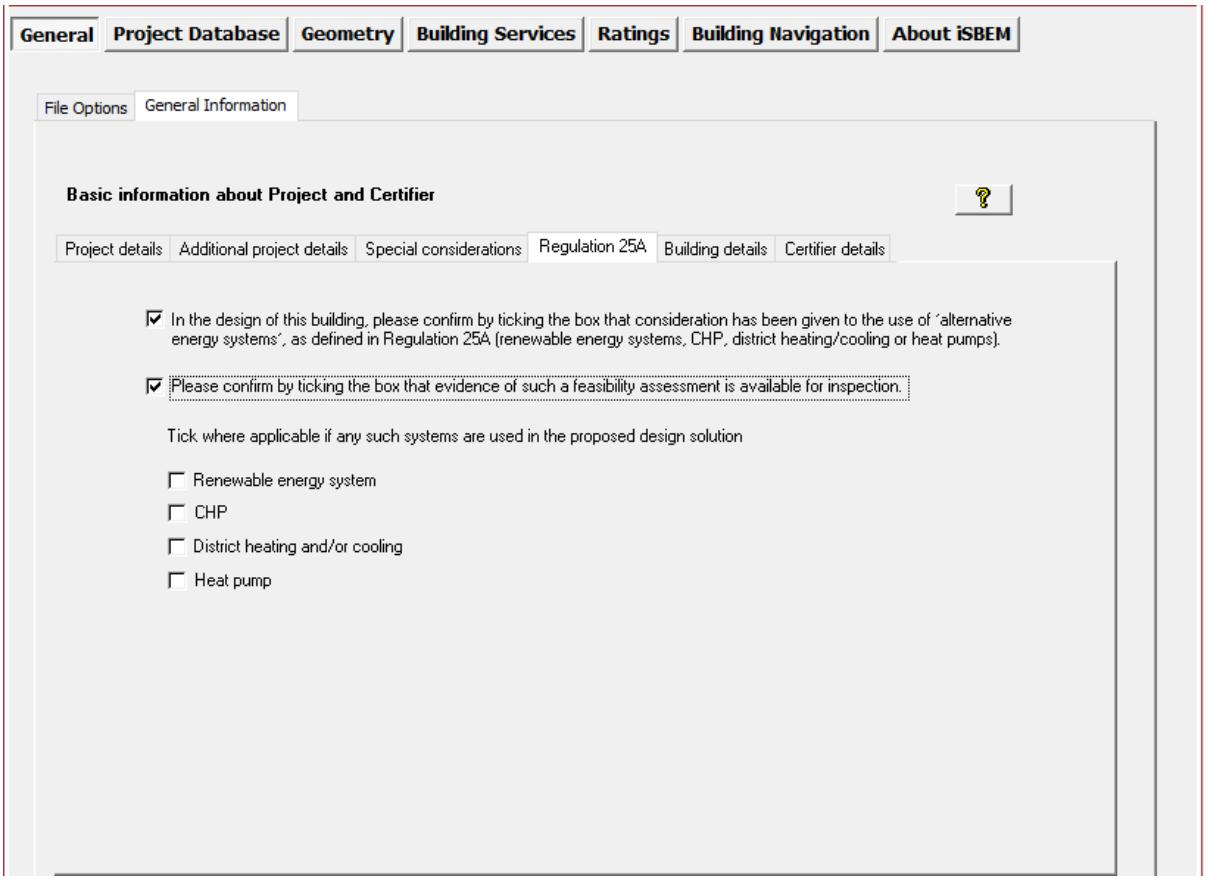


Figure 7: The Regulation 25A sub-tab of the General Information tab in the General form

Regulation 25A sub-tab:

In this sub-tab (Figure 7), the following information can be entered:

1. Tick box to indicate if in the design of this building, consideration has been given to the use of ‘alternative energy systems’, as defined in Regulation 25A (renewable energy

systems, CHP, district heating/cooling, or heat pumps). If the box is ticked, tick boxes for the following parameters become active:

a. Is evidence of such a feasibility assessment available for inspection?

b. Are renewable energy systems used in the proposed design solution?

c. Is CHP used in the proposed design solution?

d. Is district heating/cooling used in the proposed design solution?

e. Are heat pumps used in the proposed design solution?

NB: Refer to Regulation 25A of the Building Regulations for more information on the above parameters related to alternative energy systems and the associated requirements.

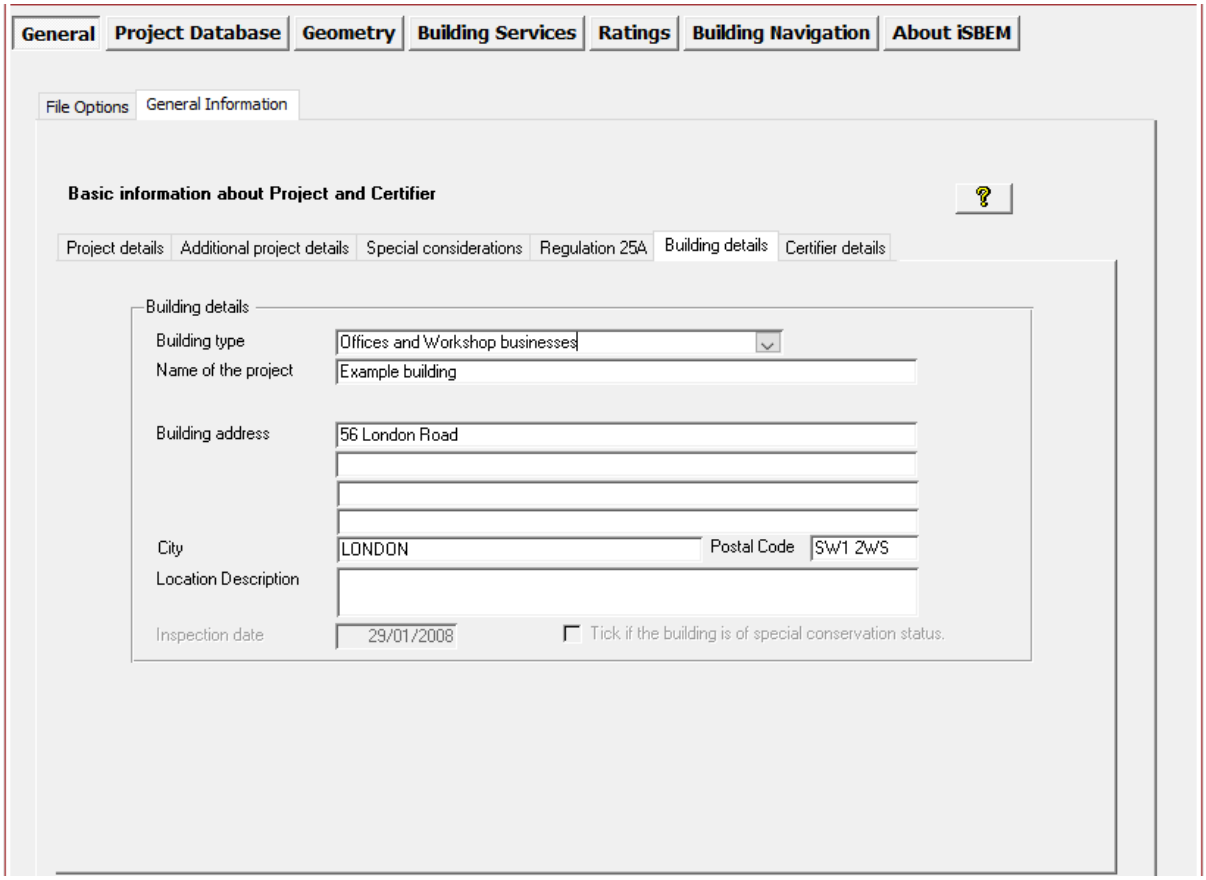


Figure 8: The Building Details sub-tab of the General Information tab in the General form

Building Details sub-tab:

In this sub-tab (Figure 8), the following information can be entered:

Building Details

1. Building type - The choice of building type here sets the default building type for the activity areas that you will define later. You will, however, be able to change the building type for each of the activity areas when you come to define them in the *Geometry* form. At this point, you should choose the building type that most closely defines the majority of the building.

NB: Only the communal areas of apartment buildings containing self-contained flats should be assessed for compliance using iSBEM, for example, circulation areas (using the

"Common circulation areas" activity under the building type "Residential spaces"). The self-contained flats themselves should be assessed using SAP (for domestic buildings).

NB: The domestic type activities available under the building type "Residential spaces" in iSBEM are to allow the energy calculations for the generation of one EPC for a building which contains residential accommodation above a non-domestic space (e.g., a shop or a pub) provided that the residential space can only be accessed from within the non-domestic space, i.e., the residential part is not designed or altered for use as a separate independent dwelling. In addition to common circulation areas of apartment buildings containing self-contained flats, these are the **only** cases where iSBEM can be used to model domestic areas. For more information on the appropriate software tools to use for modelling your building, please refer to DLUHC's publication: "Improving the energy efficiency of our buildings: A guide to energy performance certificates for the construction, sale and let of non-dwellings" which can be accessed from: www.gov.uk/government/publications/energy-performance-certificates-for-the-construction-sale-and-let-of-non-dwellings--2.

2. Name of the project. **NB:** The text input in this field should not include any double quotes.
3. Building address. **NB:** The text input in this field should not include any double quotes.
4. City. **NB:** The text input in this field should not include any double quotes.
5. Post Code. **NB:** The text input in this field should not include any double quotes.
6. Location description - a description of the building location. **NB:** The text input in this field should not include any double quotes.

Certifier Details / Agent Details sub-tab:

The name of this sub-tab changes depending on the option selected in the parameter "Purpose of Analysis" in the *Projects Details* sub-tab, as follows:

- **Certifier Details** sub-tab – if the option selected is compliance with building regulations in England, Wales, or Northern Ireland.
- **Agent Details** sub-tab – if the option selected is compliance with building regulations in Scotland.

This sub-tab (Figure 9) contains one sub-form: *Certifier Details* sub-form or *Agent Details* sub-form, depending on the purpose of analysis.

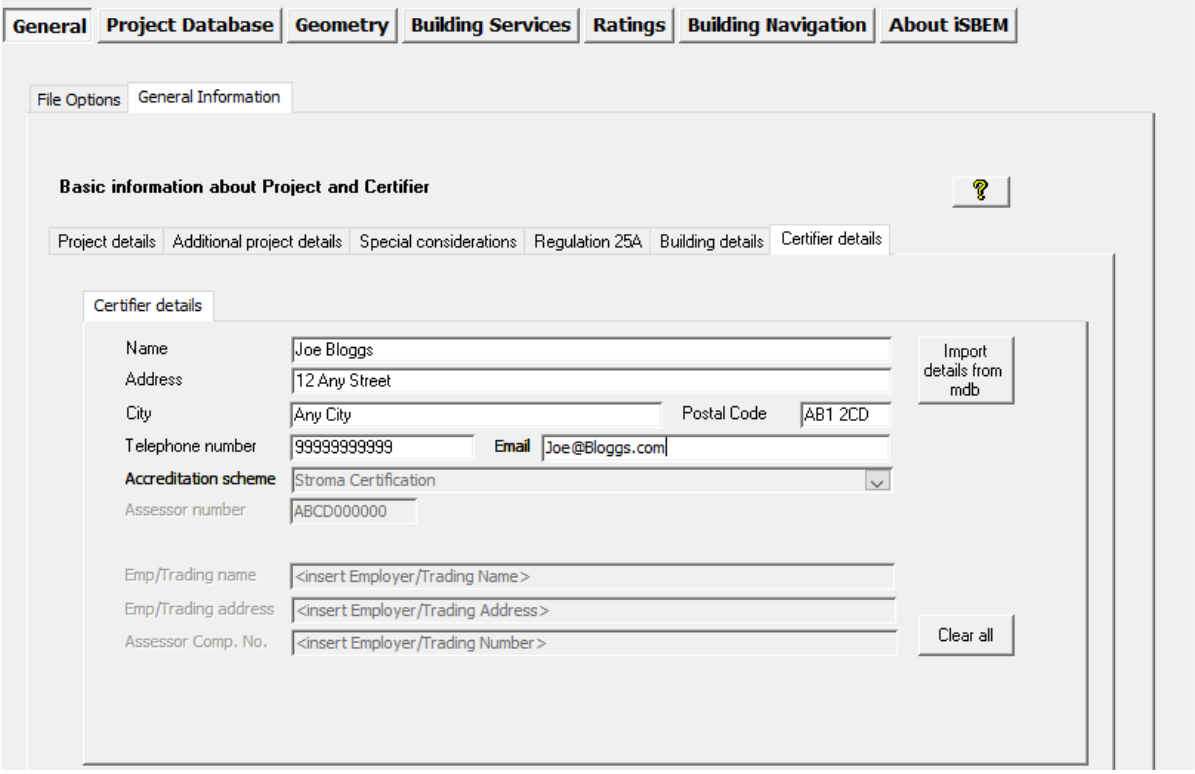


Figure 9: The Certifier Details in the General form

Certifier/Agent Details sub-form: in this sub-form, the following information can be entered:

1. Name – of the certifier or agent. **NB:** The input should be as you want it to appear on the compliance output report.
2. Address – of the certifier or agent. **NB:** The input should be as you want it to appear on the compliance output report.
3. City – of the certifier or agent. **NB:** The input should be as you want it to appear on the compliance output report.
4. Post Code – of the certifier or agent. **NB:** The input should be as you want it to appear on the compliance output report.
5. Telephone number – of the certifier or agent.
6. Email address – of the certifier or agent.

Import Details – clicking on the "Import details from mdb" button will enable you to import the assessor details which you might have entered in a previous version of iSBEM, instead of re-typing them. After you click on the button, you will have the option to browse the folders on your computer and select a previous version of iSBEM, for e.g., iSBEM_v4.1.e.mdb, from which to import the previously input details into the version of iSBEM you are working with.

Clear all – All the information in the *Certifier Details / Agent Details* sub-tab will remain visible in any new project created but can be cleared by pressing the "Clear all" button.

NB: The background information has already been entered for the Example building so there is no tutorial task relating to the *General* form.

3.3. Project Database form

Each type of construction used in the building fabric is defined within the *Project Database* form. Within this form, there are five main tabs (circled in Figure 10):

- **Constructions for Walls** tab
- **Constructions for Roofs** tab
- **Constructions for Floors** tab
- **Constructions for Doors** tab
- **Glazing** tab

In each tab, you need to enter information on each of the different types of construction found in the building. For example, in your building, there may be two glazing types. This is where you enter the details of these types. Later on, during the building's geometry definition, each of these construction/glazing types can be assigned to particular parts of the building, i.e., envelope, door, or window. In other words, **you are not defining the walls, doors, or windows of your building at this stage; just the characteristics of the materials used in their construction**.

Clicking on the "Check Objects assignment" button produces two reports: the *Unassigned Objects* Report and the *Data Summary* Report. These reports can be used to check the data entered at any stage of inputting a building into the interface. There is a "Reports" button on each tab within the interface so it is not necessary to return to this form to access the reports. How to double-check the data you have entered is explained at the end of this chapter (see Section 3.8: Double-checking the data).

Notes:

- Constructions for intermediate floors/ceilings are dealt with under the *Constructions for Floors* tab.
- If the space in the roof is unconditioned, the top floor ceiling should be dealt with as a "roof". It should be given the combined thermal performance of the whole construction including the ceiling construction, the void, and the roof construction.
- Only constructions for external doors and windows need to be defined in iSBEM (i.e., ignore doors and windows within envelopes that are **not** adjacent to the exterior).

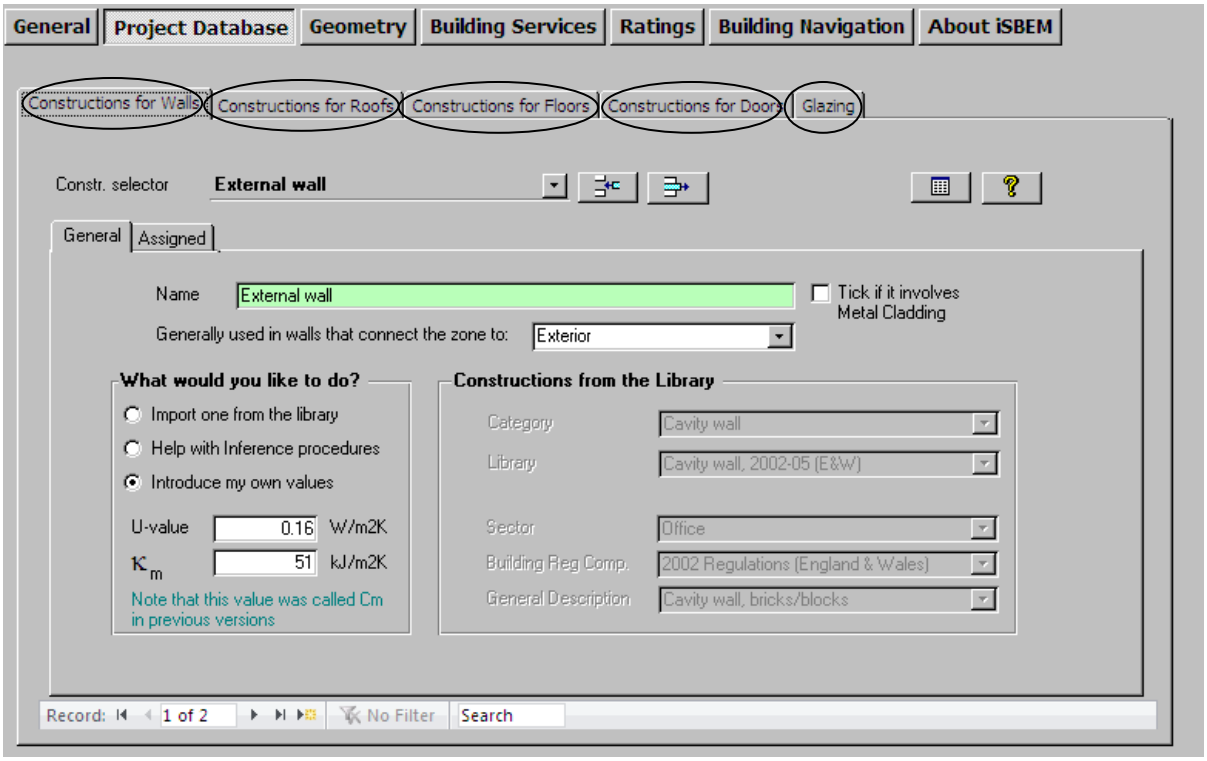


Figure 10: The Constructions and Glazing tabs in the Project Database form

Each of the main tabs in the *Project Database* form has two sub-tabs: *General* and *Assigned*. The *General* tab is where the information is entered to define your construction types - see the following section on how this is done. The *Assigned* tab contains a list of all the envelope elements (i.e., envelopes, doors, or windows) of the building to which this construction (or glazing) has been "assigned". You cannot edit the list on this screen as it is provided for viewing only (see Figure 11). It reflects your input in the *Geometry* form when assigning envelope elements to constructions.

NB: At this stage in the tutorial, most of the *Assigned* tabs will be blank as you will not have yet created the building elements to which these constructions need to be assigned. You will do this in Section 3.4: Geometry form.

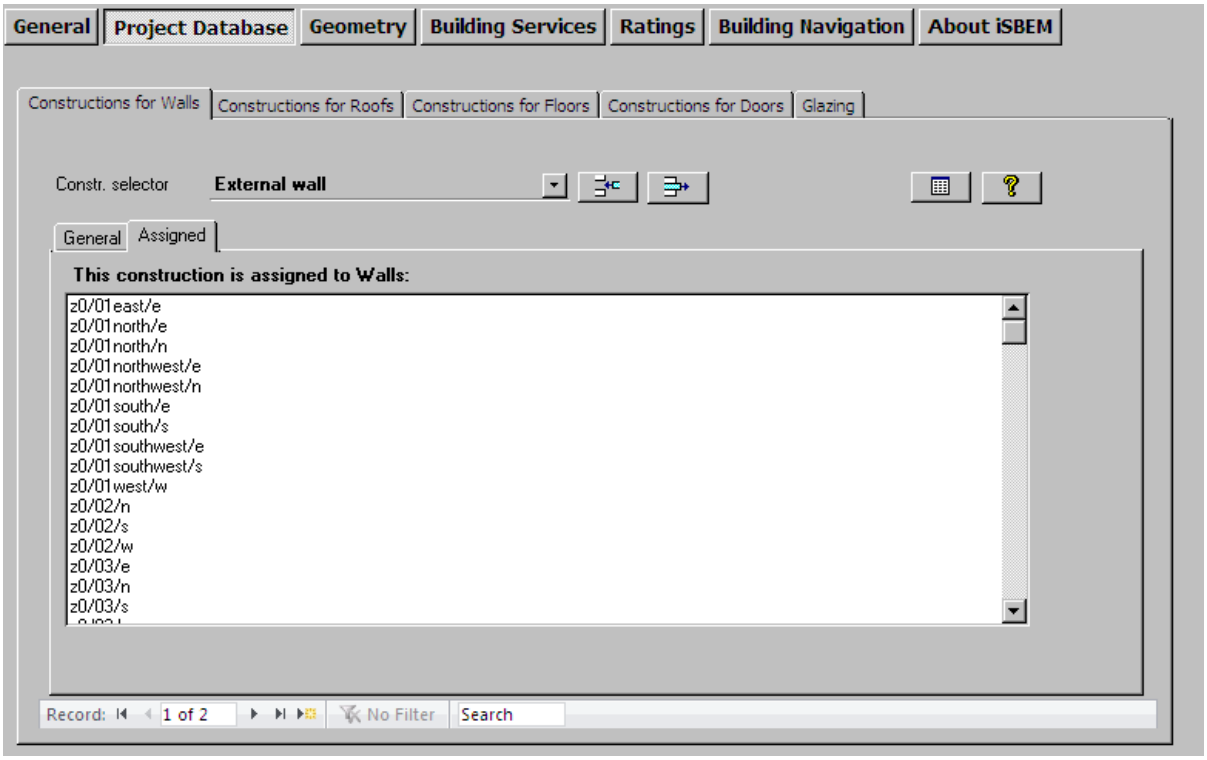


Figure 11: The Assigned sub-tab in the Constructions for Walls tab

3.3.1. Defining construction types

To insert a new type of construction, you must firstly create a new record by clicking on the "Create a new record" button shown in Figure 12. For each new construction, you need to enter the following information:

1. Name - You will be prompted to enter a unique name for your construction (this must be done before you can continue with the construction's definition).
2. Generally used in walls/floors/roofs which connect zones to (for walls, roofs, and floors only) – Here you need to select from the options in the drop-down menu (see Figure 12), which include the options of: Exterior, Strongly ventilated space, Unheated adjoining space, Conditioned adjoining space, Underground, and Same space. This sets the default or 'global' condition of the adjacent space which will appear when you assign this construction for a specific envelope element (see Section 3.4.4: Defining envelope, for details on how this global value is used). This parameter is only required for walls, roofs, and floors, and you can alter it for any individual envelope when defining its geometry.
3. Tick if the construction involves metal cladding (for walls and roofs only) – tick box.

NB: Constructions involving metal cladding are roof or wall systems where metal forms an integral part of the construction, such as metal twin-skin systems where the insulation is located between the metal skins and where the metal skins are typically 0.4 mm to 1.2 mm thick. Metal cladding systems are divided into two broad categories: (a) built-up metal cladding systems involving rail and bracket or z-spacer systems with insulation within the panels, and (b) composite-panel metal cladding systems with insulation inside the panels. If the metal is simply used as an external shield against the weather, such as a rainscreen, this is not, for the purposes of SBEM calculations, considered as "metal cladding".

4. Description of the construction - SBEM requires a number of parameters to describe the thermal characteristics of the construction types. These can be introduced into iSBEM in one of three ways:

    i. Import directly from the library - This is the default option. If it is not already selected, you need to click on the "Import one from the library" radio button. Then, in the library drop-down menu(s), choose the construction that most closely matches the one you are trying to define, from your knowledge of what has been found in the building or is specified on drawings or schedules.

    ii. Choose from the library following inference procedures - This option is intended for use when certifying existing buildings, when you may not have the drawings or schedules which specify the construction types used in the building. The inference procedures will help you to select construction types on the basis of non-technical information you may have on the building. To use this option, you need to click on the "Help with Inference procedures" radio button and then in the inference drop-down menus, choose the options that most closely describe your construction. For example, for a wall, you may be able to choose a construction based on the sector, the building regulations year with which you think it would be compliant, and a general description.

    iii. Manually introduce the values - Click on the "Introduce my own values" radio button if you wish to enter your own values to define the thermal characteristics of the construction.

    For **walls, roofs, floors, and doors,** there are two parameters which need to be entered: the U-value (W/m^2K) and the κ_m value (renamed from C_m value) (kJ/m^2K). (See below for the description of these parameters). <u>If the user selects a construction type from the construction library or through the inference procedures, these values are imported automatically from the NCM Construction database.</u>

    For **glazing** types, the parameters that need to be entered manually are: the U-value, the total solar transmittance (T-Solar), and the light transmittance (L-Solar). (See below for the description of these parameters). <u>If the user selects a glazing type from the glazing library or through the inference procedures, these values are imported automatically from the NCM Glazing database.</u>

NB: Remember that the values chosen may have to be justified to the Building Control officers to gain Building Regulations approval.

NB: <u>Glazed Doors</u> - Doors which are more than 50% glazed should be entered into iSBEM as windows, and their light and solar characteristics should be entered into the *Project Database* form > *Glazing* tab. Doors which are 50% or less glazed can be treated as opaque doors.

U-Value

The U-value is the thermal transmittance of the construction, given in W/m^2K. It can be calculated using the "combined method" given in BS EN ISO 6946 for simple constructions. Constructions such as cladding and steel frame constructions require more complicated calculation procedures, and an appropriate methodology should be followed. For example, the "BRE U-value Calculator" would be appropriate for these construction types. (Guidance on the calculation of U-values for curtain walls can be found in 'The Thermal Assessment of Window Assemblies, Curtain Walling, and Non-traditional Building Envelopes', *Ledbetter, S., et al.*, Centre for Window and Cladding Technology, University of Bath, Bath, March 2006).

NB: In the case of a user-defined U-value for solid ground floors (in contact with the earth), the user needs to specify (using the relevant tick-box) whether the U-value entered into

iSBEM has been obtained following the guidance specified in section 3.5.2 of "CIBSE Guide - Vol. A - 2018" (and ISO 13370:2017 – *Thermal Performance of Buildings – Heat Transfer via the Ground – Calculation Methods*)[ii], i.e., the U-value has been modified/corrected to account for insulation to counter the heat loss through floors in contact with the ground. If the U-value input by the user has already been modified, then SBEM will use the U-value as input. Otherwise, SBEM will make the modification (as a function of the ratio of exposed perimeter to floor area and the thermal resistance of the floor construction), which is always the case when the solid ground floor construction is selected from the Library or using Inference procedures. The user input un-corrected U-value for the ground floor should be the inverse of the thermal resistance of the floor construction only (R_f in equation 3.21 of "CIBSE Guide - Vol. A - 2018") before allowing for any ground effect (perimeter to area) or edge insulation.

NB: The glazing U-value entered in the software is the overall U-value for the complete unit, i.e., should include the glass, the frame, and any bars that form part of the glazing system. By default, the input U-value for a glazed unit is assumed to relate to the performance of the unit in the vertical orientation and, where relevant, is later adjusted inside SBEM to produce the correct U-value for the inclination of the parent envelope (the correction for horizontal flat roofs is +0.3 to the U-value and for pitched roofs, it is +0.2 to the U-value). However, if the input U-value relates to a rooflight, and it has already been adjusted for the horizontal orientation, the user can indicate this by ticking the relevant tick-box, and no further adjustment will be applied by SBEM. Otherwise, the box should be left unticked. **NB:** All the glazing U-values retrieved from the NCM Glazing Database refer to the vertical orientation.

NB: The U-value that is checked for compliance against the limiting standards in England's Building Regulations relates to the performance of the unit in the vertical orientation for windows and roof windows, and in the horizontal orientation for rooflights[ii].

NB: When an ".nct" file is converted from a previous version of iSBEM, the definition of any construction, which was done in the *Project Database* form using either the library or inference in the original ".nct" file, is converted to "introduce my own value" using the U-value and κ_m value which corresponded to the construction selected in the original ".nct" file so that even if the NCM Construction Database is updated between versions (which is likely), the same values from the original selection are used in the converted file, unless the user revises and modifies his construction selections in the converted file.

κ_m (Kappa m) value

The κ_m value (renamed from C_m value) is the effective thermal capacity of an element (wall, floor, ceiling, etc.), given in kJ/m^{2}K. As it takes some time for heat to flow into or out of the building fabric, not all the thermal capacity is useful. The κ_m value represents that part which affects the heating and cooling energy demands. The rules for calculating it can be found in the standard BS EN ISO 13790:2008. In brief, for each construction element: Calculate the contribution of each layer of construction by calculating: *density* (kg/m^3) x *thickness* (m) x *specific heat capacity* (kJ/(kgK)). Starting from the layer of the construction closest to the space (i.e., from the interior), add these values together until any one of the following conditions is satisfied:

- the sum of the layers thicknesses has reached 0.1 m,
- you have reached the mid-point of the construction, or
- you have reached an insulating layer (defined, for SBEM purposes, as having a conductivity of 0.08 W/mK or less).

[ii] Further guidance in BR 443 - Conventions for U-value Calculations, 2019 Edition.

NB: If the construction contains an air cavity whose conductivity is above 0.08 W/mK, the contribution of the air cavity needs to be taken into account in the calculation of the κ_m value (although the contribution to the thermal mass of the construction would be very small), i.e., it is not considered as an insulating layer.

T Solar
T Solar is the total solar energy transmittance (*g perp*) defined as the time-averaged ratio of energy passing through the un-shaded element to that incident upon it. T Solar values entered by the user should refer to values for normal incidence of solar radiation. **NB:** External movable devices for solar protection are accounted for later when defining the window in the *Geometry* form, through the shading system options.

L Solar
L Solar (light transmittance) is the amount of visible solar energy that passes through a glazing system, expressed as a fraction of the visible solar energy incident on it. This value will be used for the daylighting calculations. L Solar values entered by the user should refer to values for normal incidence of solar radiation.

NB: Total solar energy transmittance values given by windows manufacturers are usually given for solar radiation perpendicular (normal) to the glazing (*g perp*). However, SBEM uses monthly calculations and therefore, a value (*g*) averaged over all angles of incidence. SBEM calculates this value by multiplying (*g perp*) by a correction factor corresponding to the orientation of the glazing and its tilt from the horizontal.

NB: In the Glazing Database, "Uncoated, clear" refers to ordinary clear glass which has no low-emissivity coating and no tint, "Reflectance, low-emissivity" refers to glazing in which at least one glass pane has a low-emissivity coating (such as "Pilkington K" glass or "Optitherm" glass), and "Tinted" refers to glazing where at least one pane is colour-tinted.

NB: For windows or other glazed envelope elements with non-scattering glazing, ISO 9050 and EN410 provide a method to obtain the solar energy transmittance for radiation perpendicular to the glazing. EN 13363-2 and ISO 15099 provide methods of determination of the total solar energy transmittance of glazing equipped with solar protection devices. For more information, see also section 11.4 of the CEN Standard prEN wi 14.

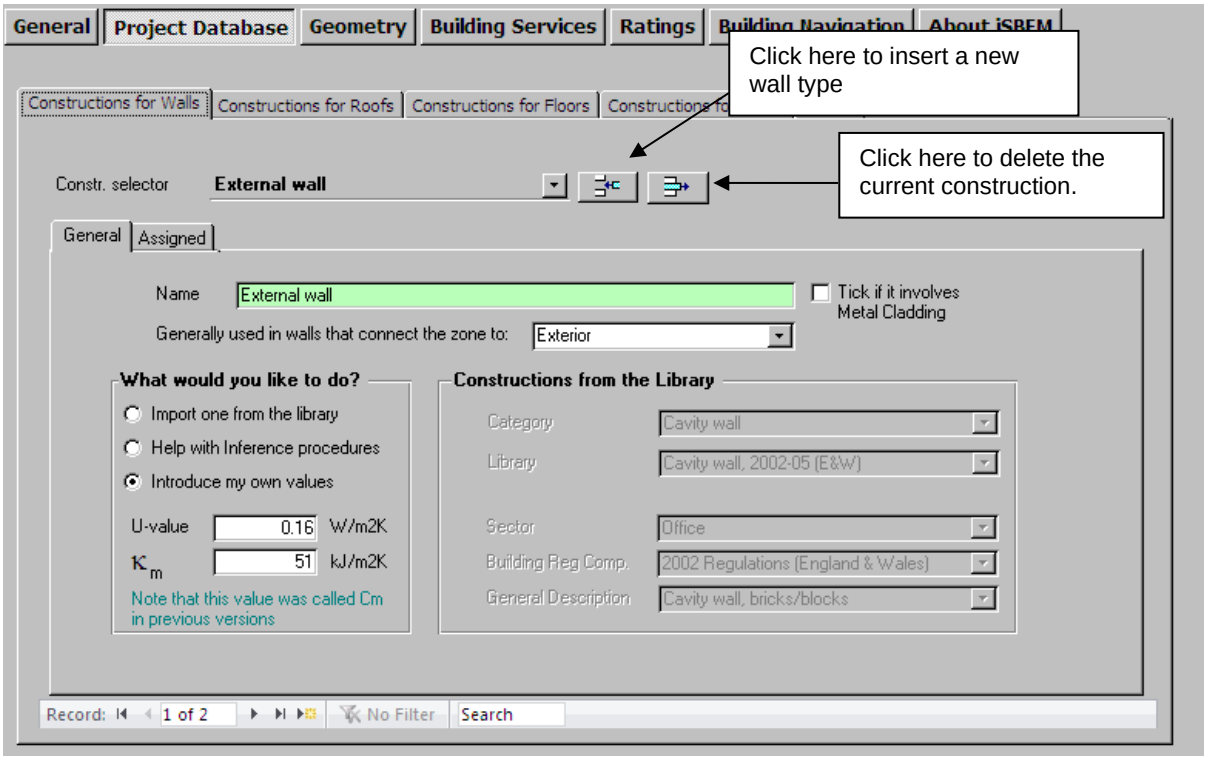


Figure 12: An external wall being defined in the Constructions for Walls tab

Task 4: Define each of the construction types

Fabric details for the Example building are listed in APPENDIX A:, Section A.1. Look through the records in each of the sub-tabs using the record selector, and you will see that five out of the seven constructions have been defined for you. You need to define the roof and the internal wall constructions. This will involve clicking on the appropriate sub-tab, adding a new record, clicking on the appropriate radio button, and choosing the appropriate options from the drop-down menus.

As you will see, some constructions have already been entered manually, and simple names such as “Ground floor” have been used.

Viewing and deleting construction types

To view the construction types that you have in your *Project Database* form, you need to click on the record selector[iii] in each of the four tabs. A drop-down list will then appear showing all of the constructions that have been defined in that project so far. To delete a construction or glazing type, you need to select it using the record selector, and then click on the “Delete record” button.

3.4. Geometry form

Depending on what information you have first, you can start by entering information into either the *Geometry* form or the *Building Services* form.

[iii] For further descriptions of the various commands in iSBEM, see the User Guide volume “How to use iSBEM: Basics - UK”.

To define the geometry of your own building, you will need to have followed the instructions on “zoning” given in the User Guide volume “**How to use iSBEM: Basics - UK**”. (The Example building has been “zoned” for you. Details can be found in Table 14, Figure 77: Ground floor plan, and Figure 78: First floor plan in APPENDIX A:.)

The *Geometry* form contains the following main tabs (see Figure 13):

- **Project** tab – This tab requires geometrical information on the whole building rather than on a zone level and is where you can enter global default values for a number of parameters to be used.

The geometry of **each zone** is then described in the following four tabs:

- **Zones** tab
- **Envelopes** tab
- **Doors** tab
- **Windows and rooflights** tab

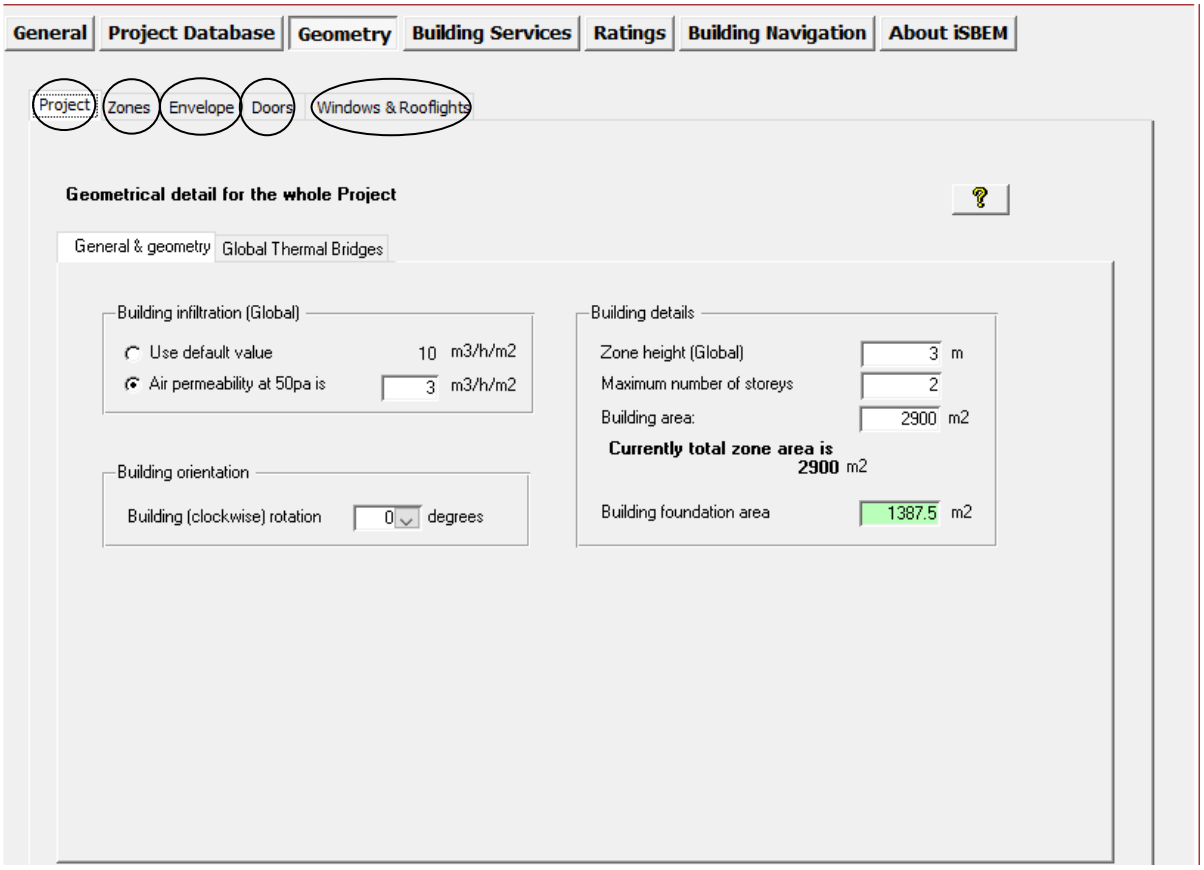


Figure 13: The Project, Zones, Envelopes, Doors, and Windows & Rooflights tabs in the Geometry form

3.4.1. Summary of how to define the geometry of a building

There are **5** steps to defining the geometry of a building:

1. **Enter building scale information** (total floor area) **and global values** which apply to most zones (such as zone height and Psi values for thermal bridges). This is done in the *Project* tab (Section 3.4.1: Project tab).

Then for **each zone**:

2. **Create the zone** - This is done in the *General* sub-tab of the *Zones* tab (Section 3.4.3: Defining zones).
3. **Create its envelope elements** – There are two ways to create envelope elements (walls, floor, and roof/ceiling):
    a. In the *Envelopes* main tab (Section 3.4.4).
    b. In the *Quick Envelopes* sub-tab of the *Zones* tab (Section 3.4.8).
4. **Create any windows** – There are two ways to do this:
    a. In the *Windows* main tab (Section 3.4.5).
    b. In the *Quick Envelope* sub-tab of the *Zones* tab at the same time as creating the envelope element it is part of (Section 3.4.8).
5. **Create any external doors** – In the *Doors* tab (Section 3.4.7).

NB: Internal windows and doors should not be entered into iSBEM.

The tabs in *italics* above are the main tabs of the *Geometry* form (see Figure 13). It is important to understand how to introduce information into these tabs (as well as being able to use the *Quick Envelope* function) as there are some parameters which can only be entered using these tabs. However, once familiar with the basis of the geometry objects, it is likely that you will enter most of your data using the *Quick Envelope* function.

Order of data entry

You need to create the zone before defining its envelope. It is not mandatory to enter all the information about the zone (envelopes, doors, windows, thermal bridges) before moving onto the next zone as you can always add or edit this information at a later time. Where possible, however, you should introduce each zone one at a time into the interface.

Description of what is happening in iSBEM

When you create a zone, envelope element, or window, you are creating what is referred to in iSBEM as a 'building object'. These building objects need to be linked together correctly in order to define the geometry of a zone. When you define an envelope element in the *Envelopes* main tab, you will be prompted to link (or assign) it to a zone. Equally, when you define a window in the *Windows & Rooflights* main tab, you are prompted to link it to an envelope element. If you create the envelope element or window in the *Quick Envelope* sub-tab, these links are established automatically. This will be further explained as you work through the Example building. The final stage of defining a zone is to assign it to the appropriate building services systems. This can be done in either the *Geometry* (partly) or *Building Services* form.

Figure 14 below is an example of a simple zone. To define the geometry of this zone, you would need to create the zone, 6 envelope elements, one window, and one door. The south wall door and window would need to be linked to the south wall, which in turn (along with the other 5 envelope elements) would need to be linked to the zone, as shown by the arrows in the diagram below.

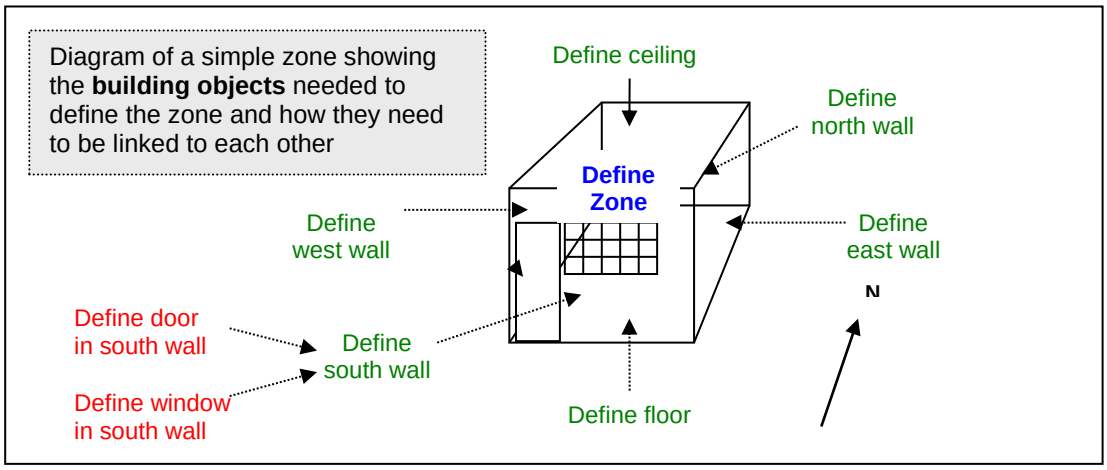


Figure 14: Diagram of building objects needed to define a simple zone

NB: The tutorial will take you through how to define and link the building objects needed to complete the geometrical definition of a zone.

3.4.2. Project tab

Before defining the geometry of each zone, there are several parameters at the building scale which you need to enter, such as the total floor area of the building. You can also enter global[iv] values which apply to all or most zones (zone height and air permeability). These parameters are entered into two sub-tabs:

- **General & Geometry** sub-tab
- **Thermal Bridges** sub-tab

General & Geometry sub-tab:

This sub-tab requires the input of the following information, as shown in Figure 16:

Building Infiltration (Global)

1. Air permeability at 50 pa ($m^3/h.m^2$) - The value you enter here will be the global or default value assigned to each zone. You can choose later to either use this global value or enter a different value for each zone that you define (see Section 3.4.3: Defining zones). Air permeability is the physical parameter used to quantify the air tightness of the building fabric. It measures the resistance of the building envelope to infiltration. It is defined as the average volume of air (in m^3 per hour) that passes through unit area of the building envelope (in m^2) when subject to an internal to external pressure difference of 50 Pascals. The envelope area of the building is defined as the total area of the floor, walls, and roof separating the interior volume from the outside environment. It is measured with ventilators closed.

   NB: If the purpose of analysis option that has been selected in the *General* form > *General Information* tab > *Project Details* sub-tab is compliance with building regulations, the default value will be 10 $m^3/h.m^2$. However, the user can over-write the default value by manually entering an alternative value.

[iv] For further details on global values, see the User Guide volume "How to use iSBEM: Basics - UK".

NB: According to the Approved Documents, buildings with less than 500 m^2 total useful floor area may avoid the need for a pressure test provided that the air permeability is taken as 15 $m^3/(h.m^2)$ at 50 Pa. SBEM is able to acknowledge this during the compliance checking.

Building Orientation

2. Building (clockwise) rotation – In degrees from north.

   NB: For example, Figure 15, a rotation of 45 degrees would change north-facing walls to north-east. However, note that the nomenclature in the names of already created envelopes (denoting orientation) would not be changed automatically by the rotation. Also, note that any envelope created after the rotation is performed will still retain the original coordinate system. Hence, this parameter should be changed with caution from the default of zero.

   NB: The "Building rotation" parameter can be used when you want to model a building identical to one you have already modelled in iSBEM before (and therefore have its ".nct" file), but which has a different orientation to the original one. As such, this parameter can be used to rotate the whole building as described in the guidance, provided you do not need to make any further modifications to the geometry of the building.

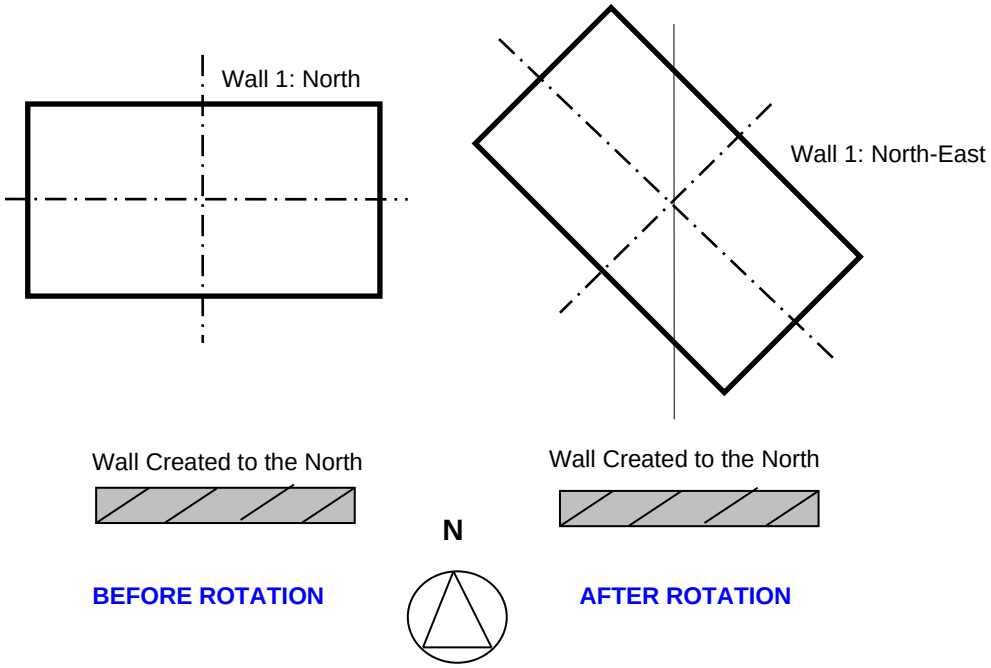


Figure 15: Example of a 45-degree building rotation

NB: The user is no longer required to enter the building height (height to eaves, in m).

Building Details

3. Zone height (Global) – Floor to floor height (floor to soffit for top floor), in m, i.e., including floor void, ceiling void, and floor slab. As with the global building infiltration parameter, the value you enter here will be given as the global or default zone height in each of the zones. You can choose to use this global value or enter a new value for each respective zone (see Section 3.4.3: Defining zones).

   NB: For a zone with a flat roof, the zone height would be from top of floor to top of roof. For a zone with a pitched roof and a flat ceiling underneath it, the zone height

would be from top of floor to underside of soffit. For a zone with a sloping roof (i.e., an exposed pitched roof with no flat ceiling underneath it), the zone height would be from top of floor to soffit height. If there is a suspended floor, the zone height would be measured from the floor surface (rather than the slab underneath it).

4. Maximum number of storeys – Number of storeys of the building being modelled. If the building does not have the same number of storeys all over the floor plan, input the maximum number of storeys.
5. Building area – The total building (sum of zone areas) floor area (m^2) – This field is for data entry checking purposes only (i.e., the value entered into this field is not used in any part of the calculation). The user can compare this figure to the figure calculated by iSBEM and reported directly below it as: "Currently the total zone area is…" which is a sum of all the areas of the entered zones. A red warning will appear if these values are not identical. The total zone area calculated by iSBEM takes into consideration the value input in the multiplier parameter for each of the zones.

Modified

6. Foundation area – The foundation area of the building (m^2), as defined in DLUHC's 2021 NCM Modelling Guide (and Scotland's 2022 NCM Modelling Guide) – This field is required for England's and Scotland's compliance purposes of analysis.

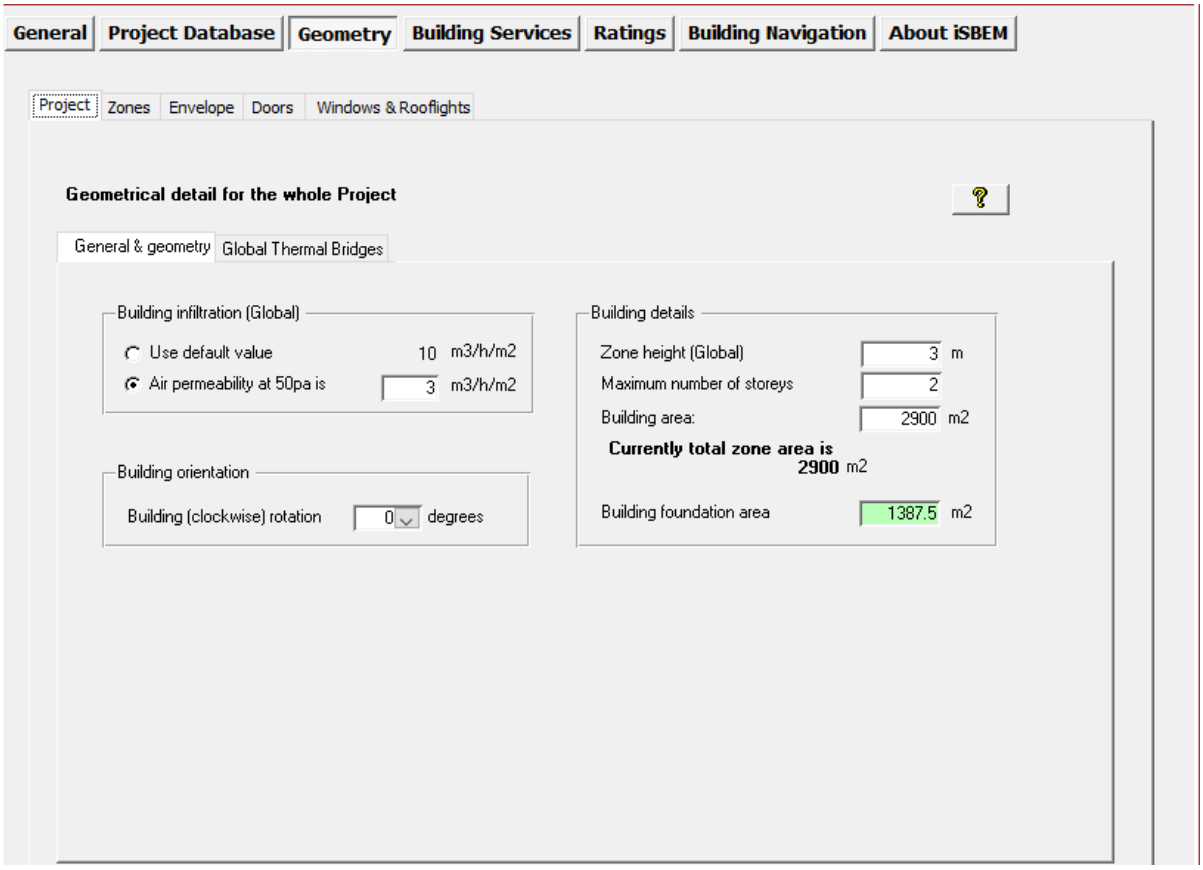


Figure 16: General & Geometry sub-tab of Project tab in the Geometry form

Thermal bridges sub-tab:

The *Thermal bridges* sub-tab allows you to define 'global' Psi values for thermal bridges. These global values can be selected when defining a zone so that you do not need to define the thermal bridges separately for each zone. If, however, the global values you define here do not apply to a specific zone, you can always choose not to use the global values (when

defining the zone) and enter new values to be applied to that specific zone only (see Section 3.4.3: Defining zones).

SBEM requires information about non-repeating thermal bridges[v] associated with junctions between envelope elements, windows, and doors which are in contact with the exterior as shown in Figure 17: Defining the global thermal bridges (see footnote below on types of thermal bridges).

These types of junctions fall into two categories:

1. Junctions involving metal cladding
2. Junctions NOT involving metal cladding.

For each type of junction, you can enter an Psi (ψ) value (W/mK) for the linear thermal transmittance or use the default values in iSBEM. As specified in ADL2 2021, where the user enters the Psi values manually into iSBEM, these values must have been calculated by a person with suitable expertise and experience following the guidance set out in BR497[vi] and following a process flow sequence that has been provided to Building Control, indicating the way in which the detail should be constructed. Note that, as specified in the NCM Modelling Guide, the default psi values visible in the interface are further degraded by the greater of 0.04 W/mK or 50% before being used in the calculation.

In Figure 17, the Psi values for all the junctions in the building have been set to use the tool's defaults.

[v] **Note on types of thermal bridges:** There are two types of thermal bridge; repeating and non-repeating. Repeating thermal bridges should be taken into account when calculating the U-value of a construction. Non-repeating thermal bridges can arise from a number of situations, but SBEM is only concerned with those arising from junctions between envelope elements, windows, and doors which are in contact with the exterior as shown in Figure 17.

[vi] BR497 Conventions for calculating linear thermal transmittance and temperature factors, BRE, 2007.

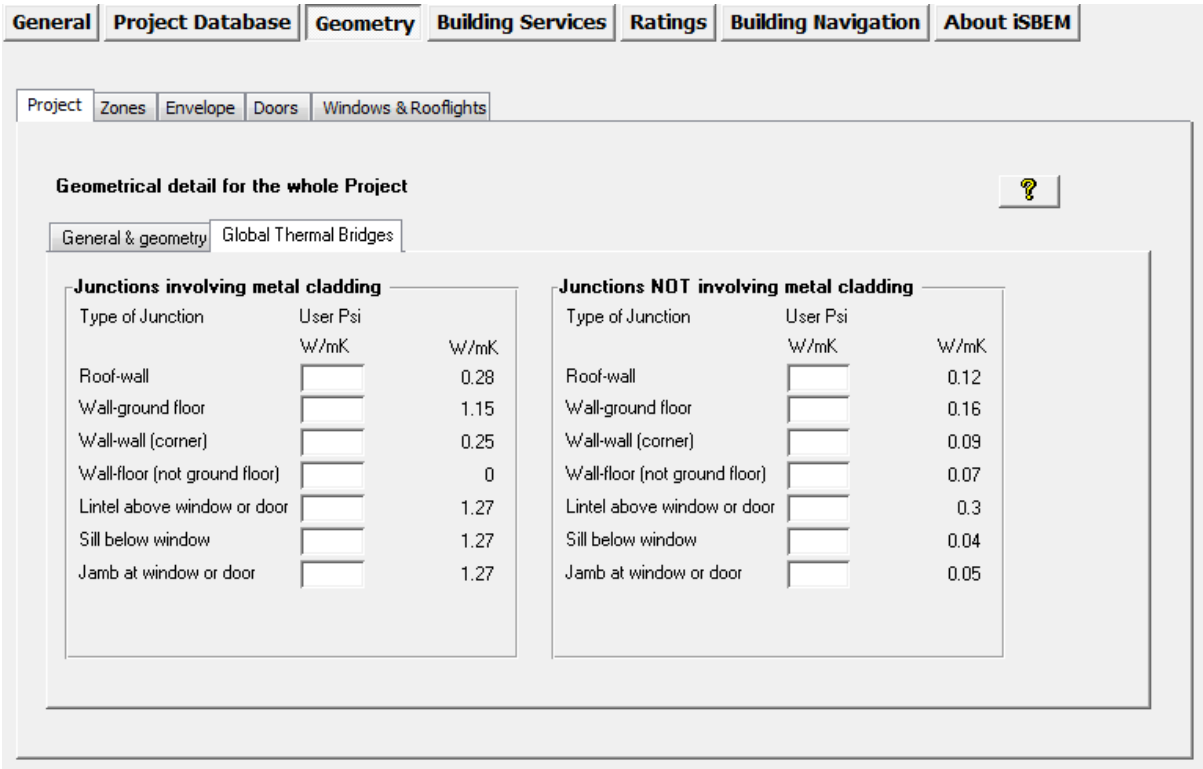


Figure 17: Defining the global thermal bridges

NB: Thermal bridging at junctions and around openings, which is not covered in Accredited Construction Details[vii] or MCRMA guidance[viii], needs to be accounted for, and this may be done using the method in BRE Information Paper IP 1/06[ix], making use, where appropriate, of the new publication on conventions for temperature factors and linear thermal transmittance[x].

3.4.3. Defining zones – Zones tab

The first step in defining the geometry of a zone is to create the zone in the *Zones* tab of the *Geometry* form.

NB: For building regulations calculations purposes, we recommend that users generally avoid creating more than 100-150 zones in iSBEM. However, the processing time will depend on the total number of objects (not just zones), i.e., zones, envelopes, windows, etc. Note that for building regulations compliance checking, the calculation has to generate 2 buildings: the Actual and Notional, so the number of objects (all the zones, envelopes, windows, etc.) that the calculation has to process is multiplied by 2. Hence, creating a project with a very large number of objects will slow down the calculation and may cause it to crash.

[vii] Accredited Construction Details for Limiting Thermal bridging and air leakage. Details on www.gov.uk/government/organisations/department-for-levelling-up-housing-and-communities.
[viii] Design of metal roofing and cladding systems: Guidance to complement Approved Documents L2A and L2B. MCRMA Technical paper no. 17, joint publication by MCRMA and EPIC, 2006.
[ix] Assessing the effects of thermal bridging at junctions and around openings (BRE IP 1/06).
[x] Conventions for calculating temperature factors and linear thermal transmittance (Report BR 497).

The *Zones* tab contains four sub-tabs:

- **General** sub-tab: This is where the zones are created and defined. You need to give each zone a unique name, select its building and activity types, and enter its area, height, and infiltration characteristics. You can also specify which HVAC system the zone is served by in this tab (but only if you have already defined the HVAC system in the *Building Services* form or you are using one of the default HVAC systems in iSBEM). (see below).
- **Quick Envelopes** sub-tab: This is one way to define the envelope elements and assign them to the zone as described in Section 3.4.8: Quick Envelopes tab: Short cut to creating envelopes and windows.
- **Thermal bridges** sub-tab: This is where the global thermal bridges for the zone are defined (see below).
- **Envelope Summary** sub-tab: This tab displays a summary of all the envelope elements defined so far in the zone.

General sub-tab:

To create a zone, you will need to click into the *General* sub-tab of the *Zones* tab, add a new record, and enter the following information:

1. Name – Any name can be given to a zone. The only requirement is that it is unique. There are certain recommendations to avoid it becoming complicated since there are so many elements in iSBEM which require naming. See the User Guide volume "**How to use iSBEM: Basics - UK**" for guidance on how to name your zones, envelope elements, doors, and windows.
2. Multiplier – Indicate how many zones exactly identical to this one exist in the building (if more than the default of 1). Remember that this would also "multiply" all of its associated envelopes, windows, doors, and additional thermal bridges during the calculation.
3. HVAC System – If you have defined your HVAC systems before defining your zones (i.e., if you have started with the *Building Services* form instead of the *Geometry* form), you can select the HVAC system that serves this zone from the drop-down list. If no HVAC system serves the space (i.e., an unconditioned zone that is intended to remain that way), select 'Zones without HVAC system' (spaces which have no heating or cooling, e.g., plant rooms, storage spaces, exposed circulation spaces). If you have not yet defined your HVAC system, this can be left as 'Unassigned' at this stage. You will be able to assign the zones to an HVAC system later within the *Building Services* form so there is no need to define the HVAC system before continuing. If you leave the zone as unassigned, a red warning will appear in the top right-hand corner to let you know how many zones remain unassigned so that you would not proceed with running the calculation before assigning them.

   NB: If a zone is defined as having no heating or cooling, i.e., assigned to 'Zones without HVAC system', but the activity type selected for the zone is one which typically requires conditioning (according to the Activity Database), a red exclamation mark "**!**" will appear next to this parameter as a warning to the user, in case this was done in error. Ultimately, however, the calculation will be carried out using the data input by the user. On the other hand, if the user assigns an HVAC system (i.e., which provides heating or heating and cooling) to a zone whose activity type is typically unconditioned in the NCM Activity Database, a similar red exclamation mark "**!**" will appear next to this parameter in the interface, and if the calculation is initiated, it will be terminated by the SBEM engine. Because there are no values for heating-set-point or cooling-set-point temperatures specified in the NCM Activity Database for

these unconditioned activities, no heating or cooling energy demand can be calculated by the SBEM engine for these activities.

NB: The default HVAC systems in iSBEM are representative of existing rather than new buildings and should only be used if you are running an EPC calculation for an existing building (not a compliance calculation for a new building) and do not know the type of the HVAC system in your building or its detailed parameters as the default efficiencies assumed by iSBEM for them are quite pessimistic and cannot be edited by the user.
NB: See note in Section 3.5.10: Defining the zone-specific building services- Zones tab, regarding indirectly conditioned spaces.

4. Building type – The default for this field is the building type that was selected when creating the project (this information is recorded in the *General Information* tab in the *General* form). However, it can be changed for any particular zone, if appropriate (see note below).
5. Activity type – A building can be divided into a number of activity areas. For example, in an office building, there may be a reception, open plan office, some cellular offices, a tea room, circulation areas, and some toilets. When you choose your building type and activity area, you are setting a number of default parameters which the tool uses to calculate the energy consumption. These parameters include temperature set points, heat gains from people and equipment, required illuminance level, and fresh air requirements amongst others. Each building type has a number of different activity areas to choose from. The description of the activity area, as it appears in the NCM Activity Database, is displayed in a box at the right-hand side of the sub-tab. For more information on building types and activity areas, please refer to the NCM Activity Database (available for download from the NCM website[xi]).

NB: It is not a problem in iSBEM to introduce activities from building types other than the default building type introduced at the beginning of an iSBEM project. For example, an office may have activities from the "Office" building type (e.g., office area, reception, eating/drinking area, etc...) but may also have atypical activities which are not included in the office building type, e.g., a shop, in which case the user would need to use a "Retail" building activity such as a sales area or similar. The building type does not need to be the same for all activities in a project. It is intended to be a default for the project in iSBEM (could apply to other interfaces) and provides a 'filter' on the many activities available in the database, making it easier for users to find and make a choice of activity for each zone. Generally, activities from the default building type should be used, but if there is nothing suitable available, another building type could be used.

NB: Only the communal areas of apartment buildings containing self-contained flats should be assessed for compliance using iSBEM, for example, circulation areas (using the "Common circulation areas" activity under the building type "Residential spaces"). The self-contained flats themselves should be assessed using SAP (for domestic buildings).

NB: The domestic type activities available under the building type "Residential spaces" in iSBEM are to allow the energy calculations for the generation of one EPC for a building which contains residential accommodation above a non-domestic space (e.g., a shop or a pub) provided that the residential space can only be accessed from within the non-domestic space, i.e., the residential part is not designed or altered for use as a separate independent dwelling. In addition to common circulation areas of apartment buildings containing self-contained flats, these are the **only** cases where iSBEM can be used to model domestic areas. For more information on the appropriate software tools to use for modelling your building, please refer to DLUHC's publication: "Improving the energy efficiency of our buildings: A guide to energy performance certificates for the construction, sale, and let of

[xi] www.uk-ncm.org.uk

non-dwellings" which can be accessed from DLUHC's website at www.gov.uk/government/publications/energy-performance-certificates-for-the-construction-sale-and-let-of-non-dwellings--2.

6. Area - Floor area of the zone, in m^2, calculated using the internal horizontal dimensions between the internal surfaces of the external zone walls and half-way through the thickness of the internal zone walls (see in the User Guide volume "**How to use iSBEM: Basics - UK**"). This parameter is used to multiply area-related parameters in the databases.

NB: If the zone has any virtual boundaries created due to the zoning rules on daylight access, you need to consider the area of the zone as that delimited by the 'line' created by that virtual boundary (the virtual boundary itself is not entered into iSBEM).

NB: Where there is an unconditioned, unoccupied roof space (i.e., between a pitched roof and a flat ceiling) above an activity area, it should not be treated as a separate unheated zone. Instead, the void should be considered as part of the construction when calculating the U-value between the occupied activity area and the outside (i.e., the top floor ceiling should be defined as a 'roof' and given the combined thermal performance of the whole construction including the ceiling construction, the void, and the roof construction – see BR 443[ii]). On the other hand, if the roof space is occupied (heated or unheated), then it becomes a normal activity area to be defined as usual in the building model. If surfaces of the room are not rectilinear, for example, if a pitched roof is exposed to the inside of the conditioned zone (i.e., there is no flat ceiling underneath it), then the roof area will be that of the inner surface area of the roof as "seen" by the heat flux.

7. Zone height – Floor to floor height (floor to soffit for the top floor), in m, i.e., including floor void, ceiling void, and floor slab, is used for calculating the length of the wall-to-wall junctions and radiant and temperature gradient corrections. Either enter you own figure into the box or click on the Global button (). Pressing the Global button brings the global default value, which you previously defined in the *Projects* tab, into the field.

   NB: For a zone with a flat roof, the zone height would be from top of floor to top of roof. For a zone with a pitched roof and a flat ceiling underneath it, the zone height would be from top of floor to underside of soffit. For a zone with a sloping roof (i.e., an exposed pitched roof with no flat ceiling underneath it), the zone height would be from top of floor to soffit height. If there is a suspended floor, the zone height would be measured from the floor surface (rather than the slab underneath it).

8. Tick box to indicate if this zone is a shell area (in a building with a shell and core configuration), i.e., the zone is a shell whose fit-out with building services will be carried out at a later stage. This tick box becomes active only if the relevant 'shell and core' tick box in the *General* form > *General Information* tab > *Project Details* sub-tab has been ticked.

   NB: In shell and core buildings, the user should define for shell zones assumed building services of the types that are most likely to be installed later in those shell areas (i.e., suitable for the type of spaces) and which have the minimum acceptable specification standards that meet the requirements in Part L of the Building Regulations in force when the building was constructed (the minimum standards for building services are specified in the Approved Documents). When the calculation is run for the purposes of compliance assessments at the "as designed" stage, the output energy consumption and emissions results are calculated in SBEM using those assumed building services for the shell areas, as well as the installed services for the core areas as defined. On the other hand, when the calculation is run for compliance assessments at the "as built" stage, all the energy consumption and

emissions associated with shell zones is excluded from the calculation in SBEM, and only energy associated with the core areas is considered.

Infiltration

9. Air permeability at 50pa, in $m^3/h.m^2$ - Similar to the zone height, you have the option to either enter you own value or use the global value which you previously defined in the *Projects* tab by clicking on the "Global" button. Otherwise, a default value (visible in the interface) will be used by the software. Air permeability is the physical parameter used to quantify the air tightness of the building fabric. It measures the resistance of the building envelope to infiltration. It is defined as the average volume of air (in m^3 per hour) that passes through unit area of the building envelope (in m^2) when subject to an internal to external pressure difference of 50 Pascals. The envelope area of the building is defined as the total area of the floor, walls, and roof separating the interior volume from the outside environment. It is measured with ventilators closed.

   NB: If the purpose of analysis option that has been selected in the *General* form > *General Information* tab > *Project Details* sub-tab is compliance with building regulations, the default value will be 10 $m^3/h.m^2$. However, the user can over-write the default value by manually entering an alternative value.

NB: According to the Approved Documents, buildings with less than 500 m^2 total useful floor area may avoid the need for a pressure test provided that the air permeability is taken as 15 $m^3/(h.m^2)$ at 50 Pa. SBEM is able to acknowledge this in the compliance checking module.

10. Thermal bridges:
    a. Tick here to use global Psi values – If the box is ticked, the *Thermal Bridges* sub-tab disappears, and the global Psi values defined in the *Project* tab of the *Geometry* form are applied to the selected zone.
11. User's notes – This box is provided for the user to fill in, at their discretion, any details (description) about the zone that are not covered by the other fields. iSBEM does not process the data entered in this field.

Figure 18 shows a zone being defined.

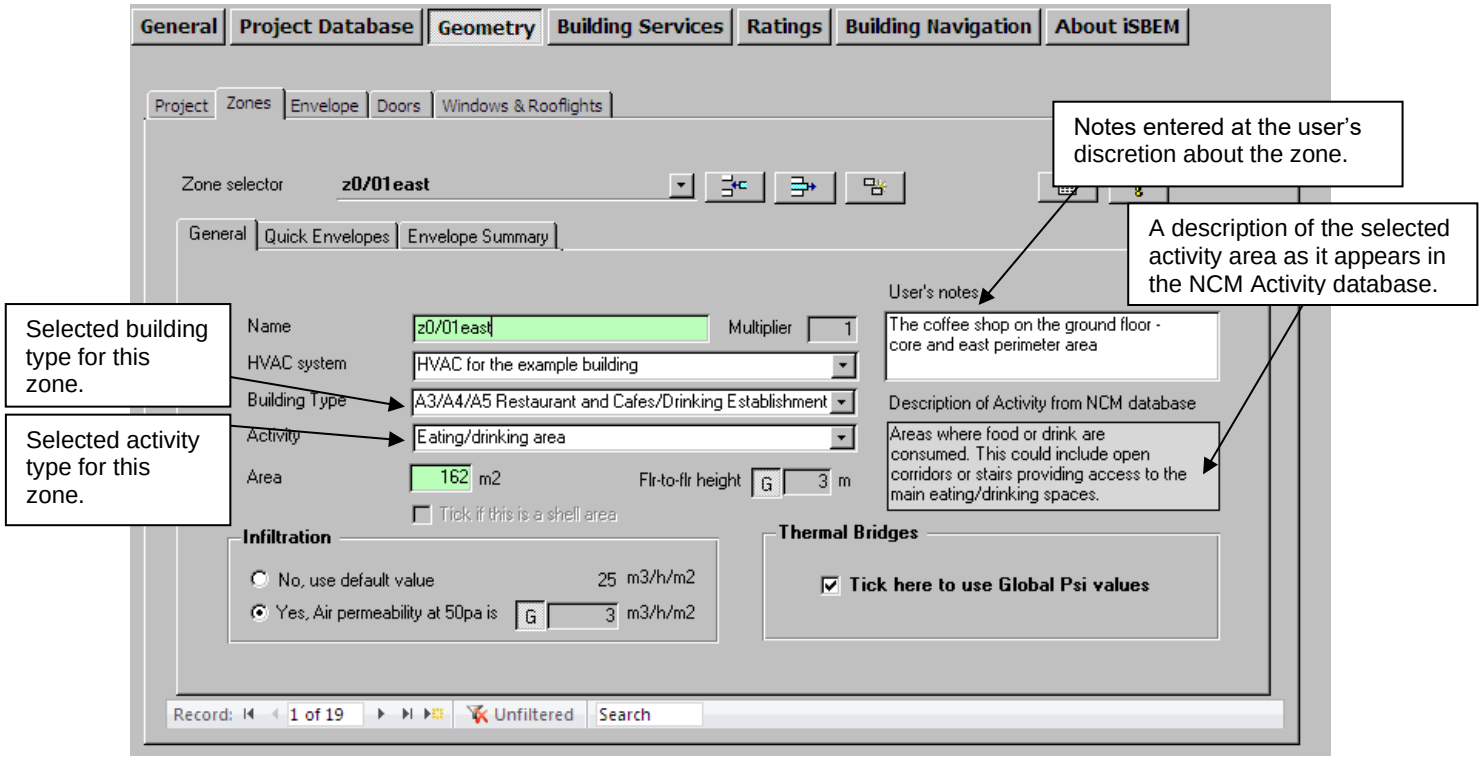


Figure 18: A zone being defined in the General sub-tab of the Zones tab in the Geometry form

At the top right-hand side of the *Zones* tab, a message (in red text) will appear indicating how many zones have not yet been assigned to HVAC systems. To see a list of all the zones which have not yet been assigned, click on the "Reports" button to access the *Unassigned Objects* report (for more details about the Objects reports, see Section 3.8: Double-checking the data).

Notes on viewing/deleting/copying zones

To **view** the zones that you have created, you need to click on the record selector in the *Zones* tab. A drop-down list will then appear showing all of the zones that you have defined in that project so far. To the right of the zone's name will be the HVAC system which that zone has been assigned to. If a zone has not yet been assigned to an HVAC system, it will say "Unassigned".

NB: At this stage in the tutorial, you will not have created the HVAC system yet so it will say "Unassigned" to the right of your zones.

To **delete** a zone (along with all its associated envelope elements, doors, and windows), you need to select it using the record selector, and then click on the "Delete record" button.

If you press the **copy** button, you will copy the selected zone along with all of the envelope elements, doors, and windows that have been created and linked to it. The new zone will be automatically named for you - it will be the "name of copied zone**.1**". Once it has been created, you can change its name. However, the names of the copied envelope elements, doors, and windows will still have the same names as those they were copied from. The following sections will explain how to rename and edit the envelope elements, doors, and

windows. (There will be an option to just copy the zone by itself, without its child objects, in future versions of the tool.)

Task 5: Create Zone z0/02 in the General tab (the circulation area on the ground floor)

The building has already been zoned for you. See Figure 77: Ground floor plan and Figure 78: First floor plan in APPENDIX A:. A summary of the zoning, along with recommended names for the zones, is given in Table 14.

The six zones which make up the coffee shop have been entered for you so you can start by entering the information for Zone z0/02. Firstly, click on the *Geometry* form and the *Zones* tab. You should then be in the *General* sub-tab. Add a new record and, by referring to APPENDIX A:, enter the zone's name, select the appropriate building and activity types, and finally, enter the zone's area and height.

Using the record selector, you should now be able to view seven zones in total.

Thermal Bridge sub-tab:

If the tick box 'tick here to use global Psi values' in the *General* sub-tab of the *Zones* tab (see above) is not ticked, the *Thermal Bridges* sub-tab will be visible, as shown in Figure 19. Here, you can define any thermal bridges that might occur in the selected zone relating to junctions between envelope elements, windows, and doors which are in contact with the exterior. This is done in the same way as setting the global defaults for thermal bridges in the *Projects* tab (see Section 3.4.2: Project tab).

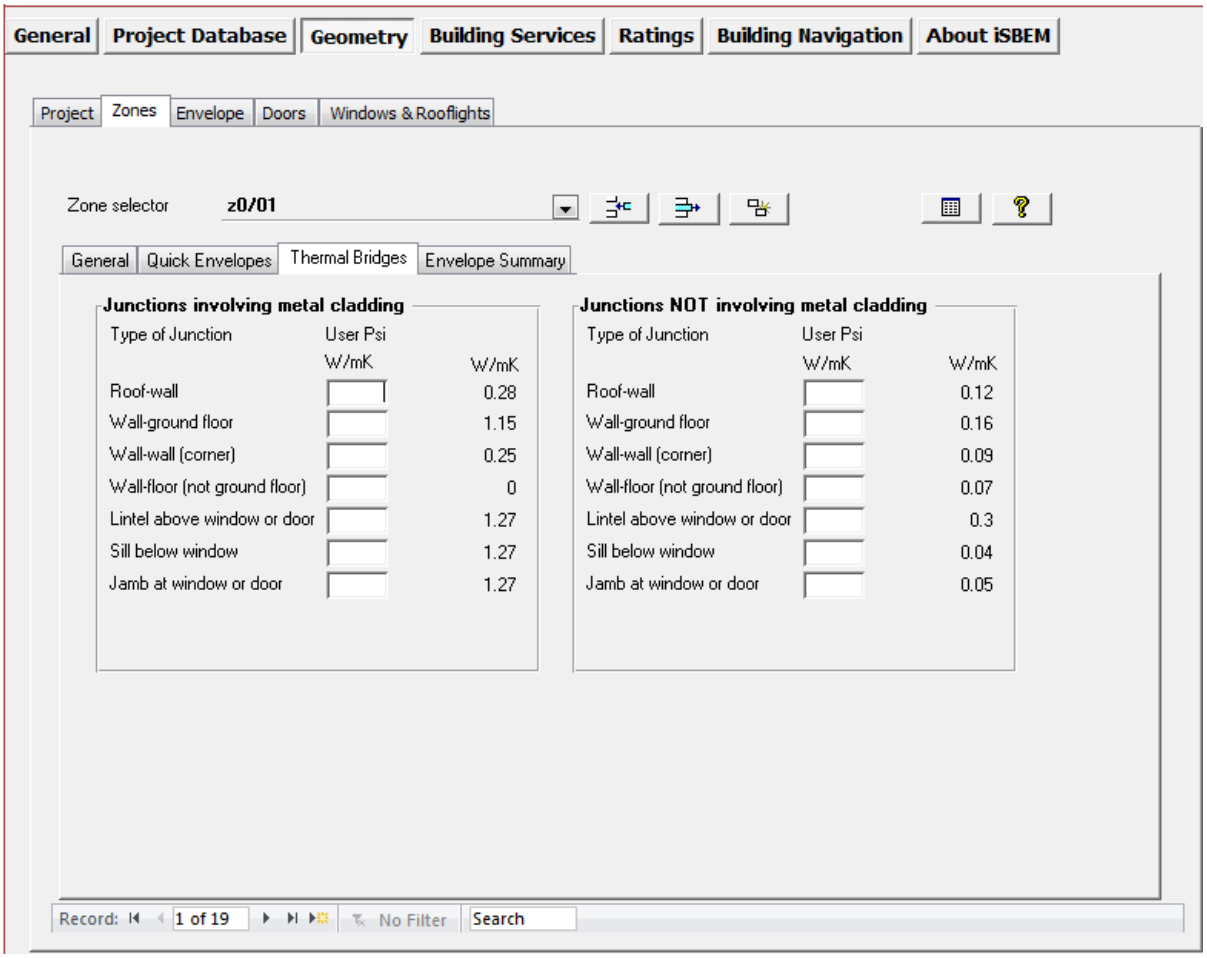


Figure 19: The Thermal Bridge sub-tab of the Zones tab

Envelope Summary sub-tab:

The envelope elements of a zone can be viewed in the *Envelope Summary* sub-tab of the *Zones* tab, shown in Figure 20, (see Section 3.4.4: Defining envelopes – Envelope tab for details on how the envelopes for each zone are created). Depending on which radio button is selected in the 'Show Objects' section, you can choose to either view only the envelopes attached to the zone or view the zone's envelopes as well as any windows or doors assigned to the envelopes. The zone's envelopes are listed in the left-hand side window in terms of their names and types of envelope (<w> for wall, <f> for floor/ceiling, and <r> for roof). If any of the envelopes, windows, or doors, are highlighted in the left-hand side window, more details about that object appear in the 'Selected objects properties' window, such as its area, construction, and the condition of the space it connects the zone to. Also included in the details is the ID number given by iSBEM to this envelope. This ID number can be used to locate this particular envelope quickly, using the "Go to ID" field in the *Envelope* tab, should any editing of its parameters be required (see Section 3.4.4: Defining envelopes – Envelope tab and Figure 21).

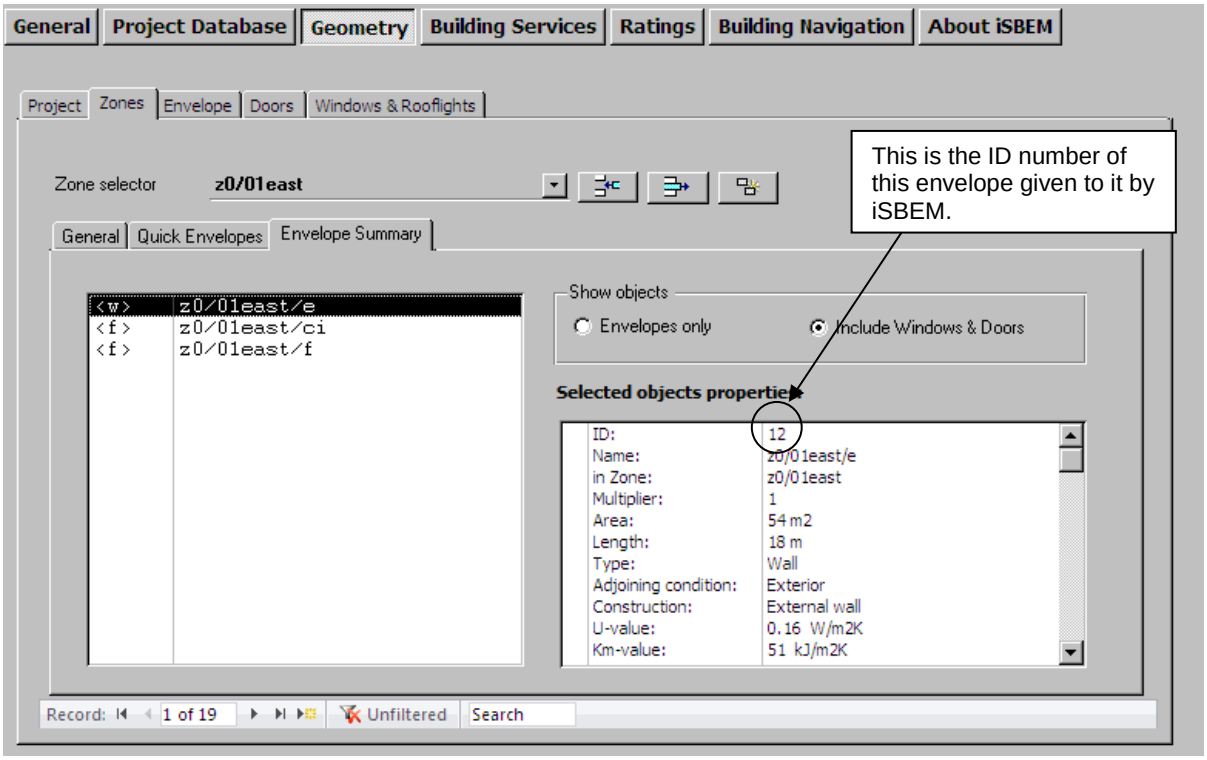


Figure 20: Envelope Summary sub-tab

NB: The *Quick Envelope* function will be explained in Section 3.4.8: Quick Envelopes tab: Short cut to creating envelopes and windows.

3.4.4. Defining envelopes – Envelope tab

The second stage of defining the geometry of a zone is to define its envelopes (walls, floor, and ceiling/roof). There are two ways of doing this:

1. In the *Envelopes* tab – Where you can create the envelope elements and define all of their parameters. This method is explained below.
2. In the *Quick Envelopes* sub-tab of the *Zones* tab - Where you can create and define the basic parameters for the envelope elements and windows. This is explained in Section 3.4.8. There are some parameters, however, for both envelope elements and windows which can only be defined in their main tabs. These tabs will, therefore, be explained first.

The main *Envelope* tab, shown in Figure 21, contains two sub-tabs:

- **General** sub-tab: This is where you can create and define the envelope elements in terms of name, area, orientation, construction type, what type of space it is adjacent to, and its (additional) thermal bridges.
- **Window & Door Summary** sub-tab: This tab displays a summary of the windows and doors present in each envelope element.

General sub-tab:

For each envelope element, you will need to click into the *General* sub-tab of the *Envelope* tab, create a new record, and add the following information:

1. Name – Similar to the naming of the zones (see the User Guide volume "**How to use iSBEM: Basics - UK**" for more information).
2. Multiplier – Indicates how many envelope elements identical to this one exist in the selected zone. Remember that this would also "multiply" all of its associated windows, doors, and additional thermal bridges during the calculation.
3. Zone – Here you need to select the zone from the drop-down list (of zones defined so far) which this envelope element is part of.
4. Type of envelope – Choose between wall, floor or ceiling, and roof. If you select 'roof' or 'floor or ceiling', the following parameter becomes active:
    i. Pitch[xii] – You need to enter the pitch angle, in degrees, from the horizontal.

    If you select 'wall', the following parameter becomes active:

    ii. Perimeter – You need to enter the perimeter length, in m. This is the horizontal dimension of the wall. Limits for this horizontal dimension are defined by the type of the adjacent walls (usually at right angles to the vertical envelope element in question). If the adjacent wall is external or a perimeter wall, the limit will be the internal side of the adjacent wall. If the adjacent wall is internal, the limit will be half-way through its thickness.

NB: Smoke vents are not used in NCM calculations, and so their input into iSBEM is not required. Their area should be substituted by the relevant (i.e., immediately surrounding) opaque fabric (roof or wall). Compliance checking with respect to their U-values, where applicable, will, therefore, need to be carried out outside of iSBEM.

5. Connects space to (sometimes referred to as "adjacent condition") – Here you need to select what conditions apply on the other side of the wall/floor or ceiling/roof. If you click the 'Global' button, the condition associated with the type of construction selected below (as has been defined in the *Project Database* form) will be inserted as the default. If this is not appropriate, you can un-click the Global button and select between: Conditioned adjoining space, External, Strongly ventilated, Underground, Unheated space, or Same space (see Table 2).

Option	Brief Description
Exterior	For an envelope separating the considered zone from the outside air or water.
Strongly ventilated spaces	For an envelope separating the considered zone from a space provided with one or more permanent openings (i.e., that cannot be closed), with a capacity for the supply of fresh air and extract of inside air, determined according to section 5.3 of NEN 1087, of at least $3x10^{-3}$ m^3/s per m^2 useable area.
Unheated adjoining space	For an envelope separating the considered zone from an unheated adjoining space, other than meant under 'Strongly ventilated spaces'.
Conditioned adjoining space	For an envelope separating the considered zone from another conditioned zone.

[xii] A pitched roof has a pitch greater than 10° (If the roof's pitch is 10° or less, it can be considered flat). If the pitch is greater than 70°, it should be modelled as a wall.

Underground	For an envelope separating the considered zone from the ground.
Same space	For constructions representing the internal envelopes that separate contiguous zones which have been merged into one zone, i.e., the envelope is “contained” within the merged zone.

Table 2: Options for ‘Connects space to’ field for envelopes

NB: Note that the Building Regulations compliance check regarding U-values will be applied by the tool to all envelopes which are not adjacent to a ‘Conditioned adjoining space’ or ‘Same space’. Also note that the tool will not check the U-values of envelopes of unconditioned zones for compliance.

6. Construction – Here you need to select the type of construction for the envelope. When you click the drop-down menu to the right of the construction field, you will be presented with all the constructions of that type (type of envelope defined above) that you have defined in the *Project Database* form, as well as a default construction (For e.g., if this is a wall, then all the constructions you previously defined in the *Project Database* form > *Constructions for walls* tab will be visible). Select one of these. If you need another construction type, you will need to go back to the *Project Database* form and create it first.

NB: Defining non-transpired solar collectors: As non-transpired solar collector are structural elements, rather than “add-on” elements like the transpired solar collectors, they also need to be defined as a wall construction in the *Project Database* form and then assigned to the relevant wall in the *Geometry* form. Within the *Project Database* form > *Constructions for walls* tab > *General* sub-tab, when the “Import from library” option is selected, and the option selected for the “Category” parameter is “Light steel framing”, there are options for non-transpired solar collectors with different thicknesses. One of them should be selected, unless the thermal parameters (U-value and kappa-m value) are known already and can be input manually. This wall construction type should then be assigned to the appropriate wall in the *Geometry* form > *Envelope* tab > *General* sub-tab as the option for the “Construction” parameter.

7. Area – This is the area of envelope element inclusive of any windows and doors, in m^2. This value is used to calculate the fabric heat loss so this is the area to which the U-value is applied (the areas of windows and doors will be deducted within the calculation when necessary). For floors and flat roofs/ceilings, the envelope area is calculated in the same manner as the zone area (see the User Guide volume “**How to use iSBEM: Basics - UK**”). The area for an exposed pitched roof (i.e., without an internal horizontal ceiling) will be that of the inner surface area of the roof. For vertical envelopes (i.e., walls), the area is calculated as follows:

   $Area\ of\ vertical\ envelope\ element = h \times w$ where:

   h = floor to floor height (floor to soffit on top floor), in m, i.e., including floor void, ceiling void, and floor slab, and

   w = horizontal dimension of the wall. Limits for this horizontal dimension are defined by the type of the adjacent walls (usually at right angles to the vertical envelope element in question). If the adjacent wall is external or a perimeter wall, the limit will be the internal side of the adjacent wall. Otherwise, the limit will be half-way through its thickness.

NB: If surfaces of the room are not rectilinear, for example, if a pitched roof is exposed to the inside of the conditioned zone (i.e., there is no flat ceiling underneath it), then the roof area will be that of the inner surface area of the roof as "seen" by the heat flux.

NB: During the calculation, if the area of the wall input is found to be less than the total area of windows and doors defined within it, SBEM will increase the area of the wall to fit the areas of all the defined openings in it. The corresponding wall in the Notional building will similarly have the increased area. Therefore, you should always ensure that you double-check the figures you input for your model geometry in iSBEM before running the calculation.

8. Orientation – Here you need to select from the drop-down menu whether the element faces north, north-east, east, etc., or is horizontal.
9. Tick box to indicate if there is a solar collector (transpired or non-transpired) on this envelope. This tick box becomes active only if a solar collector object has been defined in the *Building Services* form of this project, and if this envelope is a wall. If the box is ticked, the following two parameters become active:
    i. A drop-down menu to select the name of the solar collector, already defined in the *Building Services* form, which is installed on the exterior of this wall.
    ii. Area of the solar collector, in m^2, which is installed on the exterior of this wall.

NB: <u>Defining non-transpired solar collectors:</u> As non-transpired solar collector are structural elements, rather than "add-on" elements like the transpired solar collectors, they also need to be defined as a wall construction in the *Project Database* form and then assigned to the relevant wall in the *Geometry* form. Within the *Project Database* form > *Constructions for walls* tab > *General* sub-tab, when the "Import from library" option is selected, and the option selected for the "Category" parameter is "Light steel framing", there are options for non-transpired solar collectors with different thicknesses. One of them should be selected, unless the thermal parameters (U-value and kappa-m value) are known already and can be input manually. This wall construction type should then be assigned to the appropriate wall in the *Geometry* form > *Envelope* tab > *General* sub-tab as the option for the "Construction" parameter.

10. Additional Thermal Bridges – If there are any thermal bridges <u>in addition</u> to those already described in the *Thermal Bridges* sub-tab of *Project* tab (if the global values are being applied) or the *Thermal Bridges* sub-tab of the *Zones* tab (if they are not), then they need to be entered here in terms of the length of the thermal bridge (m) and its linear thermal transmittance, the ψ (Psi) value (W/mK). (See notes in Section 3.4.2: Project tab regarding thermal bridges.).
11. Go to ID – this parameter can be used to quickly 'jump to' a particular envelope. The ID number of an envelope is visible among the envelope details displayed in the *Envelope Summary* sub-tab of the zone to which this envelope belongs. For example, if while reviewing the details in the *Envelope Summary* sub-tab, an error was detected in the description of a particular envelope, you can make a note of its ID number (Figure 20), go to the *Envelope* tab, type the ID number in the box, and press the arrow key  . This will take you to the *General* sub-tab of that particular envelope where you can correct the error (see Envelope Summary sub-tab in section 3.4.3: Defining zones – Zones tab).

Figure 21 shows a wall being defined.

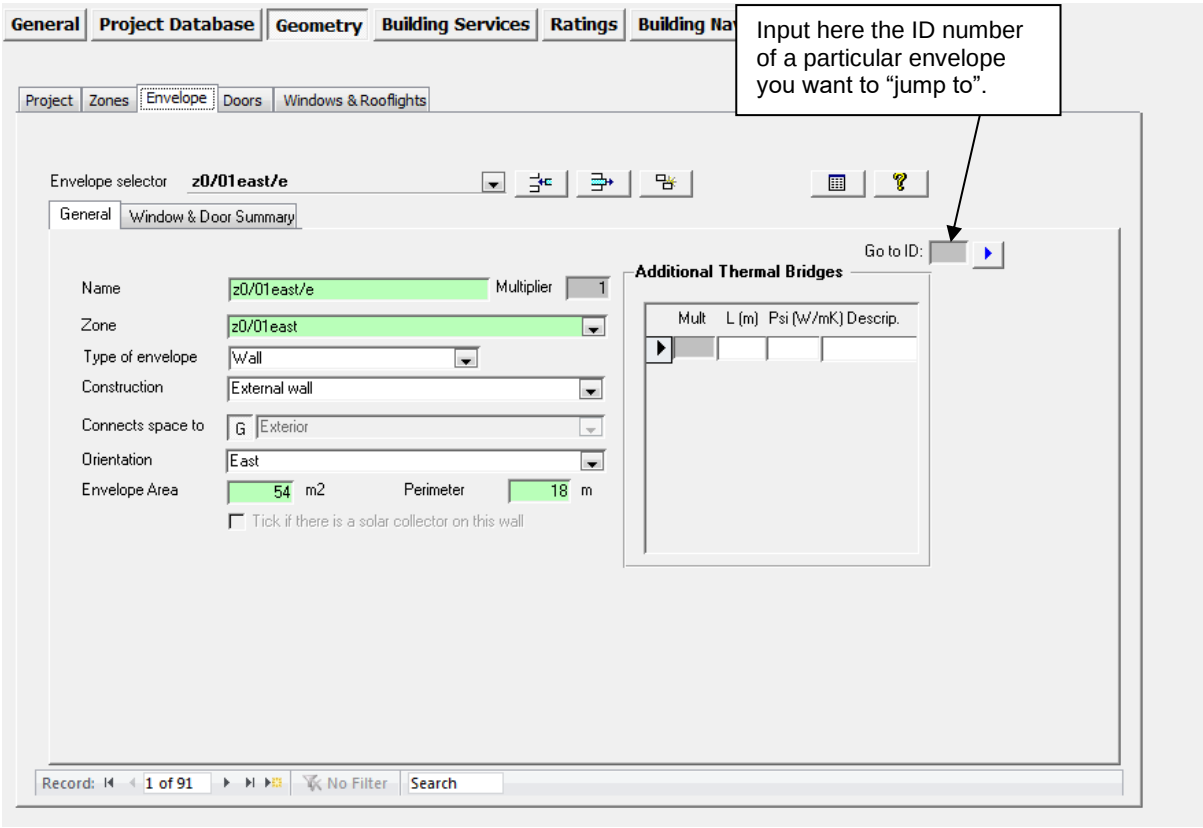


Figure 21: A wall being defined in the General sub-tab of the Envelope tab in the Geometry form

At the top right-hand side of the *Envelope* tab, a message appears if any of the envelope elements have not yet been assigned to a zone. To see a list of all the envelope elements which have not been assigned to zones, click the Reports button (for more details about the Objects reports, see Section 3.8: Double-checking the data).

Task 6: Create all the envelope elements for zone z0/02

The details on the walls, floors, and ceilings/roofs can be found in Table 14 in APPENDIX A:. First, click on the *Geometry* form and the *Envelope* tab. You should then be in the *General* sub-tab. For each new envelope element, you will need to add a new record and by referring to Table 14, enter its required parameters. Do this for all the envelope elements for zone z0/02 (This includes the four walls, the floor, and the ceiling). The envelope elements for zones z0/04, z0/01, z0/08, z0/06, z0/05, and z0/07 have been entered for you, and you will be able to view them using the record selector.

Viewing, deleting, and copying envelope elements in the Envelope main tab

To **view** the envelope element that you have created, you need to click on the record selector in the main *Envelope* tab. A drop-down list will then appear showing all of the envelope elements that you have defined in that project so far. To the right of the envelope's name will be the zone which that envelope element is part of, followed by the HVAC system which the zone has been assigned to. If the zone has not been assigned to an HVAC system, it will say "Unassigned".

NB: At this stage in the tutorial, you will not have created any HVAC systems yet so it will say “Unassigned” to the right of your zones

To **delete** an envelope element (and any associated windows or doors), you need to select it using the record selector and then click on the “Delete Record” button.

If you press the “Copy Record” button, you will **copy** the selected envelope element along with any windows and doors that have been created and linked to it. The new envelope will be automatically named for you - it will be the “name of copied envelope**.1**”. Once it has been created, you can change its name. (The names of the copied windows and doors associated with the envelope, however, will have the same name as those they were copied from - the following section will explain how to rename and edit the windows).

Task 7: View the envelope elements you have created for zone z0/02 in the Envelope main tab AND in the Envelope Summary tab

First, using the record selector in the main *Envelope* tab, view the envelope elements that have been created in this project.

Then, go back to the *Zones* main tab, select zone z0/02, and click on the *Envelope Summary* sub-tab. Here, you should be able to see all the envelope elements that you have created in Task 6. If you have made any errors, you will need to go back to the main *Envelope* tab and edit the envelope elements there.

Task 8: Create a new envelope element and then delete it

So that you become familiar with the functionality of the tool, try introducing a made-up envelope element for zone z0/02 using the *Envelope* tab. Once it has been sufficiently defined (i.e., the green fields have been filled in), you will be able to delete it.

Windows & Doors Summary sub-tab:

The windows and doors assigned to an envelope element can be viewed in the *Window & Door Summary* sub-tab of the *Envelope* tab, shown in Figure 22, (see Section 3.4.5: Defining windows, for details on creating windows and rooflights and Section 3.4.7: Defining doors, for details on creating doors). Depending on which radio button is selected in the ‘Objects’ section, you can choose to either view only the windows and rooflights attached to the envelope, view only the doors, or view the envelope’s windows and rooflights as well as any doors. The envelope’s windows and/or doors are then listed in the left-hand side window in terms of their names and types (<wi> for window and <d> for door). If any of the windows or doors are highlighted in the left-hand side window, more details about that object appear in the ‘Selected objects properties’ window, such as its area and construction.

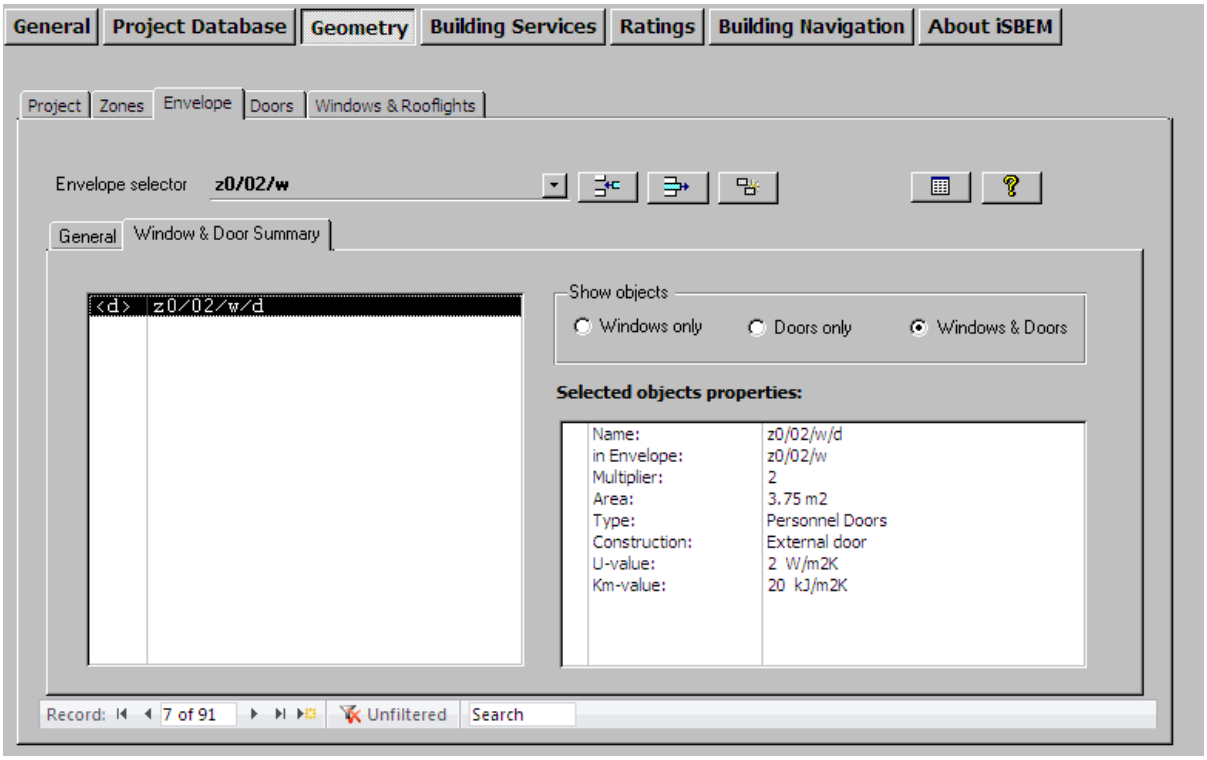


Figure 22: Windows & Doors Summary sub-tab

NB: The *Quick Envelope* function is explained in Section 3.4.8: Quick Envelopes tab: Short cut to creating envelopes and windows.)

3.4.5. Defining windows and rooflights – Windows & Rooflights tab

For each envelope element in the building, you need to define the type and amount of glazing it contains, if any. If there is more than one window/rooflight of the same glazing type, area, shading type, etc. in one wall/roof, you can define only one of them and use the multiplier field to define how many of them exist in the wall/roof. The principal way to define the windows is in the main *Windows & Rooflights* tab. Rooflights are considered in the same way as windows in iSBEM.

There is only one sub-tab in the *Windows & Rooflights* tab:

- **General** sub-tab.

General sub-tab:

This is where you need to enter the window name, assign it to an envelope element, enter the glazing type, area, shading system, transmission factor, and details of any additional thermal bridges, etc.

NB: Internal windows and doors should not be entered into iSBEM.

For each window, you will need to create a new record and add the following information:

1. Name – As before, the name must be unique and should indicate which wall it is to be attached to (see the User Guide volume "**How to use iSBEM: Basics - UK**" for more information) for easier reference.

2. Multiplier – Indicate how many windows identical to this one exist in the selected envelope element. Remember that this would also "multiply" all of its associated additional thermal bridges during the calculation.
3. In Envelope – Here, you need to select from the drop-down box, which envelope element this window is in (be it a wall or a roof).
4. Glazing type – Here, you need to select the type of glazing. When you click on the drop-down menu to the right of the glazing field, you will be presented with all the glazing types that you already defined in the *Project Database* form, as well as a default glazing.
5. Area – Area of the structural opening in the wall/roof including the frame, in m^2.

   NB: If the wall/roof is fully glazed, then the area of the window will be equal to the area of the wall/roof.

   NB: If a wall/roof contains a row/array of identical windows/rooflights, you should input the area of only one window/rooflight and use the "multiplier" field to define the number of identical windows/rooflights that exist in the same wall/roof.

   NB: During the calculation, if the area of the wall input is found to be less than the total area of the windows and doors defined within it, SBEM will increase the area of the wall to fit the areas of all the defined openings in it. The corresponding wall in the Notional building will similarly have the increased area. Therefore, you should always ensure that you double-check the figures you input for your model geometry in iSBEM before running the calculation.
6. Surface area ratio – This is the "developed area to projected area" ratio for the window or rooflight. The developed area is the total area of the glass plus the frame, and the projected area is the area of the opening in the wall/roof. Therefore, for domed or conical rooflights, for example, this ratio would be larger than 1, and for typical windows and flat rooflights, the value is 1. It cannot have a value which is less than 1. The default values are 1 for windows and 1.3 for rooflights.
7. Roof opening type – If the envelope in which this glazed opening has been defined is a roof, this parameter becomes active to enable you to define whether this is a roof window or a rooflight[ii]. Depending on the purpose of analysis, this could have an impact on how the U-value of the corresponding glazing is processed by the calculation engine and on the compliance check against the limiting standards in the Building Regulations (see the relevant Approved Documents).
8. Display window tick box – Tick this box if the window being defined is for display purposes (e.g., a shop front window), as defined in the Approved Documents.

NB: As per the Approved Documents, the tool does not check 'display windows' for compliance with regards to the glazing's limiting standards for U-values

9. Frame factor – This is the ratio of the window or rooflight area which is occupied by the frame to the total window or rooflight area. The default value is 0.1 for a window (i.e., 10% of the total area is occupied by the frame and 90% by the glazing) and 0.3 for a rooflight. It cannot have a value which is less than 0 or which is larger than 1.
10. Aspect ratio – This is the ratio of the window's height to its width. The default value is 0.7.
11. Shading position – Here, you need to select from the drop-down menu whether the window has: external, internal, or no moveable solar shading device (see Figure 23 and Figure 24). This is used (together with the next 2 parameters) to calculate the reduction factor due to shading devices, which reduce the amount of solar heat gains entering the zone through the glazing. If the option selected is not "None (no shading)", the following 2 parameters become active:

a. Shading colour – Here, you need to select from the drop-down menu the colour of the moveable solar shading device (see corresponding properties used by the calculation in Table 3 to select the most suitable option for your shading).

b. Shading translucency – Here, you need to select from the drop-down menu the degree of translucency of the moveable solar shading device (see corresponding properties used by the calculation in Table 3 to select the most suitable option for your shading).

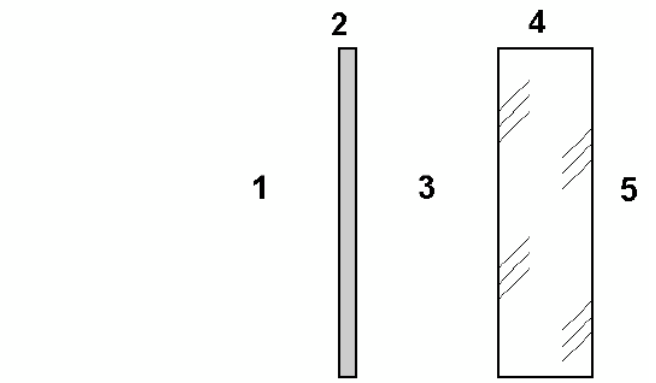
12. Transmission factor – This is the fraction of light transmitted through that specific window after accounting for shading from overhangs and fins. (For details on how to calculate the transmission factor, see Section 3.4.6: Transmission correction factors.) A transmission factor of 1 refers to 100% of light transmitted, i.e., no shading from fins or overhangs, and a value of 0 means the window is completely shaded by fins and/or overhangs such that no light is transmitted through it, which is an unlikely situation.
13. Brise-soleil tick box – Tick this box if the overhang whose transmission factor is accounted for in the previous parameter is in fact a brise-soleil. **NB:** For the purposes of the calculation, a brise-soleil has strips, louvres, holes, etc., as opposed to a solid overhang.
14. Thermal Bridges – Here, you need to define any thermal bridges <u>in addition</u> to those already described in the *Thermal Bridges* sub-tab of the *Project* tab (if the global values are being applied) or the *Thermal Bridges* sub-tab of the *Zones* tab (it they are not), in terms of the length of the thermal bridge (m) and its linear thermal transmittance, the ψ (Psi) value (W/mK). (See notes in Section 3.4.2: Project tab, regarding thermal bridges.)

NB: Doors which are more than 50% glazed should be entered into iSBEM as windows, and their light and solar characteristics should be entered into the *Project Database* form > *Glazing* tab. Doors which are 50% or less glazed can be treated as opaque doors.

Transmittance $\tau_{e,B}$		**Reflectance** $\rho_{e,B}$			
		white	**pastel**	**dark**	**black**
Opaque	0.0	0.7	0.5	0.3	0.1
Medium translucent	0.2	0.6	0.4	0.2	0.1
High translucent	0.4	0.4	0.3	0.2	0.1

Table 3: Data for typical solar protection devices[xiii]

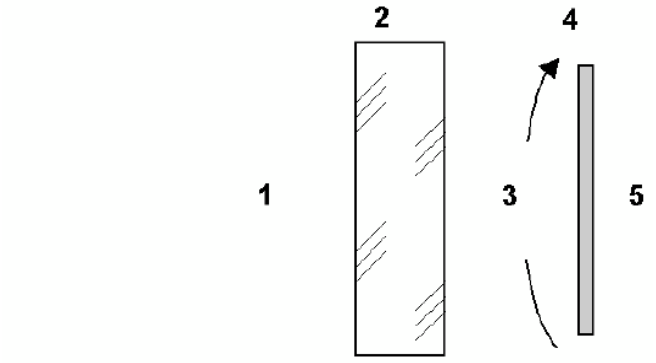
[xiii] Extracted from BS EN 13363-1:2003+A1:2007 - *Solar protection devices combined with glazing - Calculation of solar and light transmittance - Part 1: Simplified method*.



Key

1 Exterior
2 Solar protection device
3 Unventilated air space
4 Glazing
5 Interior

Figure 23: Characteristic position of external solar protection device[xiii]



Key

1 Exterior
2 Glazing
3 Air space, ventilated to the interior
4 Solar protection device
5 Interior

Figure 24: Characteristic position of internal solar protection device[xiii]

Figure 25 shows a window being defined.

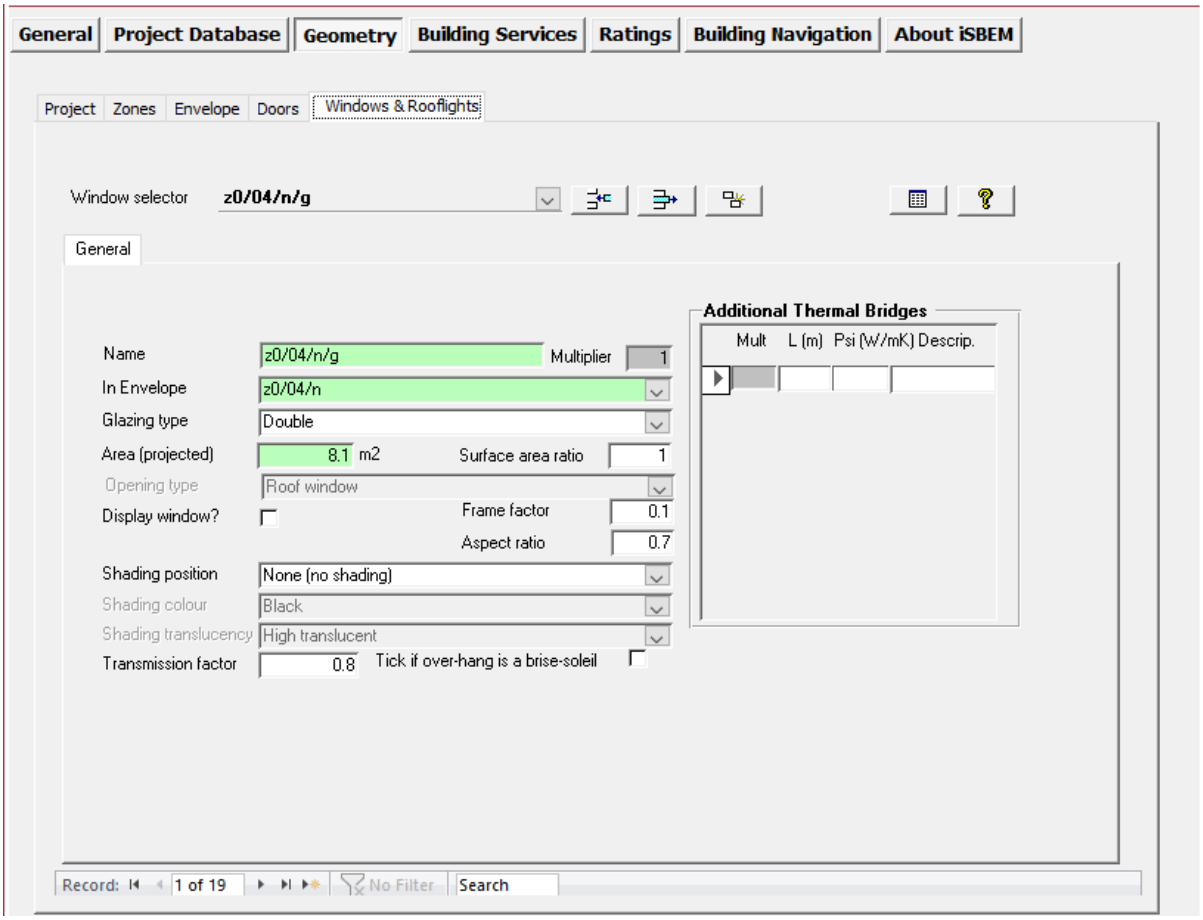


Figure 25: A window being defined in the General sub-tab of the Windows & Rooflights tab in the Geometry form

At the top right-hand side of the *Windows* tab, a message will appear indicating how many windows have not yet been assigned to an envelope element. To see a list of all the windows which have not been assigned to envelope elements, click on the Reports button (for more details about the Objects reports, see Section 3.8: Double-checking the data).

Task 9: Create the windows for zone z0/06

The details of all the glazing present in each zone are given in Table 14 in APPENDIX A:. First, click on the *Geometry* form, the *Windows & Rooflights* tab, and then the *General* sub-tab. For each new window, you will need to add a new record and by referring to Table 14, enter all the required parameters. Do this for the window in zone z0/06 (z0/06/w/g).

Viewing, deleting, and copying windows in the Windows & Rooflights tab

To **view** the windows that you have created, you need to click on the record selector in the main windows tab. A drop-down list will then appear showing all of the windows that you have defined in that project. To the right of the window's name will be the names of the envelope element which that window is part of, followed by the name of the zone to which the envelope belongs.

To **delete** a window, you need to select it using the record selector, and then click on the "Delete Record" button.

If you press the “Copy Record” button, you will **copy** the selected window. The new window will be automatically named for you – it will be the “name of copied window**.1**”. Once it has been created, you can change its name.

Task 10: View the window that you have created for zone z0/06 in the Windows main tab AND in the Windows Summary tab

First, using the record selector in the main *Windows* tab, view the windows that have been created in this project. You should be able to see 7 (6 already created for you plus the one you have created).

Then, go back to the *Envelope* main tab, select envelope z0/06/w, and click on the *Windows & Doors Summary* sub-tab. Here, you should be able to see the window that you have created in Task 9. If you have made any errors, you will need to go back to the main *Windows & Rooflights* tab and edit them.

Task 11: Create a window and then delete it

So that you become familiar with the functionality of the tool, try introducing a made-up window for zone z0/06 using the *Window & Rooflights* tab. Once it has been sufficiently defined (i.e., the green fields have been filled in), you will be able to delete it.

3.4.6. Transmission correction factors

The transmission factor for windows can be calculated from[xiv]:

$$TS = F_o \times F_f$$

where:

F_o is the partial shading correction factor for overhangs, and
F_f is the partial shading correction factor for fins.

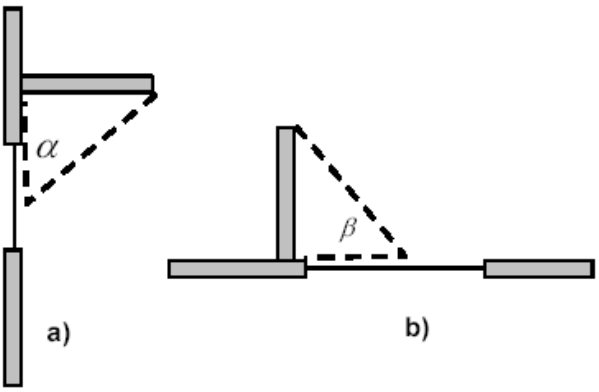
A transmission factor of 1 refers to 100% of light transmitted, i.e., no shading from fins or overhangs, and a value of 0 means the window is completely shaded by fins and/or overhangs such that no light is transmitted through it, which is an unlikely situation.

NB: The effect of shading from the horizon (e.g., the ground, trees, and other buildings) is not considered for the calculations carried out by SBEM.

Shading from overhangs and fins

The shading from overhangs and fins depends on the overhang or fin angle, latitude, orientation, and local climate. Seasonal shading correction factors for typical climates are given in Table 4 and Table 5.

[xiv] The source of the shading calculation due to fins and overhangs is the CEN standard "EN 13790: Energy performance of buildings — Calculation of energy use for space heating and cooling".



a) Vertical section b) Horizontal section

Key
α overhang angle
β fin angle

Figure 26: Shading from overhangs and fins

NB: For the purposes of this calculation, the angles alpha and beta, indicated by the dashed lines in Figure 26, are taken between the plane of the window and the overhang or fin shadow line at mid-window.

Overhang angle	45°N latitude			55°N latitude			65°N latitude		
	S	E/W	N	S	E/W	N	S	E/W	N
0°	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30°	0.90	0.89	0.91	0.93	0.91	0.91	0.95	0.92	0.90
45°	0.74	0.76	0.80	0.80	0.79	0.80	0.85	0.81	0.80
60°	0.50	0.58	0.66	0.60	0.61	0.65	0.66	0.65	0.66

Table 4: Partial shading correction factor for overhangs[xv], F_o

Fin angle	45°N latitude			55°N latitude			65°N latitude		
	S	E/W	N	S	E/W	N	S	E/W	N
0°	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
30°	0.94	0.92	1.00	0.94	0.91	0.99	0.94	0.90	0.98
45°	0.84	0.84	1.00	0.86	0.83	0.99	0.85	0.82	0.98
60°	0.72	0.75	1.00	0.74	0.75	0.99	0.73	0.73	0.98

Table 5: Partial shading correction factor for fins[xv], F_f

3.4.7. Defining doors – Doors tab

Only a zone's **external** doors need to be defined in iSBEM.

[xv] Extracted from EN ISO 13790:2008 - Energy performance of buildings — Calculation of energy use for space heating and cooling.

The *Doors* tab contains one sub-tab:

- **General** sub-tab

General sub-tab:

This is where you need to enter the name of the door, assign it to an envelope element, and enter its area, its construction type, its additional thermal bridges (if applicable), and what type of door it is. If there is a number of doors in the same wall with the same area, construction, type, etc., then you can define only one door and use the multiplier field to denote the number of identical doors that exist in the wall.

NB: Internal windows and doors should not be entered into iSBEM.

For each door, you will need to create a new record and add the following information:

1. Name – As before, the name must be unique and must indicate which wall it is to be attached to (see the User Guide volume "**How to use iSBEM: Basics - UK**" for more information) for easier reference.
2. Multiplier – Indicate how many doors identical to this one exist in the selected envelope element. Remember that this would also "multiply" all of its associated additional thermal bridges during the calculation.
3. In Envelope – Here, you need to select which element this door is part of from a drop-down box of the envelopes already created.
4. Type – Here, you need to select between: Personnel Doors, High Usage Entrance Doors, and Vehicle Access Doors, as defined in the Approved Documents.
5. Construction type – Here, you need to select the type of construction. When you click on the drop-down menu to the right of the construction field, you will be presented with all the constructions for doors that you defined in the *Project Database* form, as well as a default construction.
6. Area – Specifies the area of the door including the frame, in m^2, i.e., the area of the structural opening in the wall.

   NB: If an external wall contains a row/array of identical doors, you should input the area of only <u>one</u> door and use the "multiplier" field to define the number of identical doors that exist in the same wall.

   NB: During the calculation, if the area of the wall input is found to be less than the total area of windows and doors defined within it, SBEM will increase the area of the wall to fit the areas of all the defined openings in it. The corresponding wall in the Notional building will similarly have the increased area. Therefore, you should always ensure that you double-check the figures you input for your model geometry in iSBEM before running the calculation.
7. Thermal Bridges – Here, you need to define any thermal bridges <u>in addition</u> to those described in the *Thermal Bridges* sub-tab of *Project* tab (if the global values are being applied) or the *Thermal Bridges* sub-tab of the *Zones* tab (it they are not), in terms of the length of the thermal bridge (m) and its linear thermal transmittance, the ψ (Psi) value (W/mK). (See notes in Section 3.4.2: Project tab, regarding thermal bridges.)

NB: Doors which are more than 50% glazed should be entered into iSBEM as windows, and their light and solar characteristics should be entered into the *Project Database* form > *Glazing* tab. Doors which are 50% or less glazed can be treated as opaque doors.

Figure 27 shows a door being defined. In this example, a personnel door of 3.75 m^2 in area has been entered.

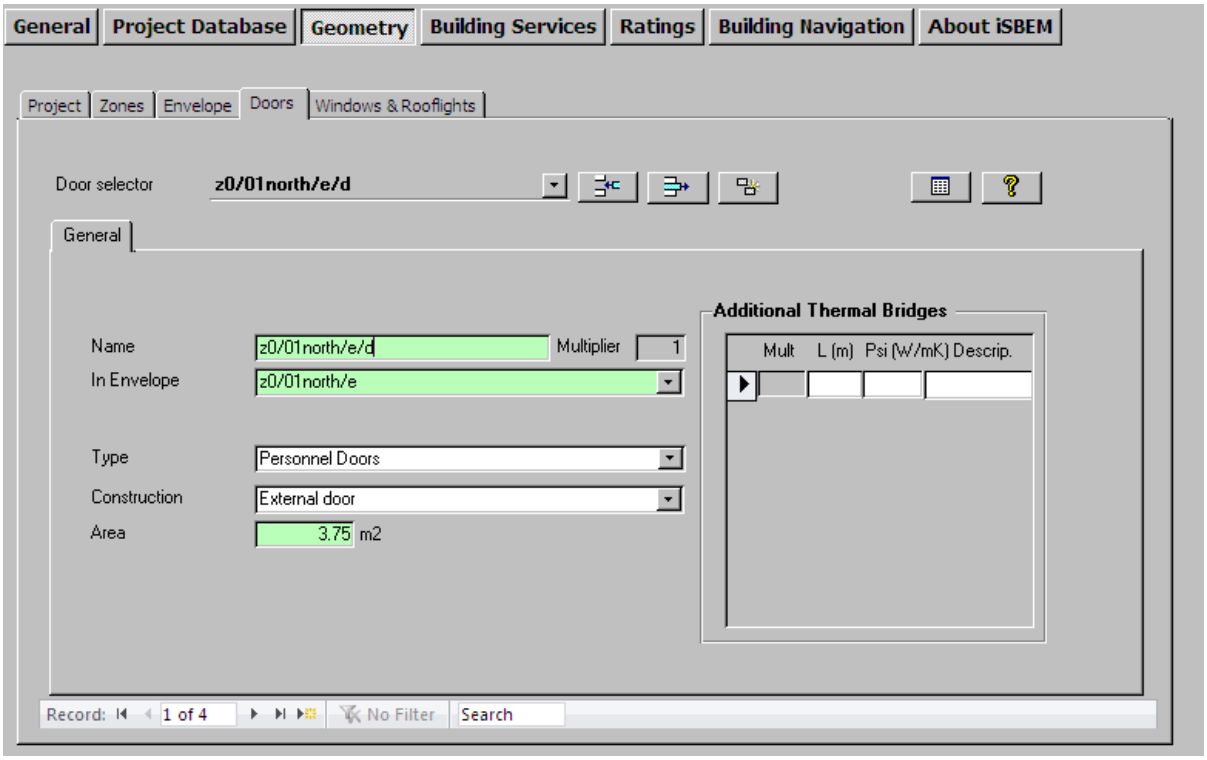


Figure 27: A Door being defined in the Doors tab

3.4.8. Quick Envelopes tab: Short cut to creating envelopes and windows

The *Quick Envelopes* sub-tab provides an alternative way of introducing the envelope elements and windows without having to assign them manually to a zone or envelope element, respectively.

The information required is a selection of the parameters required in the main *Envelope* and *Windows & Rooflights* tabs.

Envelopes elements and windows are created as follows:

The zone to which the envelopes and windows are to be assigned is defined by the zone selected using the record selector.

The type (wall, floor/ceiling, or roof) and orientation of the envelope element is defined by which row you enter your information into. The first eight rows are for creating walls with orientations S, SE, E, NE, N, NW, W, and SW, and the last three rows are for ceilings, floors, and roofs.

There are then the following fields that need to be filled in for each envelope element:

1. Construction type (choose between a default construction and the constructions that you already defined in the *Project Database* form).
2. Adjacent condition – Here you have 2 options:
   a. Leave the “Global” button pressed in and hence apply the global default adjacency condition that was associated with the selected construction in the *Project Database* form (see Section 3.3.1: Defining construction types) or
   b. Un-depress the “Global” button and select a condition from the drop-down menu (choose between: Exterior, Strongly ventilated spaces, Unheated adjoining space, Conditioned adjoining space, Underground, or Same space).

3. Area of the envelope (calculated as described in section 3.4.4: Defining envelopes – Envelope tab), in m^2.
4. Perimeter length (L), in m, if the envelope is a wall. **NB:** If this box is left blank, iSBEM will calculate the perimeter length using the input envelope area and assuming the height of the envelope to be the same as the height defined for the zone. However, if the envelope being defined does not have the same height as that defined for the zone, the user needs to input the perimeter length manually. Otherwise, the calculated value will not be correct.
5. Pitch angle, in degrees, if the envelope is a roof.

If that envelope element has any windows or glazed areas, you need to fill in the following remaining fields:

6. Area of the window or rooflight, including the frame, in m^2. If you wish to define windows or rooflights (including the frames) using percentages of the envelope areas (as was the case in previous versions of iSBEM), then you need to untick the relevant box in the *General* form > *File Options* tab > *System Configuration (cont.)* sub-tab (see Section 3.2.1: File Options tab). The box is ticked by default.

   NB: Internal windows and doors should not be entered into iSBEM.

   NB: If the wall/roof is fully glazed, then the area of the window will be equal to, i.e. 100% of, the area of the wall/roof.

   NB: If a wall/roof contains a row/array of identical windows/rooflights, you should input the area of only <u>one</u> window/rooflight and use the "multiplier" field to define the number of identical windows/rooflights that exist in the same wall/roof.

   NB: During the calculation, if the area of the wall input is found to be less than the total area of windows and doors defined within it, SBEM will increase the area of the wall to fit the areas of all the defined openings in it. The corresponding wall in the Notional building will similarly have the increased area. Therefore, you should always ensure that you double-check the figures you input for your model geometry in iSBEM before running the calculation.
7. Glazing type (choose between a default glazing type and the glazing types that you defined in the *Project Database* form).
8. Disp? – Indicate whether it is a display window or not (as defined in the Approved Documents).

Once the information is entered, click on the **"Create Envelopes**" button to create the envelopes. Once the button has been clicked and the envelopes have been created, the contents of the *Quick Envelopes* tab will be automatically cleared. If you do not wish for the contents of the tab to be cleared after the creation of the envelopes (for e.g., so you can re-use them), then you need to untick the relevant box in the *General* form > *File Options* tab > *System Configuration (cont.)* sub-tab (see Section 3.2.1: File Options tab). The box is ticked by default.

To **view** the envelopes and windows that you have created, go to the *Envelopes Summary* sub-tab (in the *Zones* tab) and the *Windows Summary* sub-tab (in the *Envelope* tab). All the envelopes and windows will be available for **editing** in the main *Envelope* and *Windows* tabs.

NB: Doors which are more than 50% glazed should be entered into iSBEM as windows, and their light and solar characteristics should be entered into the *Project Database* form > *Glazing* tab. Doors which are 50% or less glazed can be treated as opaque doors.

The parameters that you cannot define in the Quick Envelopes sub-tab include:

- Thermal bridges for envelope elements or windows - If the envelope or window you have created contains any thermal bridges in addition to those already described in the *Thermal Bridges* sub-tab of the *Project* tab (if the global values are being applied) or the *Thermal Bridges* sub-tab of the *Zones* tab (it they are not), you will need to go to the *Envelopes* and *Windows* main tabs, select the record in question, and add the thermal bridge manually. (See notes in Section 3.4.2: Project tab regarding thermal bridges.)
- Shading position - If the window or rooflight has anything but the default for this parameter (which is None (no shading)), then you will need to go to the *Windows & Rooflights* main tab, select the window in question using the record selector, and change the details manually. There, you can also define the parameters for Shading colour and Shading translucency.
- Transmission factor - If the window or rooflight has anything but the default for this parameter (which is 1), then you will need to go to the *Windows & Rooflights* main tab, select the window in question using the record selector, and change the details manually.
- Surface area ratio – If the window or rooflight has anything but the default (which is 1 for windows and 1.3 for rooflights) for this parameter, you will need to go to the *Windows & Rooflights* main tab, select the window in question using the record selector, and change the details manually.
- Frame factor – If the window or rooflight has anything but the default (which is 0.1 for windows and 0.3 for rooflights) for this parameter, you will need to go to the *Windows & Rooflights* main tab, select the window in question using the record selector, and change the details manually.
- Roof opening type – If roof opening is other than the default, which is 'Roof window', you will need to go to the *Windows & Rooflights* main tab, select the roof opening in question using the record selector, and change the details manually.
- Aspect ratio – If the window or rooflight has anything but the default (which is 0.7) for this parameter, you will need to go to the *Windows & Rooflights* main tab, select the window in question using the record selector, and change the details manually.
- Doors definitions – All opaque doors, i.e., type, area, etc., will need to be defined in the *Doors* sub-tab.

Introducing a second envelope element with the same orientation:

If your zone has, for example, a second west-facing wall with a different construction or adjacent to a different condition on the other side, you will need to create one west wall, click on the "Clear all" button to remove the information about the first west wall, enter the information about the second west wall, and then click on "Create envelopes" again. The tool would then add the second west wall to the already created envelopes.

Naming of the envelope elements and windows created in the Quick Envelopes tabs:

The names are created automatically as described in the User Guide volume "**How to use iSBEM: Basics - UK**".

Figure 28 shows a wall and a window being defined in the *Quick Envelopes* tab. The example wall is a 15 m^2, external, 5 m perimeter, south-facing wall, constructed from an External Wall specification that had previously been defined in the *Project Database* form. It has a 7.5 m^2 window with glazing of a type previously defined in the *Project Database* form, and it is not a display window.

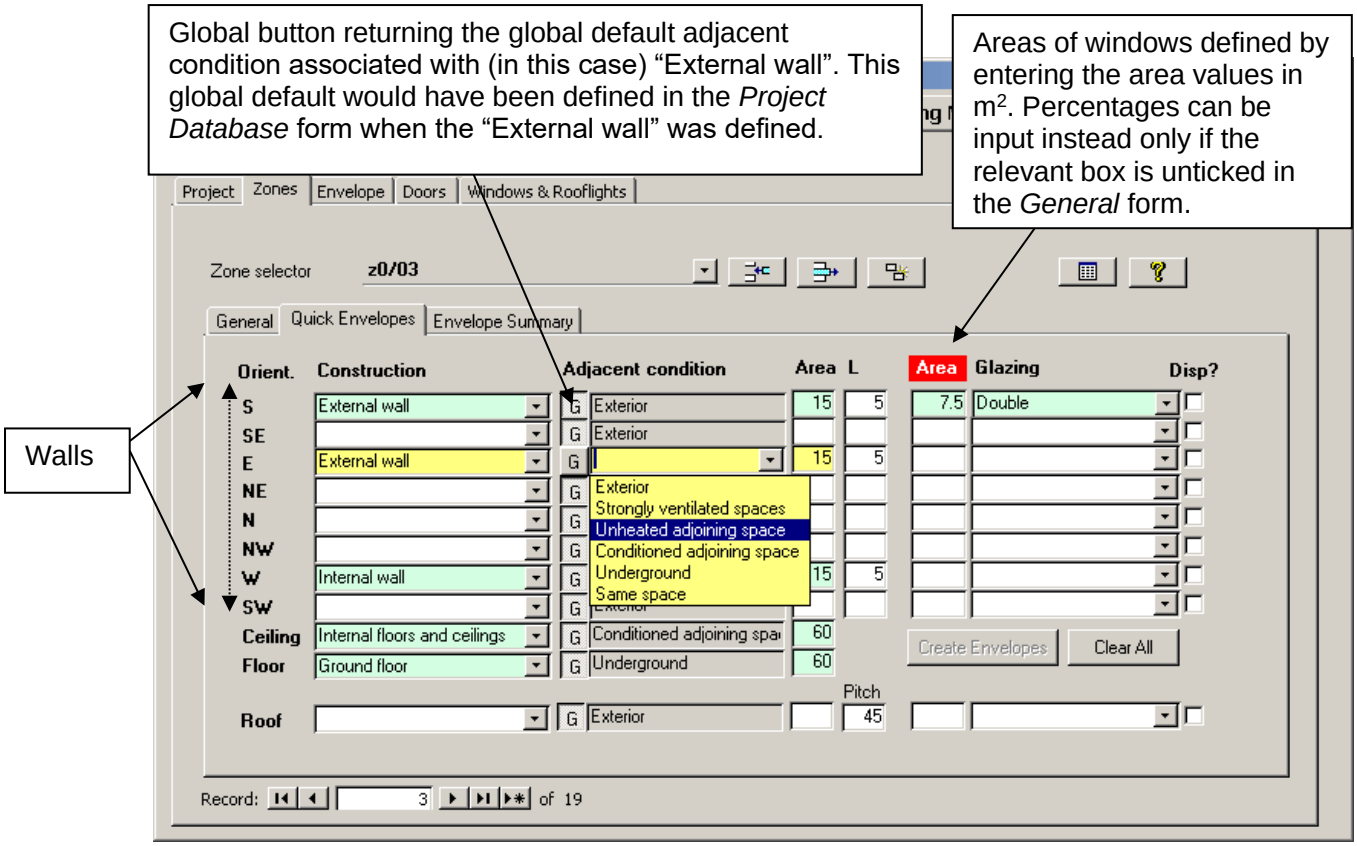


Figure 28: The Quick Envelopes sub-tab

Task 12: Create the remaining 12 zones, and define their envelopes and windows using Quick Envelopes:

Details on the remaining twelve zones are given in APPENDIX A: Table 14.

To create each new zone, you will need to go back to the *General* sub-tab of the *Zones* tab. To create a zone’s envelope elements and windows, you need to click on the *Quick Envelopes* sub-tab and, making sure that the correct zone is selected using the record selector, define its envelopes and windows, and click on “Create Envelopes”. (As this example has excluded additional thermal bridges for simplicity, there is no need to go to the *Envelopes* or *Windows & Rooflights* main tabs afterwards to assign any additional thermal bridges to any envelope element or window).

You should then go to the *Envelope Summary* sub-tab in the *Zones* tab to double-check that you have defined the envelopes correctly. If you have made any errors, you need to go to the *Envelopes* main tab and select and edit the records there.

Finally, you need to go to the *Window & Door Summary* sub-tab in the *Envelope* tab to double-check that you have defined the windows correctly. If you have made any errors, you need to go to the *Windows & Rooflights* tab and select and edit the records there.

3.4.9. Using the reports to double-check the data entry

In addition to the summary sub-tabs already discussed in the previous sections, iSBEM produces two *Objects* reports which can be used to double-check the data you have entered. For details on these two reports, see Section 3.8: Double-checking the data.

Task 13: Use the Unassigned Objects report and the Data Summary report to double-check your data entry

If you have completed all the tasks up to this point with no errors, you should find that the *Unassigned Objects* Report lists all the zones that you have created listed in the Unassigned Building Objects section.

The *Data Summary* Report should contain only zone z0/01 (one of the 6 zones already defined for you) as this is the only zone that has had its HVAC system selected.

The following section (the *Building Services* form) explains how to assign all the remaining zones in the *Geometry* form to an HVAC system. Only then will they appear in the *Data Summary* Report.

3.5. Building Services form

This form holds all the information relating to the building services. This information is entered into the following main tabs (these are circled in Figure 29):

- **Global and Defaults** tab – This tab requires information relating to the whole building, such as the electric power factor and lighting controls for the whole building.
- **HVAC systems** tab - This tab requires information on the HVAC systems in the building.
- **HWS** tab - This tab requires information on the hot water systems in the building.
- **SES** tab - This tab requires information on any solar (thermal) energy systems connected to the hot water systems in the building, if applicable.
- **PVS** tab – This tab requires information on any photovoltaic systems connected to the building, if applicable.
- **Wind generators** tab – This tab requires information on any wind generators connected to the building, if applicable.
- **CHP generator** tab (this tab only appears when one of the HVAC systems described in the *HVAC Systems* tab is specified as using CHP) – This tab requires information on any combined cooling, heating, and power generators connected to the building.
- **Solar collectors** tab – This tab requires information on any solar collectors (transpired or non- transpired) connected to the building, if applicable.
- **Showers** tab – This tab requires information on any showers served by the hot water system(s) in the building, if applicable.
- **Zones** tab – This is where you assign the appropriate HVAC system and HWS to each zone and input details on the zones' lighting and specific ventilation strategy.

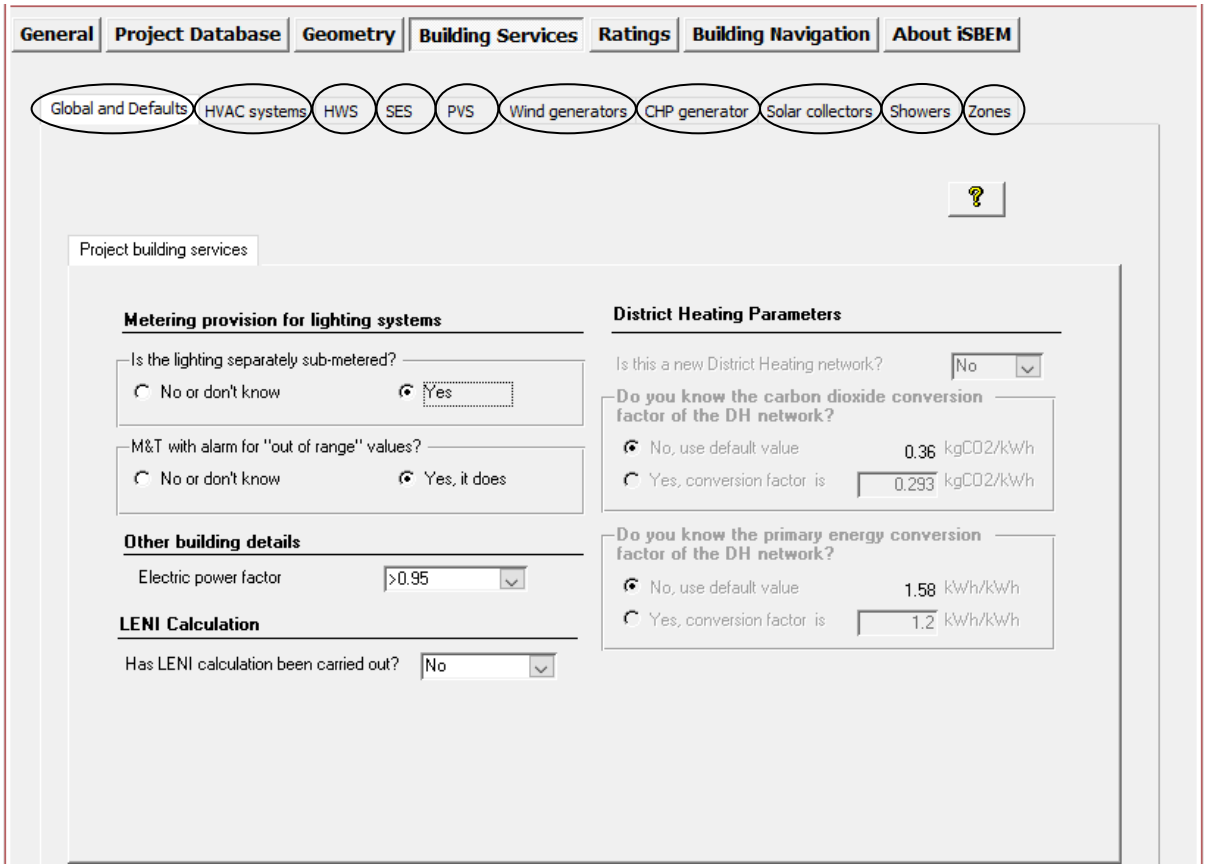


Figure 29: The tabs in the Building Services form

3.5.1. Global and Defaults tab

In this tab, there is one sub-tab:

- **Project Building Services** sub-tab

Project Building Services sub-tab:

In this sub-tab, you need to enter details about the electrical power factor and the controls provisions for lighting in the building as shown in Figure 30:

Metering provision for lighting systems

1. Is the lighting separately sub-metered? If you select “Yes”, the following question becomes active:
    - Monitoring & Targeting with alarm for “out of range” values? – This means a complete installation that measures, records, transmits, analyses, reports, and communicates meaningful energy management information to enable the operator to manage the energy it uses (for e.g., a Building Automation and Control System as specified in ADL Vol.2).

Building Details

2. Electric power factor – This is a measure of the actual electric power consumption to that usually measured by the electric metre (results from the voltage and current variations being out of phase). Select from: ‘<0.9’, ‘0.9-0.95’, and ‘>0.95’.
3. Has a LENI calculation been carried out? – This parameter allows the user to indicate whether a calculation following the Lighting Energy Numerical Indicator

(LENI) method has been carried out for the building (separately outside iSBEM) as an alternative to complying with the lighting efficacy standards specified in the Approved Documents. This will be correspondingly reported in the BRUKL output report. **NB:** The lighting energy calculation within SBEM is not affected by this parameter.

District Heating Parameters

The following 3 parameters are active only if 'District Heating' has been selected as the heat source and fuel type for any of the HVAC systems defined in the building. The first parameter is required only for England's purposes of analysis. This HVAC system can be defined as also providing the hot water.

4. Is this a new district heating network? – This parameter allows the user to indicate whether the district heating network is 'new' (yes) or 'existing' (no). It is active only if an England calculation has been selected as the purpose of analysis. The Approved Document Part L, Volume 2 defines an 'existing' district heat network as one that is either in operation or is under construction on 15 June 2022. For these purposes, under construction means any of the following: (a) the building to house the energy centre has been constructed, (b) there is a heat offtake agreement signed between the heat network and a third party, or (c) excavation for pipework has been completed. For more details, refer to the Approved Document Part L, Volume 2.
5. Do you know the *overall* CO_2 conversion factor of the district heating network? – If you select "Yes", then you can enter the value in $kgCO_2/kWh$. Otherwise, a default value will be used by the tool.
6. Do you know the *overall* primary energy conversion factor of the district heating network? – If you select "Yes", then you can enter the value in kWh/kWh. Otherwise, a default value will be used by the tool.

NB: The conversion factors for heat delivered to the building, for the above two parameters, should be available from the operators of the district heating network and should have been calculated, by a suitably qualified person, as specified in the Approved Document Part L, Volume 2, and should be based on the specific district heating fuel factors listed in DLUHC's 2021 NCM Modelling Guide. They are expected to reflect the average annual efficiency and fuel mix of the whole district heating system and so should include all heat generating plants, including any CHP generators, any waste heat recovery or heat dumping, the effect of heat losses in distribution (external to the buildings), the electricity used for pumping, etc.

The following parameter is active only for England's purposes of analysis.

7. Is the district heating network new? – This parameter allows the user to indicate whether the district heating network is 'new' (yes) or 'existing' (no), as defined in the Approved Document Part L, Volume 2.

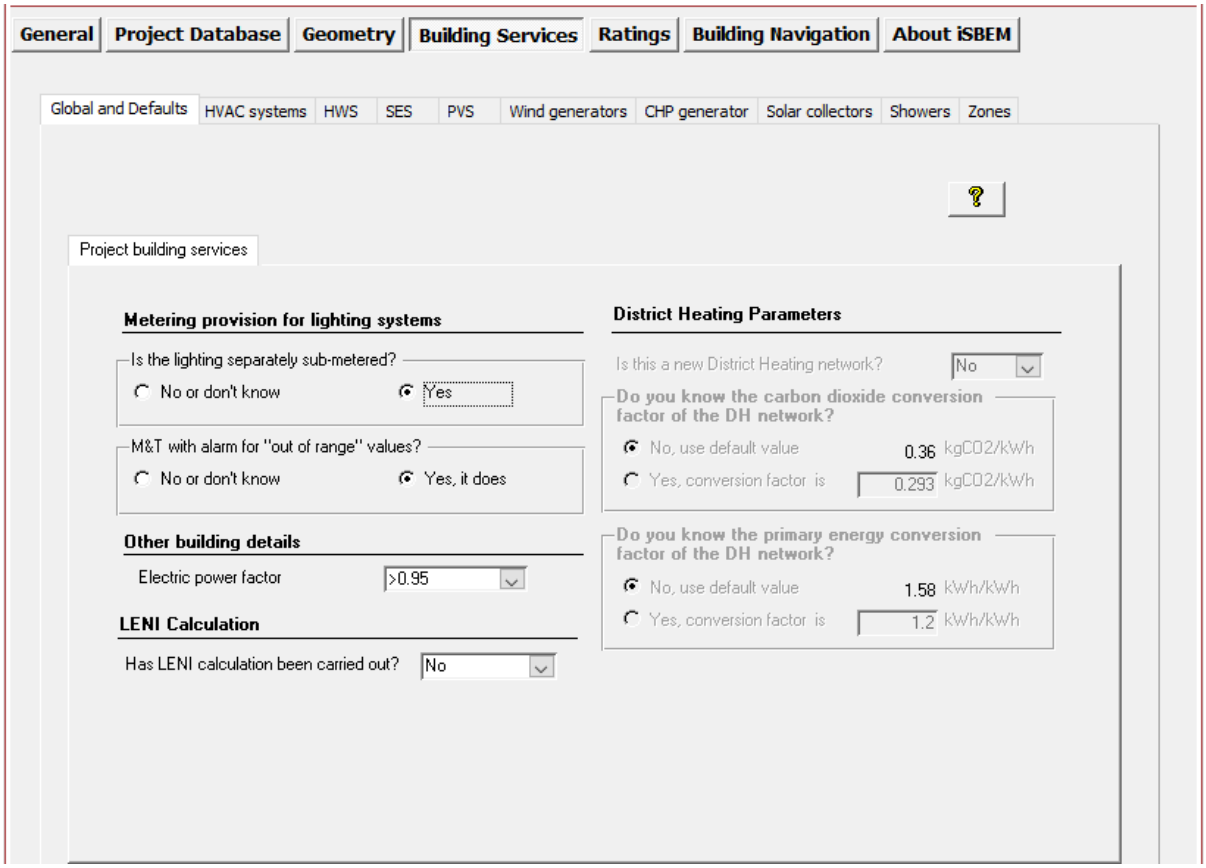


Figure 30: Project Building Services sub-tab of the Global and Defaults tab in the Building Services form

3.5.2. Defining HVAC Systems – HVAC Systems tab

Overview of how to model HVAC Systems

The building's HVAC system(s) is defined within the first six sub-tabs of the *HVAC systems* tab.

- **General** sub-tab: This is where you select the system type, give it a unique name, and enter some basic system details for each HVAC system in the building.
- **Heating** sub-tab: This is where you can further define the heat generator efficiency.
- **Cooling** sub-tab: This is where you can further define the cold generator efficiency.
- **Systems Adjustments** sub-tab: This is where details on air leakage and specific fan power can be entered.
- **Metering Provision** sub-tab: This is where details of the metering provision for each HVAC system can be defined.
- **Bi-valent Systems** sub-tab: This is where you can define bi-valent systems for HVAC.
- **Zone Summary** sub-tab: This tab displays a summary of the zones assigned to each HVAC system, along with the zones' envelopes, windows, and doors.

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The ***System type*** selected in the *General* sub-tab automatically brings with it some assumptions. For example, whether mechanical ventilation is an integral part of the system and the degree of local time and temperature control that is (or can be) provided. The

majority of system types used in UK buildings can be found in the system type drop-down box. However, there are a few systems which require further guidance, such as:

- VRF with natural ventilation – Select 'Split or multi-split system', and then adjust the efficiencies in the *Heating* and *Cooling* sub-tabs to values suitable for the VRF.
- VRF with mechanical ventilation – Select 'Variable refrigerant flow'.
- If your HVAC system is a high velocity forced-convection air heating (induction nozzle system), which does the job of mixing the air in the zone in a similar manner to destratification fans, then you can model this in iSBEM by first selecting the appropriate HVAC system type (flued or unflued) and then ticking the box relating to destratification fans (in the *Building Services* form > *Zones* tab > *HVAC & HW System* sub-tab) in the zones served by that system. The system should follow the flow rate guidelines given for destratification systems shown below. You will then need to justify this to Building Control using the necessary documentation for your system's functions.

NB: Destratification may be achieved by several means, for each of which minimum flow rates should be ensured. (Where destratification and heating is provided by the same system, higher flow rates may be needed to avoid excessive air supply temperatures):

- Cased fans installed at high level. The volume of air handled by the fans should be at least equivalent to two room volumes per hour. Total air movement will be higher than this because additional airflow will be induced.
- Open blade "sweep fans". In this case, air speeds will be lower, and the volume of air handled should be at least the equivalent of 6 room volumes per hour.
- High velocity induction nozzles with a temperature rise through the heater of at least 45˚C. The volume of primary air from the nozzles should be at least equivalent to 0.15 room volumes per hour. Total air movement will be significantly higher because of the additional airflow induced by the nozzles.

The system type, along with the further details entered in the remaining HVAC sub-tabs, allow iSBEM to calculate the System Seasonal Efficiency for heating (SSEff), the System Seasonal Energy Efficiency Ratio for cooling (SSEER), and the Auxiliary Energy. For further details on these parameters and how they are calculated, see the ADL2 and the 2021 NCM Modelling Guide.

SSEff – The System Seasonal Efficiency for heating takes account of the seasonal efficiency of the heat generator, thermal losses and gains to and from pipework and ductwork, and duct leakage. It does not include the energy used by fans and pumps. The combined heating demand of all zones served by a particular system divided by its SSEff gives the energy consumption of the heating system (For example, a boiler or boilers).

SSEER – The System Seasonal Energy Efficiency Ratio for cooling takes account of the seasonal efficiency of the cold generator, thermal losses and gains to and from pipework and ductwork, and duct leakage. It does not include the energy used by fans and pumps. The combined cooling demand of all the zones served by a particular system divided by its SSEER gives the energy consumption of the cooling system (For example, a chiller).

Auxiliary Energy – This is applied to the total floor area conditioned by a particular system. It depends on the duration of occupation and operation in the zones served, and it covers the energy used by fans, pumps, and controls. The calculation depends on the HVAC system type selected, as well as on other information provided by the user on the SFP, duct and AHU leakage, and control provision.

If no HVAC system serves the space (i.e., an unconditioned zone), you should select the option 'Zones without HVAC system' as the HVAC system for that zone in the *Geometry* form > *Zones* tab > *General* sub-tab or the *Building Services* form > *Zones* tab > *HVAC &*

HW System sub-tab (spaces which have no heating or cooling, e.g., plant rooms, storage spaces, exposed circulation spaces).

NB: The default HVAC systems in iSBEM are representative of existing rather than new buildings and should only be used if you are running an EPC calculation for an existing building (not a compliance calculation for a new building) and do not know the type of the HVAC system in your building or its detailed parameters as the default efficiencies assumed by iSBEM for them are quite pessimistic and cannot be edited by the user.

General sub-tab:

The *General* sub-tab is shown in Figure 31. For each HVAC system in your building, you will need to create a new record and add the following information:

1. Name – A unique name must be given to each HVAC system.

NB: Note that the 'Multiplier' field no longer exists for HVAC systems (or HWS. If you convert project files created with much older versions of the tool, where this field had a value of more than 1, corresponding multiples of the zones served by that HVAC system are created.

2. System type – Here, you can currently choose between 27 system types (11 heating only systems and 16 heating and cooling systems), including, for e.g., VAV (variable air volume), fan coil, dual duct, and central heating with water distribution (see Table 7 for brief definitions of the system types).

NB: In order to ensure adequate ventilation for maintaining the concentration of CO_2 below 0.5% in spaces served by unflued heating appliances[xvi], the zonal ventilation option for these spaces should be set to 'mechanical' (See Section 3.5.10: Defining the zone-specific building services- Zones tab).

NB: See note in Section 3.5.10: Defining the zone-specific building services- Zones tab, regarding defining high velocity forced-convection warm air heaters.

NB: If there is **more than one type of HVAC system in a space** with each system clearly meant to service a particular part of the space, e.g., one servicing the facade perimeter area and another servicing the core area, then the space should be divided into 2 separate zones in iSBEM (each served by its corresponding HVAC system) even if there is no physical separation between the 2 zones (e.g., a wall). However, if heating is provided in the same zone by two, or more, different types of heat sources, for e.g., a heat pump in a split system and a gas boiler in a wet system, you need to define the parameters of the different heat generators sharing the heating load in the *Bi-valent systems* sub-tab. On the other hand, if a zone is served by, for e.g., a gas-fired wet system for heating and an electric split system for cooling only, then the systems can be approximated in iSBEM by defining your HVAC system type as "split or multisplit", the heat source as "LTHW boiler", and fuel type as "natural gas", and then define the appropriate seasonal efficiency for the heating and energy efficiency ratio for the cooling. SBEM will use natural gas for the heating and grid-supplied electricity for the cooling. If applicable, you then need to define the mechanical ventilation at zone level (for all the zones served by this system) with a suitable ventilation SFP, and heat recovery, if applicable.
If you change the HVAC system type defined in your project from one that provides mechanical ventilation to one that does not (or vice versa), you must re-visit the *Ventilation* sub-tab of the *Zones* tab in the *Building Services* form for all the zones served by this HVAC System in order for all ventilation-related parameters to be updated by the tool. You may also wish to re-define the local ventilation in these

[xvi] For details, please refer to BS 5925:1991: Code of Practice for Ventilation Principles and Designing for Natural Ventilation.

zones following the change in the HVAC type (see Section 3.5.10: Defining the zone-specific building services- Zones tab).

Heating system:

3. Heat source – Depending on the system type selected, a selection of heat sources is offered. For example, if 'Single-duct VAV' is selected, you need to choose between: LTHW boiler, MTHW boiler, HTHW boiler, Direct or storage electric heater, Heat pump: air source, Heat pump: ground or water source, and District heating.
4. Fuel type – Depending on your selected heat source, you will be given a selection of heating fuel types to choose from, for e.g., Natural gas, LPG, Oil, Grid-supplied electricity.

NB: If any of the systems defined in the *Bi-valent Systems* sub-tab have 'district heating' as their heat source or fuel type, then these systems will be ignored by SBEM during the calculation. Further, if the primary heat source and fuel type defined in the *General* and *Heating* sub-tabs are 'district heating', then all the systems defined in the *Bi-valent Systems* sub-tab will be ignored by the tool during the calculation.

5. Tick if this system also uses CHP (tick box) – This tick box appears if the system type selected can use CHP. If it is ticked, a new tab appears, *CHP generator*, where further details are required to describe the CHP generator. If the box is not ticked, the tab does not appear.

Cooling system:

6. Generator type - If appropriate to your choice of system, you will be given the option to select a cooling generator type from the drop-down list: Air cooled chiller, Water cooled chiller, Remote condenser chiller, Heat pump (gas/oil), or Heat pump (electric).

Ventilation:

7. Heat recovery – Depending on the system type, this ventilation characteristic needs to be selected from: No heat recovery, Plate heat exchanger (Recuperator), Heat pipes, Thermal wheel, and Run around coil (see Table 6).

Option	Brief Definition
No heat recovery	No heat recovery system
Plate heat exchanger (Recuperator)	Recuperators usually take the form of air-to-air plate heat exchangers
Heat pipes	The heat-pipe is a passive heat exchanger of which there are two main types: • horizontal - in which a wick within the tubes transfers liquid by capillary action • vertical - in which heat from the warmer lower duct is transferred to the cold upper duct by means of a phase change in the refrigerant.
Thermal wheel	A thermal wheel comprises a cylinder packed with a suitable heat transfer medium that rotates slowly within an airtight casing which bridges the ducts between which heat is to be transferred.
Run around coil	Finned air-to-water heat exchangers are installed in the ducts between which the heat is to be transferred. A pumped water or water/glycol (for freeze protection) circuit is used to transfer heat from the warm extract air to the cooler supply air (or vice versa in summer)

Table 6: Definitions of heat recovery options in iSBEM

8. Heat recovery seasonal efficiency - This parameter is active if a heat recovery system is selected, i.e., the previous parameter is not set to 'No heat recovery'. If

you know the heat recovery efficiency, it can be introduced manually into the interface. Otherwise, a default value, corresponding to the selected heat recovery system type, will be used by SBEM.

NB: Note that in iSBEM, the value for the efficiency is always entered as a ratio. For instance, a 90% efficient boiler, the efficiency should be entered as 0.9.

9. Tick box to denote whether the heat recovery system efficiency is variable - This parameter is active if a heat recovery system is selected above. This refers to whether heat recovery can be bypassed or switched off in summer.

NB: If the SFP was calculated or measured for a mechanical ventilation system that already included heat recovery, then that is the value you enter into iSBEM. If the SFP was calculated or measured for a mechanical ventilation system before a heat recovery system was added on, then you need to add 0.15 to the SFP for a thermal wheel system and 0.3 for any of the other heat recovery options in iSBEM, to account for the additional resistance.

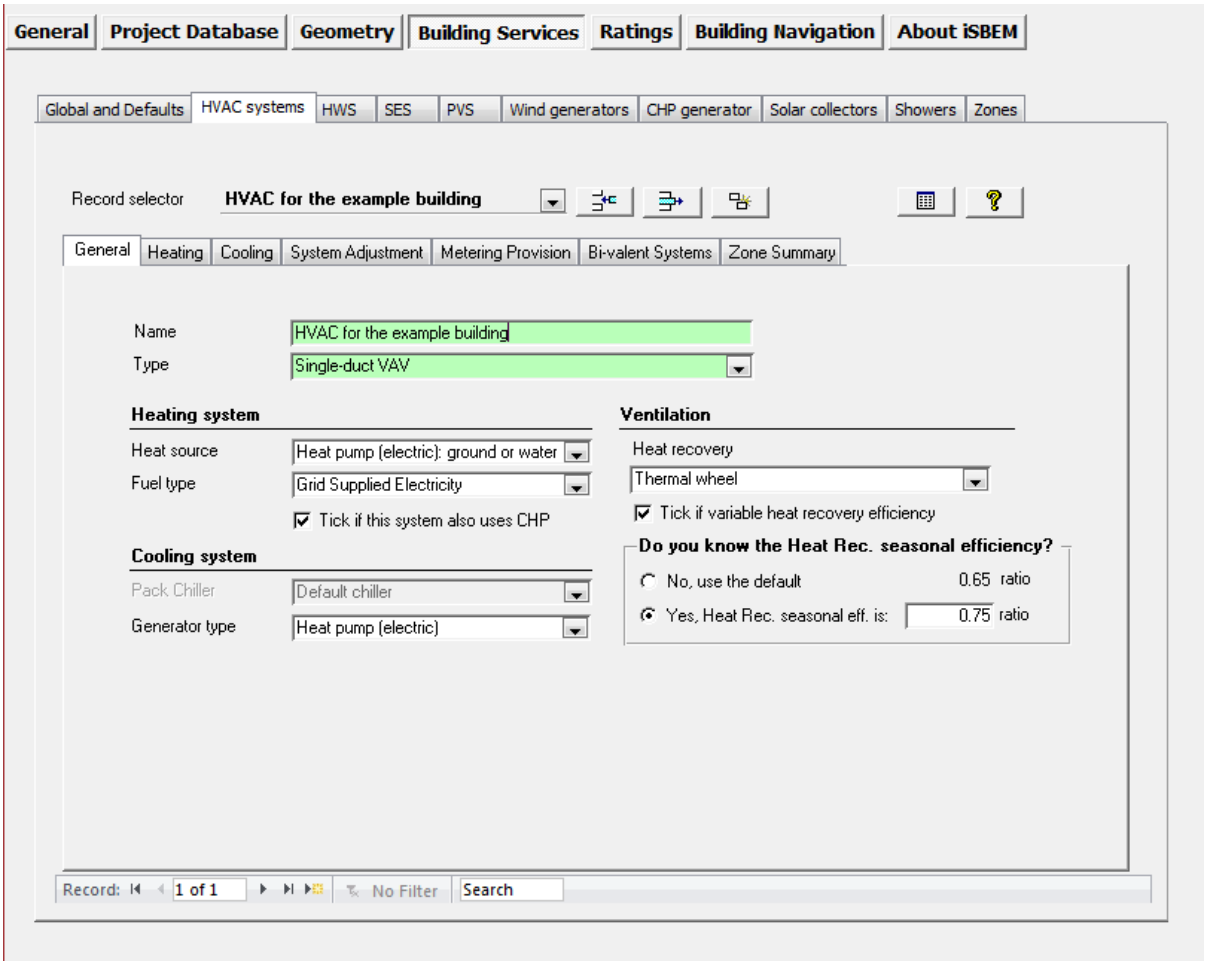


Figure 31: HVAC system definition, General sub-tab

System Type in iSBEM	Brief Definition
Central heating using water: radiators	Heating: Central heat generator(s) with water distribution and radiators
Central heating using water: convectors	Heating: Central heat generator(s) with water distribution and convectors
Central heating using water: floor heating	Heating: Central heat generator(s) with water distribution and floor heating

Central heating with air distribution	Heating & mechanical ventilation: Central heat generator(s) with air distribution
Other local room heater - fanned	Heating: Includes gas fires, gas convectors, direct electric heaters, electric storage heaters that are provided with fans. Larger units above about 10kW such as "cabinet heaters" or "unit heaters" should be classed as "forced convection air-heaters"
Other local room heater - unfanned	Heating: Includes gas fires, gas convectors, direct electric heaters, electric storage heaters that do not have fans
Unflued radiant heater	Heating: Luminous or non-luminous overhead radiant heater without flue. Includes electric overhead radiant heaters
Flued radiant heater	Heating: Luminous or non-luminous overhead radiant heater with flue
Multiburner radiant heaters	Heating: Overhead multiburner radiant heater
Flued forced-convection air heaters	Heating: May have fan to assist transportation of combustion air and/or combustion products.
Unflued forced-convection air heaters	Heating: "Direct" gas heaters. Note that provision for adequate ventilation must be provided
Single-duct VAV	Heating & cooling & mechanical ventilation: An all-air system in which the volume of supply air is modulated to match the cooling demand. May have reheat capability. Assumed to also provide heating, possibly also with separate perimeter heating system
Dual-duct VAV	Heating & cooling & mechanical ventilation: A VAV system with separate supply of hot and cold air. Assumed to also provide heating, possibly also with separate perimeter heating system
Indoor packaged cabinet (VAV)	Heating & cooling & mechanical ventilation: Local cooling/heating unit. May supply air directly into room, into under floor void, or into ceiling void. May have terminal units with variable local recirculation rate. May have electrical trim heater. Volume of air handled is sufficient to handle all the cooling load. Assumed to also provide heating, possibly also with separate perimeter heating system
Fan coil systems	Heating & cooling & mechanical ventilation: Local fanned terminal units in ceiling, on wall or on floor, with a central chilled water supply. Systems may be 2-pipe, 3-pipe or 4-pipe, changeover or non-changeover - no distinction is made here. Assumed to also provide heating. Zonal ventilation is no longer available for fan coil units. Ventilation for this HVAC type is defined at HVAC level.
Induction system	Heating & cooling & mechanical ventilation: Air is supplied from a central unit, commonly at high pressure. This induces a secondary airflow within the terminal unit to achieve an acceptable delivery temperature. Final heating or cooling is provided by heat exchangers within the terminal. Systems may be 2-pipe, 3-pipe or 4-pipe, changeover or non-changeover - no distinction is made here. Assumed to also provide heating.

Constant volume system (fixed fresh air rate)	Heating & cooling & mechanical ventilation: An all-air system in which the volume of supply air is fixed. Assumed to also provide heating, possibly also with separate perimeter heating system. If provided with local reheat capability, use the "Terminal reheat (constant volume)" system. This category includes packaged rooftop units.
Constant volume system (variable fresh air rate)	Heating & cooling & mechanical ventilation: Constant volume system in which the proportion of fresh air can be varied to limit chiller operation ("free cooling economiser").
Multizone (hot deck/cold deck)	Heating & cooling & mechanical ventilation: A central air handling unit has separate hot and cold decks. Mixing takes place at the Air handling unit and air is supplied to each zone through a single duct per zone. Assumed to also provide heating, possibly also with separate perimeter heating system.
Terminal reheat (constant volume)	Heating & cooling & mechanical ventilation: Cooled air is supplied centrally and reheated locally to the desired supply temperature for each zone. Assumed to also provide heating, possibly also with separate perimeter heating system.
Dual duct (constant volume)	Heating & cooling & mechanical ventilation: Hot and cold air are distributed separately - commonly at high pressure - and locally mixed to provide the desired supply temperature for each zone. Assumed to also provide heating, possibly also with separate perimeter heating system.
Chilled ceilings or passive chilled beams and displacement ventilation	Heating & cooling & mechanical ventilation: The combination of a chilled ceiling (or passive chilled beam) system with a separate low-level, low volume supply of cooled ventilation air. There is specific provision for displacement ventilation.
Chilled ceilings or passive chilled beams and mixing ventilation	Heating & cooling & mechanical ventilation: Chilled ceilings which provide cooling predominantly by radiation (or passive chilled beams which provide cooling predominantly by convection), operating with a mechanical ventilation system that has not been specifically designed to minimise air mixing within the space.
Active chilled beams	Heating & cooling & mechanical ventilation: Chilled beams which include the provision of cooled air from a central source, typically operating as an induction system.
Water loop heat pump	Heating & cooling & mechanical ventilation: Local heat pumps are served by a common water circuit to or from which they can reject or extract heat. Central cooling and heating plant provides the net heat or cooling input to this circuit. Assumed to also provide heating.
Variable refrigerant flow	Heating & cooling & mechanical ventilation: A type of split or multi-split system that includes provision to vary the circulation of refrigerant according to the load. Assumed to also provide heating. May be gas-fired.
Split or multi-split system	Heating & cooling: Combination of outdoor and indoor units connected by refrigerant pipe work. No mechanical ventilation system. Use this category also for ducted split systems and window/wall units.

	The SEER/SCoP should include the power consumption for compressors, controls, as well as fans and pumps within the air-conditioning units.
Single room cooling system	Heating & cooling: Integral units without ducting, such as wall or window units. Ducted units should be defined as constant or variable volume air systems, as appropriate. *The SEER/SCoP should include the power consumption for compressors, controls, as well as fans and pumps within the air-conditioning units.*

Table 7: Definitions of HVAC type options in iSBEM

Heating sub-tab:

Once you have entered the basic information on each HVAC system into the *General* sub-tab, there are a few more details on the heating efficiency which can be entered, if they are known. You will see that the 'Heat Source' and 'Fuel Type' fields that were completed in the *General* tab also appear in this tab (they can be edited in either tab).

First, you need to select the HVAC system with the record selector, and then the following information can be entered:

Heating System

1. Heat source – Depending on the system type selected, a selection of heat sources is offered. For example, if 'Single-duct VAV' is selected, you need to choose between: LTHW boiler, MTHW boiler, HTHW boiler, Direct or storage electric heater, Heat pump: air source, Heat pump: ground or water source, and District heating.
2. Fuel type – Depending on your selected heat source, you will be given a selection of heating fuel types to choose from, for e.g., Natural gas, LPG, Oil, Grid-supplied electricity.

NB: If any of the systems defined in the *Bi-valent Systems* sub-tab have 'district heating' as their heat source or fuel type, then these systems will be ignored by SBEM during the calculation. Further, if the primary heat source and fuel type defined in the *General* and *Heating* sub-tabs are 'district heating', then all the systems defined in the *Bi-valent Systems* sub-tab will be ignored by the tool during the calculation.

3. Seasonal efficiency of heat generator - If you know the seasonal efficiency of the heat generator, it can be introduced manually into the interface. Otherwise, the (conservative) default value visible in the interface will be used for the calculation.

NB: Seasonal efficiencies for boilers used in non-domestic buildings (based on 2021 ADL2 equation 6.1) can be accessed[xvii] from the NCM Products Characteristics Database (PCDB) website (www.ncm-pcdb.org.uk/sap/pcdbsearch.jsp?pid=26). Note that the maximum appliance rating for boilers from the PCDB is 70 kW.

NB: Minimum efficiency standards for the different HVAC systems in new buildings are described in the Approved Documents. Note that the necessary documentation to support the input efficiency values may be requested by Building Control.

- The default seasonal efficiency value (if no efficiency is input by the user) is based on whether the generator is on the Energy Technology List (ETL) of

[xvii] Starting 15th June 2022.

the ‘Enhanced Capital Allowance’ (ECA) scheme[xviii]. If not, you then need to select whether the generator was installed in or after 1998.

4. Generator radiant efficiency (this parameter is active if the HVAC system chosen is a radiant system) - It refers to the ratio of radiant heat output to energy input. If you know the generator’s radiant efficiency, it can be introduced manually into the interface. Otherwise, a default value will be used by SBEM.
    - The default radiant value (if no efficiency is input by the user) is based on whether the generator is on the Energy Technology List (ETL) of the ECA.

NB: Note that in iSBEM, the value for the efficiency is always entered as a ratio. For instance, a 90% efficient boiler, the efficiency should be entered as 0.9.

5. Tick box to denote whether the heating system utilises fanned convectors - This parameter is active only if the HVAC system selected is ‘Central heating using water: convectors’.
6. Ratio of fan power to heating output - If you know the associated power for integral fans, in W, per kW heat output by the heating system, it can be introduced manually into the interface. Otherwise, a (conservative) default value will be used by SBEM. This parameter is active only if the HVAC system selected is ‘Central heating using water: convectors’ and the above box is ticked to indicate that the system utilises fanned convectors, or if HVAC system selected is ‘Other local room heater - fanned’.

Figure 32 shows a heating system being defined.

[xviii] www.eca.gov.uk/etl/

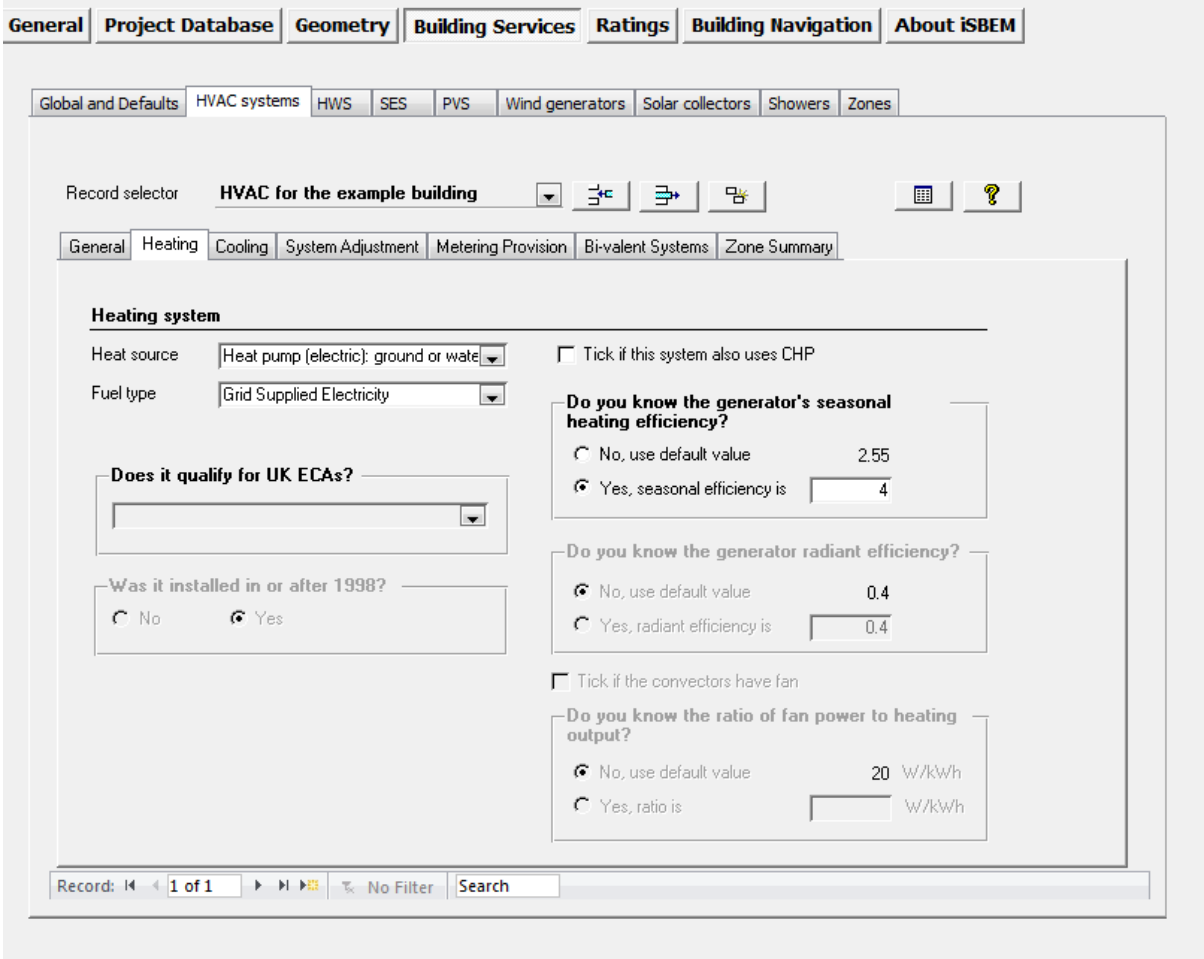


Figure 32: HVAC systems definition, Heating sub-tab

Cooling sub-tab:

In addition to the information entered in the *General* sub-tab, you can define the power rating and efficiency of the cooling system. If they are not known, default values will be used by the software. The information is entered as follows:

Cooling System

1. Generator type - If appropriate to your choice of system, you will be given the option to select a cooling generator type from the drop-down list: Air cooled chiller, Water cooled chiller, Remote condenser chiller, Heat pump (gas/oil), or Heat pump (electric).
2. Generator kW – This is the cooling generator's nominal electrical power, and if applicable, it needs to be selected from: Up to 100kW, 101 to 500kW, 501 to 750kW, and 751 to 3.5MW. This field is active if the cooling generator type selected is a chiller. The selected value (in addition to the option selected for the ECA parameter below) determines the default energy efficiency ratio used by the calculation if no efficiency value is input by the user.
3. Fuel type – Depending on your selected cooling generator type, you will be given a selection of cooling fuel types to choose from, for e.g., Natural gas, LPG, Biogas, Oil, or Grid-supplied electricity.

4. Seasonal energy efficiency ratio - If you know the seasonal energy efficiency ratio (SEER) for the cooling generator, it can be introduced manually into the interface. Otherwise, a default value will be used by SBEM. Guidance on the calculation of the seasonal energy efficiency ratio can be found in the Approved Documents.
    - The (conservative) default value is based on whether the chiller or air-conditioner is on the Energy Technology List (ETL) of the 'Enhanced Capital Allowance' (ECA) scheme (and on the electrical power rating selected in the 'Generator kW' parameter above).
5. Nominal energy efficiency ratio - If you know the nominal energy efficiency ratio (EER) for the cooling generator, it can be introduced manually into the interface. Otherwise, a default value will be used by SBEM for compliance checking.
    - The default value is based on whether or not the chiller or air-conditioner is on the Energy Technology List (ETL) of the ECA (and on the electrical power rating selected in the 'Generator kW' parameter above).

NB: The cooling generator seasonal energy efficiency ratio is the value used within iSBEM to calculate the system efficiency and the cooling energy while the cooling generator nominal energy efficiency ratio is the value displayed in the BRUKL output document for compliance checking against the limiting standards from the Approved Documents.

6. Tick box to indicate if the HVAC system uses a mixed-mode cooling operation.

NB: "Mixed-mode" refers to a hybrid approach to space conditioning that uses a combination of natural ventilation from operable windows, and mechanical systems that include air distribution equipment and refrigeration equipment for cooling. A mixed-mode building integrates the use of air-conditioning when and where it is necessary, with the use of natural ventilation whenever it is feasible or desirable, to maximize comfort while reducing the energy use (compared to year-round air conditioning).

Figure 33 shows a cooling system being defined.

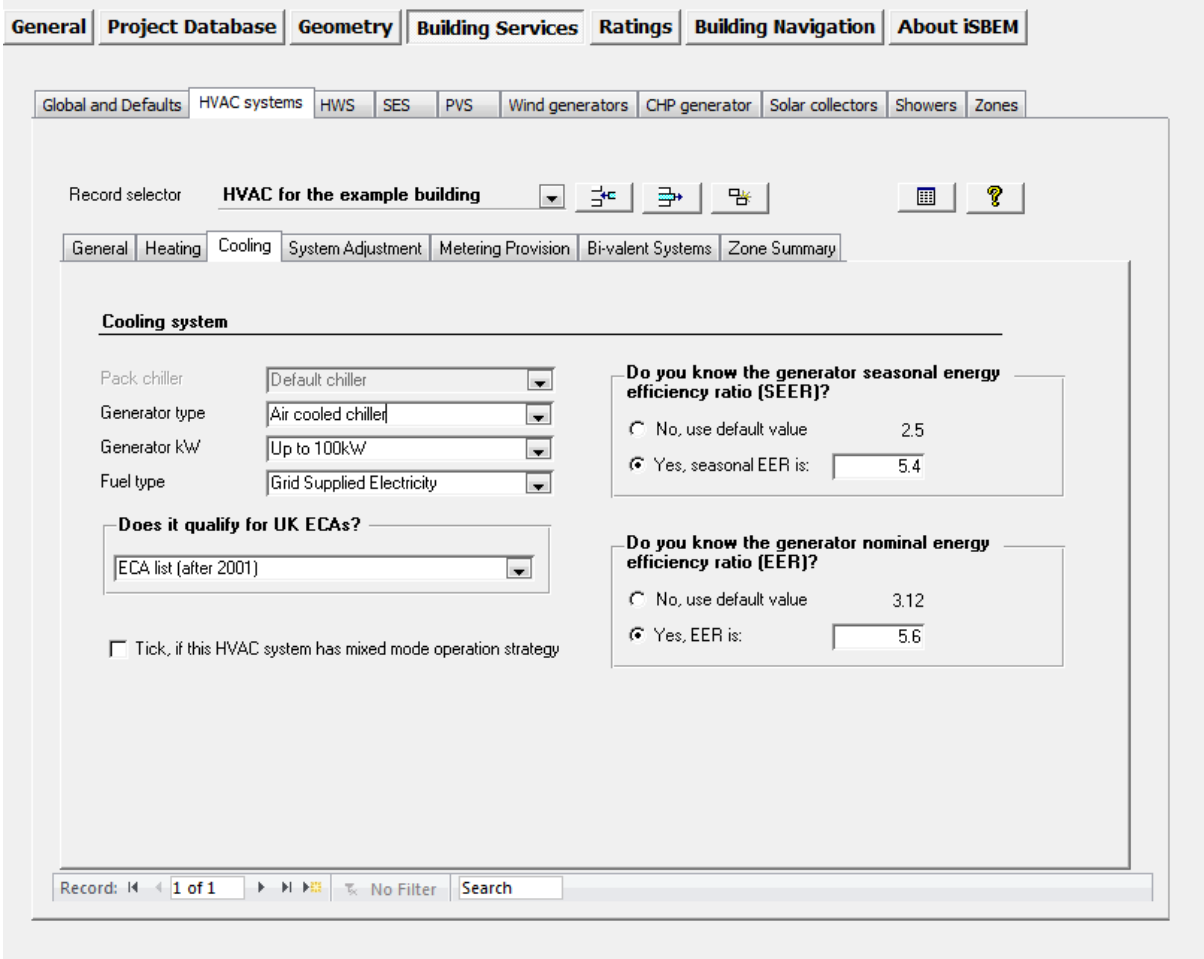


Figure 33: HVAC systems definition: Cooling sub-tab

System Adjustments sub-tab:

The *System Adjustments* sub-tab (Figure 34) allows the user to specify other system properties, such as, the air leakage associated with the ducts or the air handling unit (AHU) and the specific fan power (SFP). If this information is not known, default values will be used by the software. **NB:** These default values reflect past practices and may not be compliant with the current Building Regulations.

The information is entered as follows:

Ductwork and AHU Leakage

1. Ductwork leakage – If the ductwork has been tested or design targets set for the building, the appropriate CEN classification for air leakage can be entered by clicking on the radio button “Yes, it meets the CEN leakage classification below” and choosing from the drop-down list between: Tested but not achieving Class A, Class A, Class B, Class C, or Class D. Different classes refer to the maximum air leakage obtained for the HVAC ductwork at different test conditions.
2. AHU leakage – Similarly, if the AHU has been tested or design targets set for the building, click on the appropriate radio button and choose from the drop-down list between: Class L1, Class L2, Class L3, or Worse than Class L3.

Specific Fan Power for the System

3. Specific Fan Power (SFP) – The SFP of an air distribution system is defined as the sum of the design total circuit-watts, including all losses through switchgear and

controls such as inverters, of the fans in the system that supply air and extract it back outdoor (i.e. the sum of the total circuit-watts of supply and extract fans), divided by the design air flow rate through the system. For further details on the SFP and how it is calculated, see the Approved Documents. If the SFP for the system is known, it can be entered manually. Otherwise, the software will insert a default (conservative) value. **NB:** The default value does not necessarily comply with the Building Regulations and should be over-written for new buildings.

NB: If the SFP was calculated or measured for a mechanical ventilation system that already included heat recovery, then that is the value you should enter into iSBEM. If the SFP was calculated or measured for a mechanical ventilation system before a heat recovery system was added on, then you need to add 0.15 to the SFP for a thermal wheel system, and 0.3 for any of the other heat recovery options in iSBEM, to account for the additional resistance.

NB: If the HVAC system selected is 'Fan coil systems' or 'Indoor packaged cabinet (VAV)', the SFP input here should be for the central plant, and then the SFP for the terminal units can be input in the *Building Services* form > *Zones* tab > *Ventilation (cont.)* sub-tab for all the zones served by this HVAC system.

If the type of HVAC system selected in the *General* sub-tab is one where variable speed pumping can be applicable, the following parameters become active:

Pumps

4. A radio button to indicate whether there is constant speed pumping or variable speed pumping for, depending on the HVAC system type selected, a LTHW boiler or both a LTHW boiler and a chilled water (CHW) generator. If there is indeed variable speed pumping for this system, then the following parameter becomes active:
    a. Type – You need to select the type of variable speed control for the pumps from the options available in the drop-down menu.

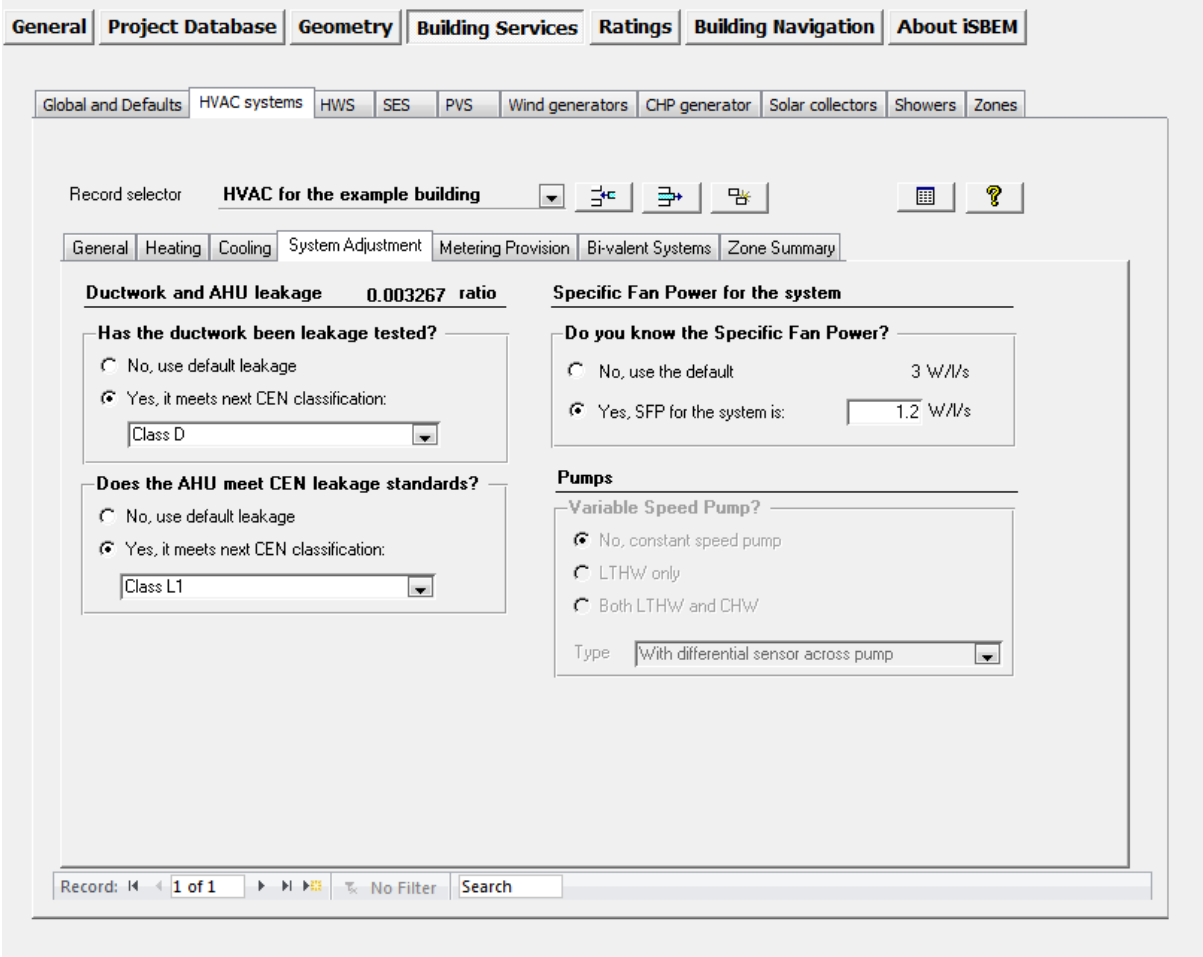


Figure 34: HVAC systems definition: System Adjustments sub-tab

Metering Provision sub-tab:

The software also considers the effect of metering and alarms on system operation. (Controls assumptions are largely determined by the system choice). There are just 2 questions to answer here (see Figure 35):

Controls Provision

1. Is this HVAC system separately sub-metered? - This refers to either energy metering of plant, and/or metering of plant hours run, and/or monitoring of internal temperatures in zones. If you click “Yes, it is”, the following question becomes active:

    b. Monitoring & Targeting with alarm for “out of range” values? – This means a complete installation that measures, records, transmits, analyses, reports, and communicates meaningful energy management information to enable the operator to manage the energy it uses (for e.g., a Building Automation and Control System as specified in ADL Vol.2).

NB: If you have more than one HVAC system defined in your project, the *Metering Provision* sub-tab will be available for each one of them, i.e., each HVAC system can be separately sub-metered.

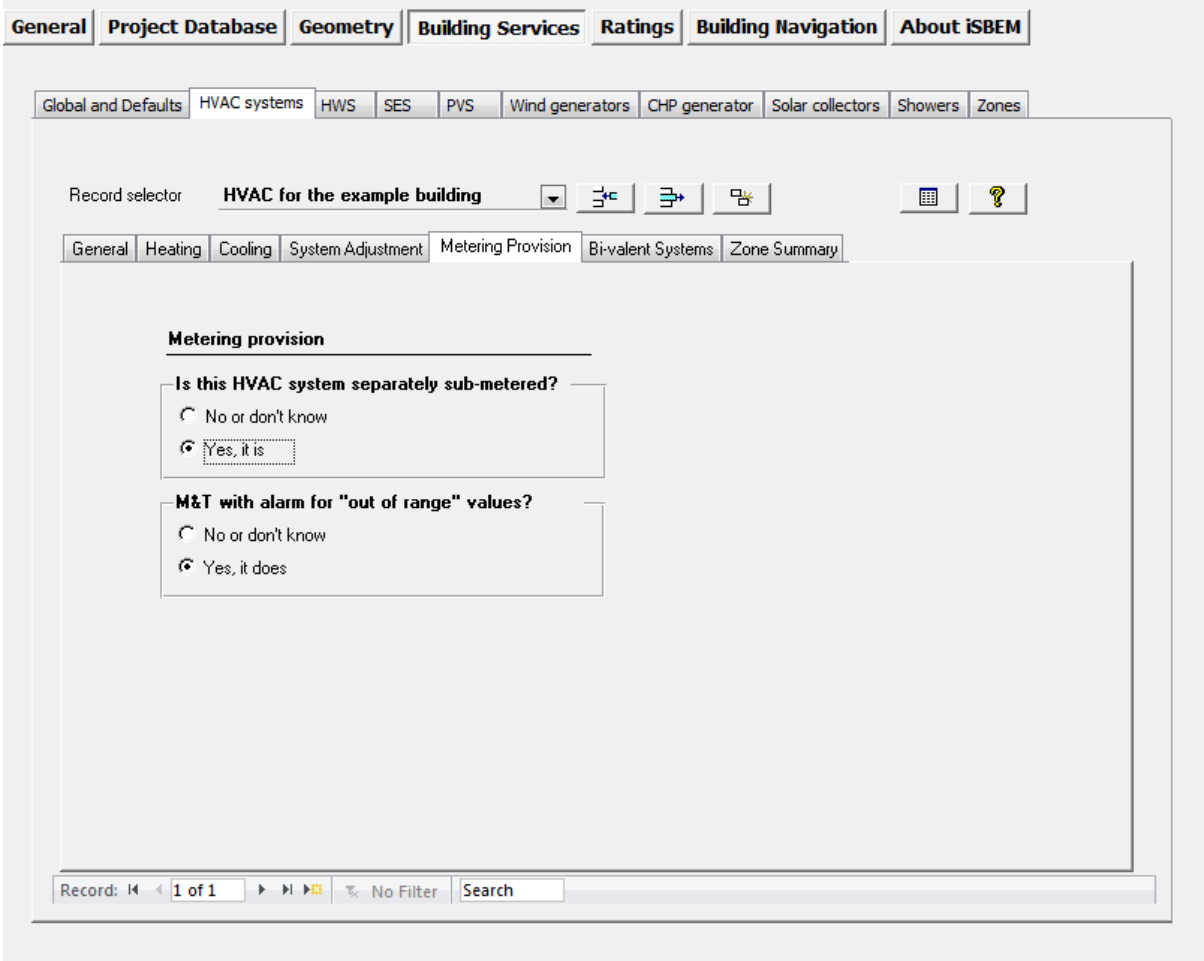


Figure 35: HVAC systems definition: Metering Provision sub-tab

Bi-valent Systems sub-tab:

A bi-valent heating system is one in which the heating is supplied by two (or more) different types of heat sources. An example could be an electric heat pump with a gas boiler for backup. As such, in addition to the heat source, seasonal efficiency, and fuel type of the primary heat generator you have already defined in the *General* and *Heating* sub-tabs, in the *Bi-valent Systems* sub-tab, you can also define additional/secondary heat generator(s) that share the total heating load with the primary heat generator (see Figure 36). For each additional heat generator, the following parameters need to be input:

1. Heat source of additional heat generator
2. Fuel type of the additional heat generator
3. Seasonal efficiency of the additional heat generator, as ratio.
4. Proportion, in %, of the heating load that the additional heat generator provides.

NB: If any of the systems defined in the *Bi-valent Systems* sub-tab have 'district heating' as their heat source or fuel type, then these systems will be ignored by SBEM during the calculation. Further, if the primary heat source and fuel type defined in the *General* and *Heating* sub-tabs are 'district heating', then all the systems defined in the *Bi-valent Systems* sub-tab will be ignored by the tool during the calculation.

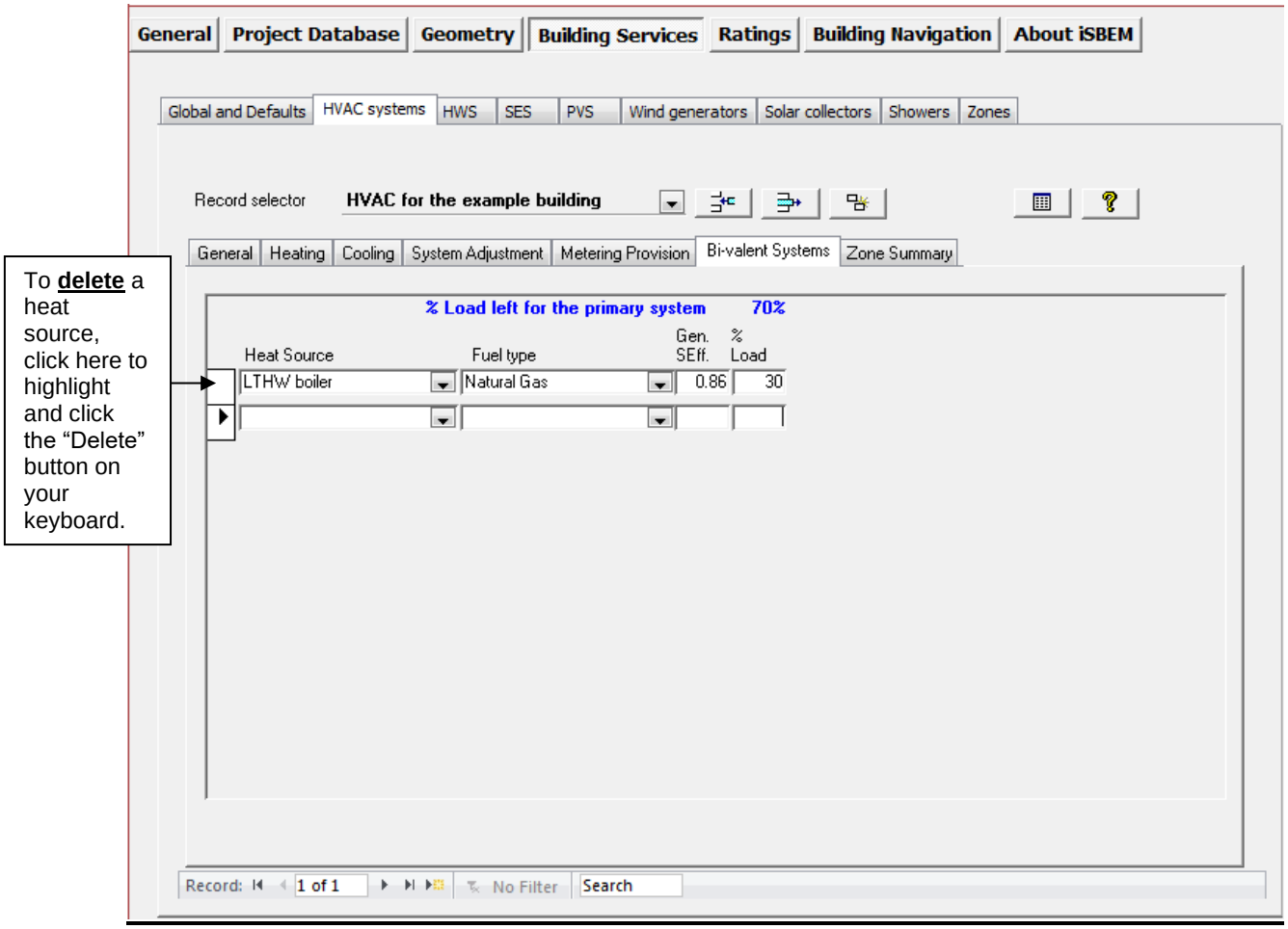


Figure 36: HVAC systems definition: Bi-valent Systems sub-tab

Zone Summary sub-tab:

The names of the zones assigned to the HVAC system can be viewed in the *Zone Summary* sub-tab of the *HVAC Systems* tab, shown in Figure 37. The zones are listed in the left-hand side window, and if any of the zones are highlighted, more details about that zone appear in the 'Zone's properties' window. For example, details such as the zone's area and activity are displayed.

Task 14: Define the HVAC system for the Example building

The details on the HVAC system can be found in Section A.1 under Systems. If you click into the *HVAC systems* tab, you will see that the HVAC system for the Example building has been named for you: "HVAC system for the Example building". You need to go through each of the sub-tabs in the *HVAC Systems* main tab in turn, entering the information provided in APPENDIX A:.

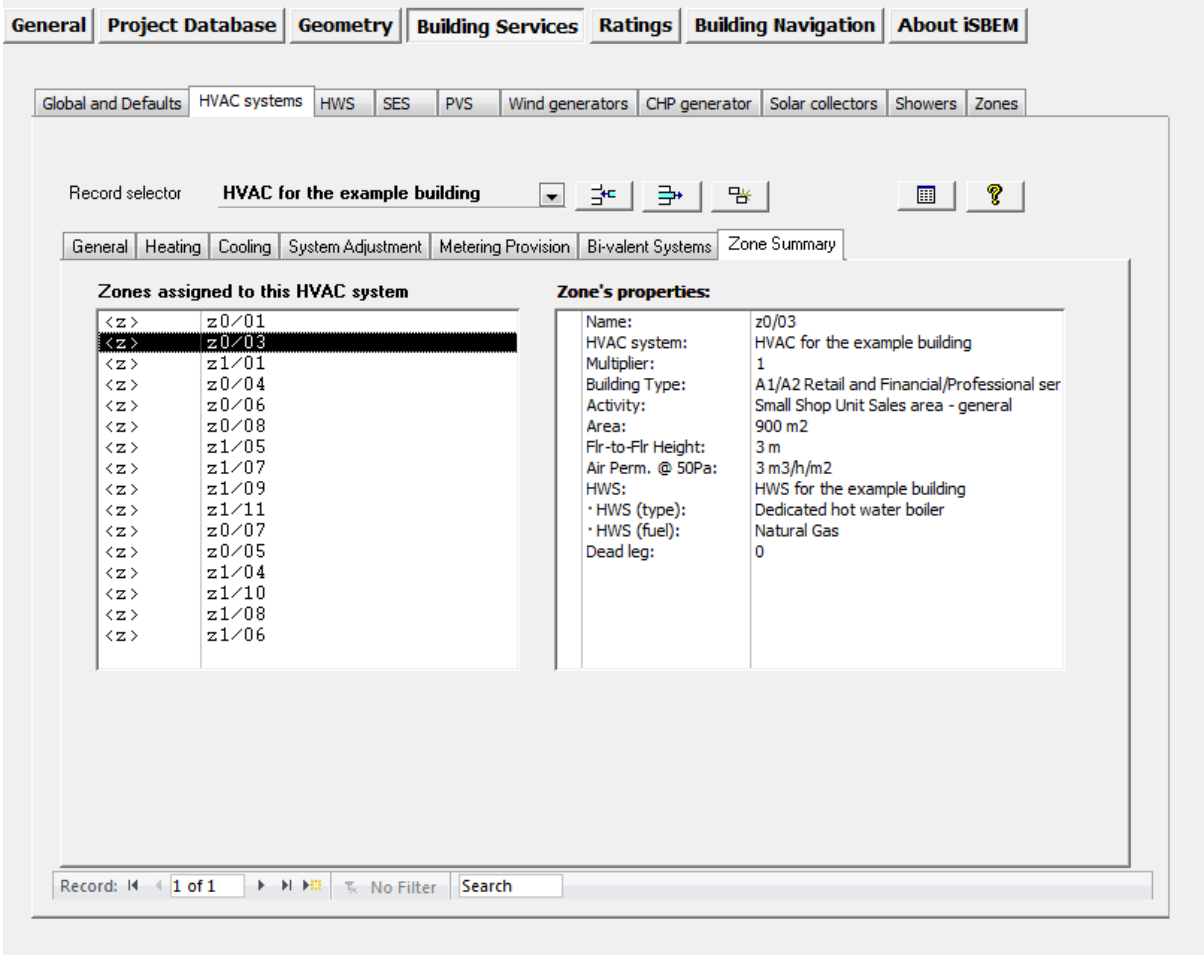


Figure 37: HVAC systems tab: Zone Summary sub-tab

3.5.3. Defining HWS – HWS tab

The *HWS* tab has four sub-tabs:

- **General** sub-tab: This is where the Hot Water System generator, fuel type, and efficiency are defined. (The HW system needs to be defined here before it can be assigned to any zones).
- **Storage & Secondary Circulation** sub-tab: This is where the data on the hot water storage and secondary circulation, if applicable, are defined.
- **Assigned** sub-tab: This tab shows which zones each HWS is assigned to serve.
- **Bi-valent Systems** sub-tab: This is where you can define bi-valent systems for water heating. This sub-tab becomes visible only if the hot water is not provided by the HVAC system.
- **Showers** sub-tab: This is where you can define the types and numbers of showers being served by this water heating system.

General sub-tab:

A HWS is defined by the following information:

1. Name – This needs to be a unique name.

NB: Note that the 'Multiplier' field no longer exists for HWS.

2. Generator type – Select from: Dedicated HWS boiler, Stand-alone water heater, Instantaneous HWS only, Instantaneous combi, Heat pump, or any of this project's HVAC systems previously defined in the *HVAC Systems* tab (see Table 8 for brief definitions of the system types).
3. Is it later than 1998? - Tick if the system was installed later than 1998. The generator type selected above determines whether this tick box is enabled. Whether this box is ticked determines the default seasonal efficiency used by the tool if no value is input by the user.
4. Fuel type – Depending on the generator type selected, a list of fuel types is available. For example, if "Instantaneous combi" is selected, you need to choose between: Natural gas, LPG, Biogas, and Oil. If one of the project's HVAC systems is chosen as the generator type, this field is not enabled as the fuel type would have been previously defined in the *HVAC Systems* tab.
5. Heat generator seasonal efficiency - If you know the seasonal efficiency of the heat generator, it can be introduced manually into the interface. Otherwise, the (conservative) default value visible in the interface will be used for the calculation. This field is inactive if the HWS Generator type selected is 'Same as HVAC'. The default value is based on the above tick box on whether the generator was installed in or later than 1998.

Further guidance

NB: Seasonal efficiencies for boilers used in non-domestic buildings (based on 2021 ADL2 equation 6.1) can be accessed from the NCM Products Characteristics Database (PCDB) website (www.ncm-pcdb.org.uk/sap/pcdbsearch.jsp?pid=26). The maximum appliance rating for boilers from the PCDB is 70 kW.

NB: Minimum efficiency standards for the different HW systems in new buildings are described in the Approved Documents. Note that the necessary documentation to support the input efficiency values may be requested by Building Control.

NB: Note that in iSBEM, the value for the efficiency is always entered as a ratio. For instance, a 90% efficient boiler, the efficiency should be entered as 0.9.

Hot Water Generator	Brief Definition
Dedicated hot water boiler	A heat generator serving a separate hot water storage unit. It does not provide a space heating service.
Stand-alone water heater	A unit that combines hot water storage and a heat generator in a single unit. It does not provide a space heating service.
Instantaneous hot water only	A water heater with no (or limited) storage capability
Instantaneous combi	A space heating boiler that also provides domestic water heater with very small or no storage capability.
Heat pump	A heat pump providing only domestic water heating service.
Same as HVAC System	Choose this option if the hot water is provided by an existing HVAC system.

Table 8: Definitions of hot water generator options in iSBEM

Figure 38 shows a HWS generator being defined.

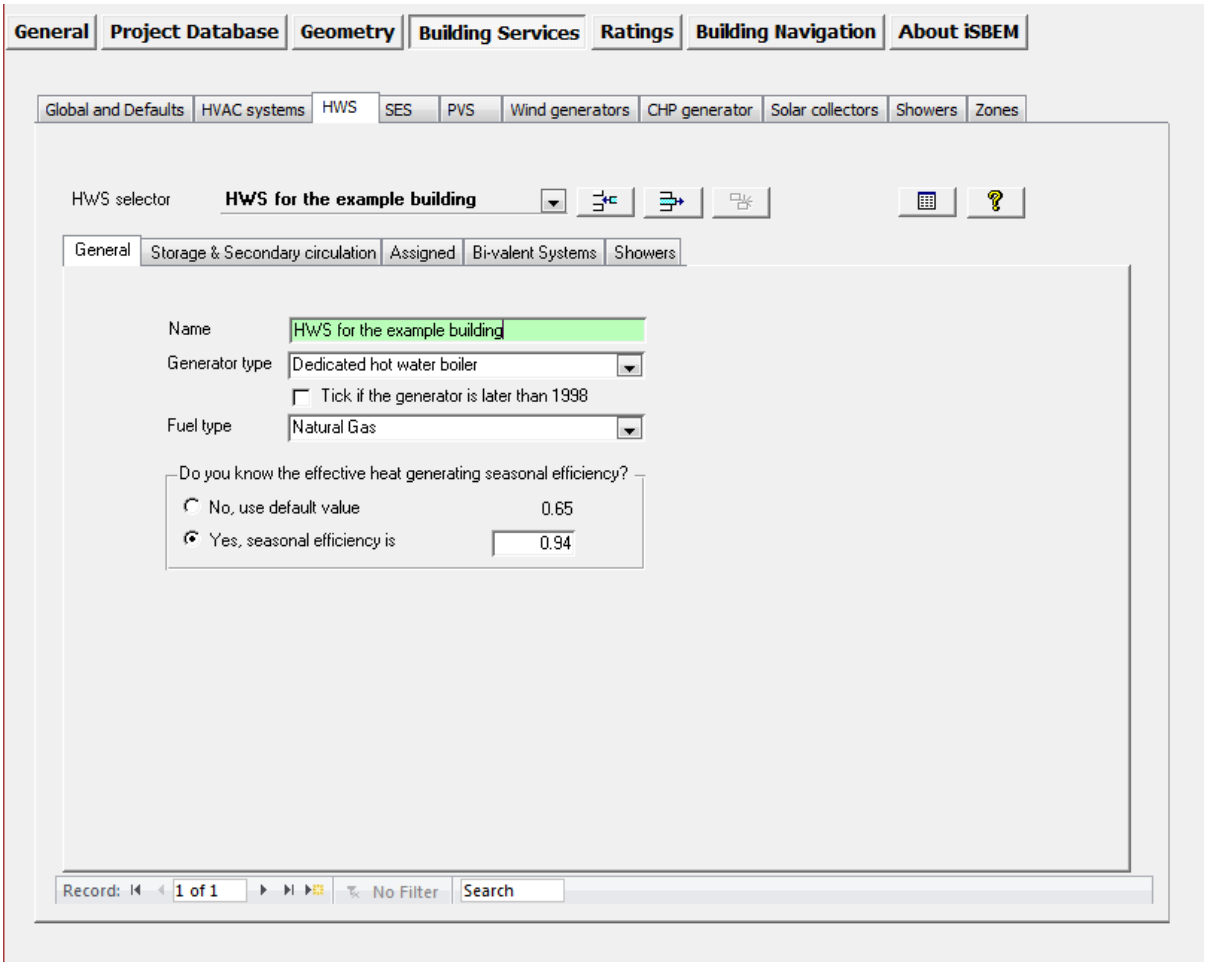


Figure 38: Defining a HWS in the General sub-tab

Storage & Secondary Circulation sub-tab:

In this sub-tab (Figure 39), you can enter the following information:

1. Is the system a storage system? – Tick if yes.
2. If the above tick box, regarding the storage system, is ticked, the following fields become active:

   Either (depending on the selected radio button)

   a. Storage volume (volume of the HWS cylinder) in litres.

   b. Insulation type (on the HWS storage cylinder) – selected from the drop-down menu. If the option selected is not “Uninsulated”, then the following parameter becomes active:

      i. Insulation thickness (on the HWS storage cylinder) in mm.

   or

   c. Storage losses in MJ/month.

   d. Does the system have secondary circulation? (tick box)

      i. If the secondary circulation tick box is ticked, default values will be assumed for heat losses per metre run (W/m), pump power (kW), and secondary pipework length (m). You can insert specific values if you know them.

ii. Tick box if there is time control on the secondary circulation.

NB: If the above two boxes regarding a HWS storage volume and secondary circulation are activated but no values are entered by the user for the relevant parameters, the default values used in the SBEM calculation will be displayed within the interface after the calculation has been run. However, these calculated defaults would be quite pessimistic, and users are advised to enter their own values instead.

NB: The secondary circulation pipework length refers to all the pipework, i.e., flow and return.

NB: If a solar energy system is connected to a HWS, then hot water storage is expected to exist.

NB: If the provision of hot water in any area/zone of the building consists of a combination of HWS generators that do not work simultaneously (such as an additional generator for backup to ensure continuity of hot water supply in a hospital), then the storage volume entered into iSBEM for the HWS should refer to the maximum storage volume that can be used at any given time during the year. The same applies to storage losses. For example, if two identical HWS generators with independent storage are installed to provide a hospital with HWS but one generator and storage are only used in case there is a failure in the primary one, you would input into iSBEM the volume and storage losses associated with only one of the systems.

NB: Modelling trace heating in iSBEM: As an approximation, it can be considered that the energy used by trace heating is equivalent to that used by a secondary circulation. You can tick the box in the *Building Services* form > *HWS* tab > *General* sub-tab to indicate that there is a secondary circulation and then leave the rest of the secondary circulation related fields blank to be calculated by SBEM. You can also leave the deadleg at the default of 0 m.

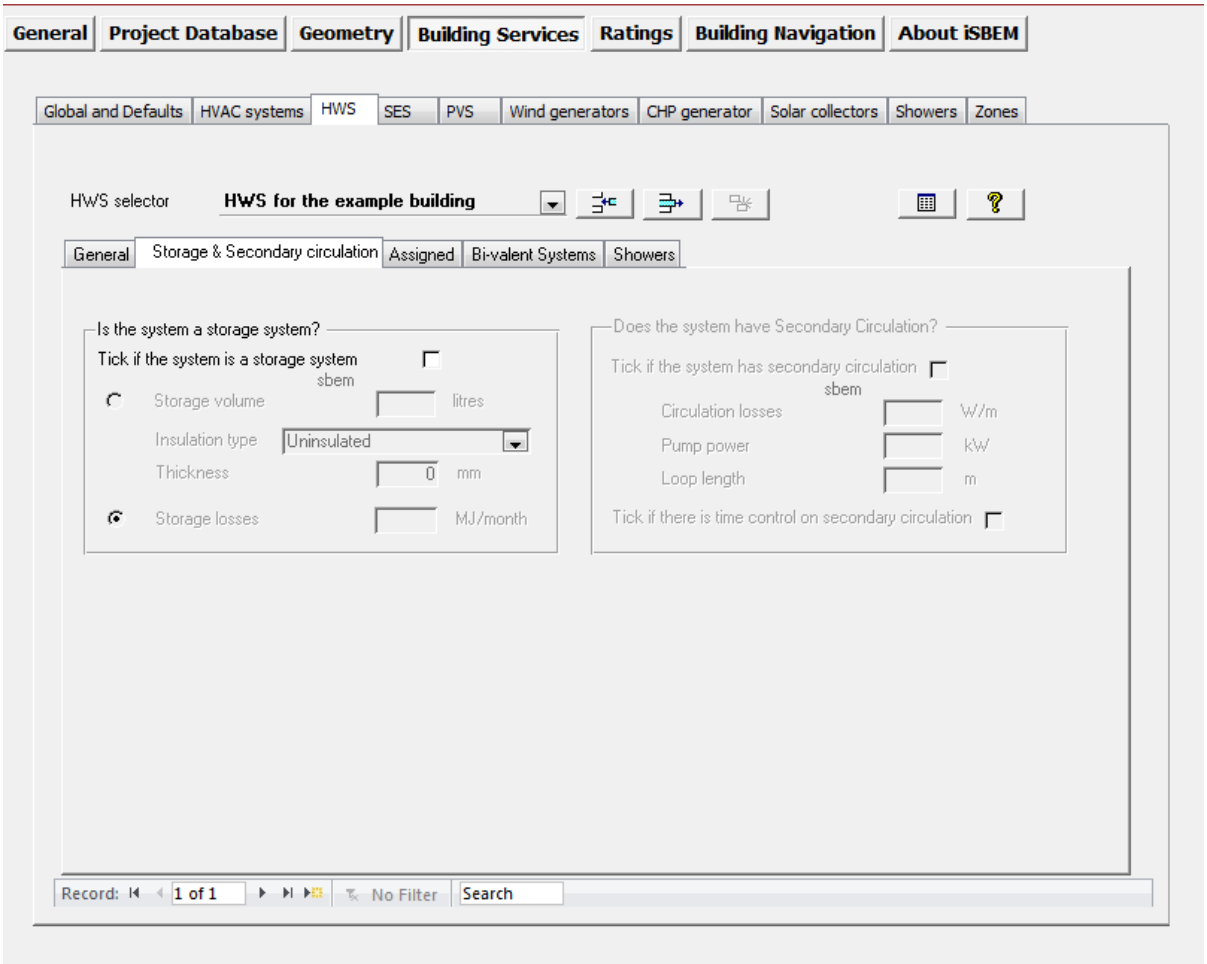
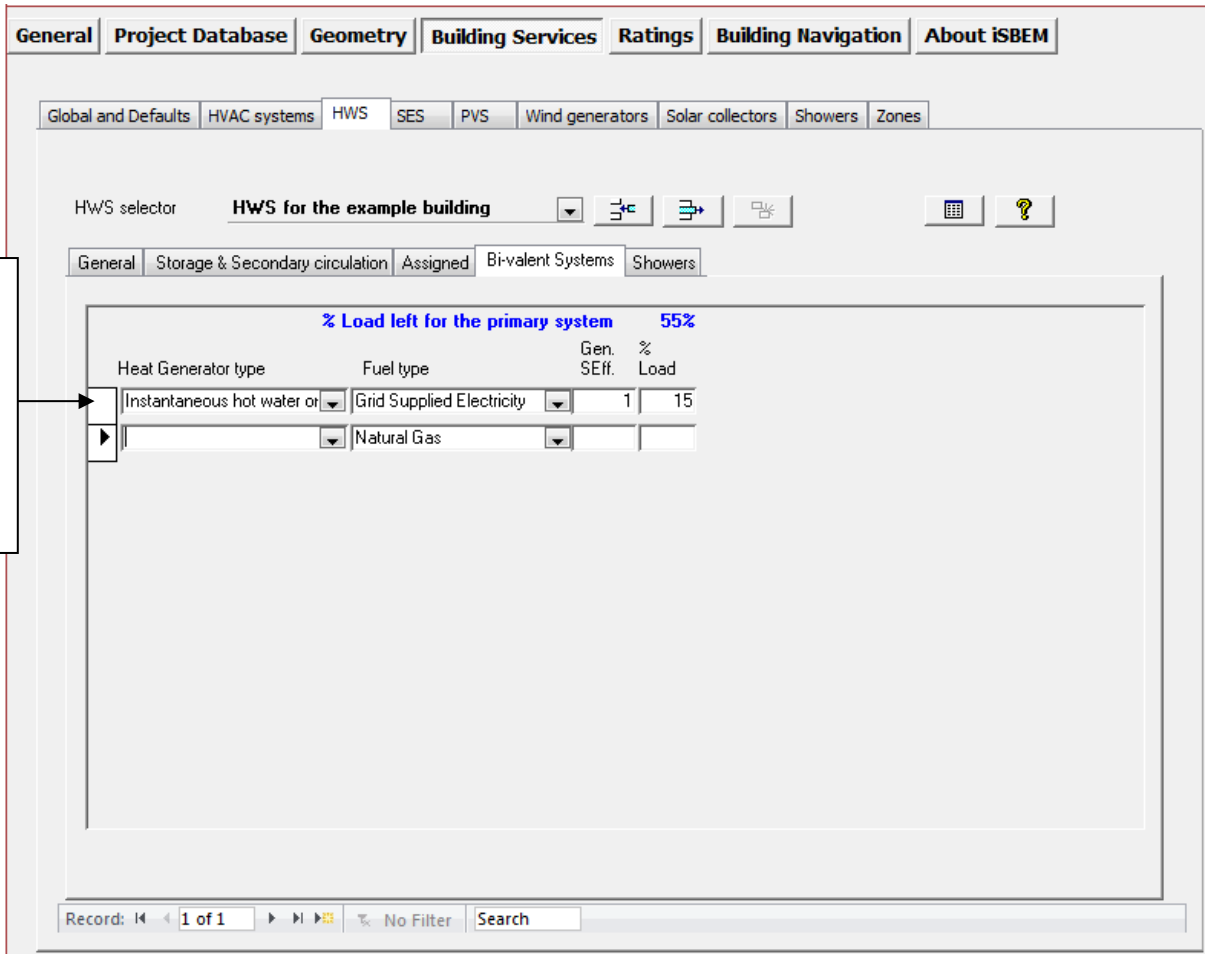


Figure 39: HW Storage and Secondary Circulation sub-tab

Bi-valent Systems sub-tab:

This sub-tab becomes active only if the generator type in the *General* sub-tab is <u>not</u> defined as 'Same as HVAC'. It allows the user to define a bi-valent water heating system, i.e., a system in which the heating is supplied by two (or more) different types of heat sources. As such, in addition to the generator type, fuel type, and seasonal efficiency, of the primary heat generator for water heating you have already defined in the *General* sub-tab, in the *Bi-valent Systems* sub-tab, you can also define additional heat generators that share the total water heating load with the primary heat generator (see Figure 36). For <u>each</u> additional heat generator, the following parameters need to be input:

1. Generator type of the additional heat generator
2. Fuel type of the additional heat generator
3. Seasonal efficiency of the additional heat generator, as a ratio.
4. Proportion, in %, of the water heating load that the additional heat generator provides.



To **delete** a generator type, click here to highlight and click the "Delete" button on your keyboard.

Figure 40: HW Bi-valent Systems sub-tab

Showers sub-tab:

In this sub-tab (see Figure 41), you can select from a list of previously defined shower objects to define the shower types and numbers that are served by this hot water system if, at least, one of those showers is fitted with a WWHRS.

NB: If all the showers served by this HWS are standard-flow types, and none of them is fitted with a WWHRS, then you do not need to provide any input in this sub-tab as these are the default assumptions that will be used in the calculation. However, if some showers in the building are fitted with WWHRS, and some are not, then you need to define both types of showers and the corresponding numbers of each type that are served by the HWS so that they can be correctly accounted for in the calculation.

For each served shower type, the following parameters can be input:

1. You need to select from the drop-down list (of the shower objects you have already defined in the *Building Services* form > *Showers* tab) the name of the shower type served by this HWS, if applicable.
2. Number of the actual shower units (≥ 1) of the type selected above which are served by this HWS in the building. **NB:** The number 0 is not a valid input for this parameter and will be removed by the calculation engine. Instead, see Figure 41 for guidance on how to delete a link to a shower object.

NB: If, based on the user's knowledge of the occupancy of the building, they know that the occupants of a particular zone definitely do not have access to a particular type of shower

that is served by the same HWS that also happens to provide the hot water for the zone for use in other purposes (i.e., none of the hot water demand from that zone will be diverted through that particular type of shower), the user should define a duplicate HWS (same generator, efficiency, etc., as the first one) but which is not attached to the shower type not accessed by the zone's occupants, and then define the zone as served by the duplicate HWS.

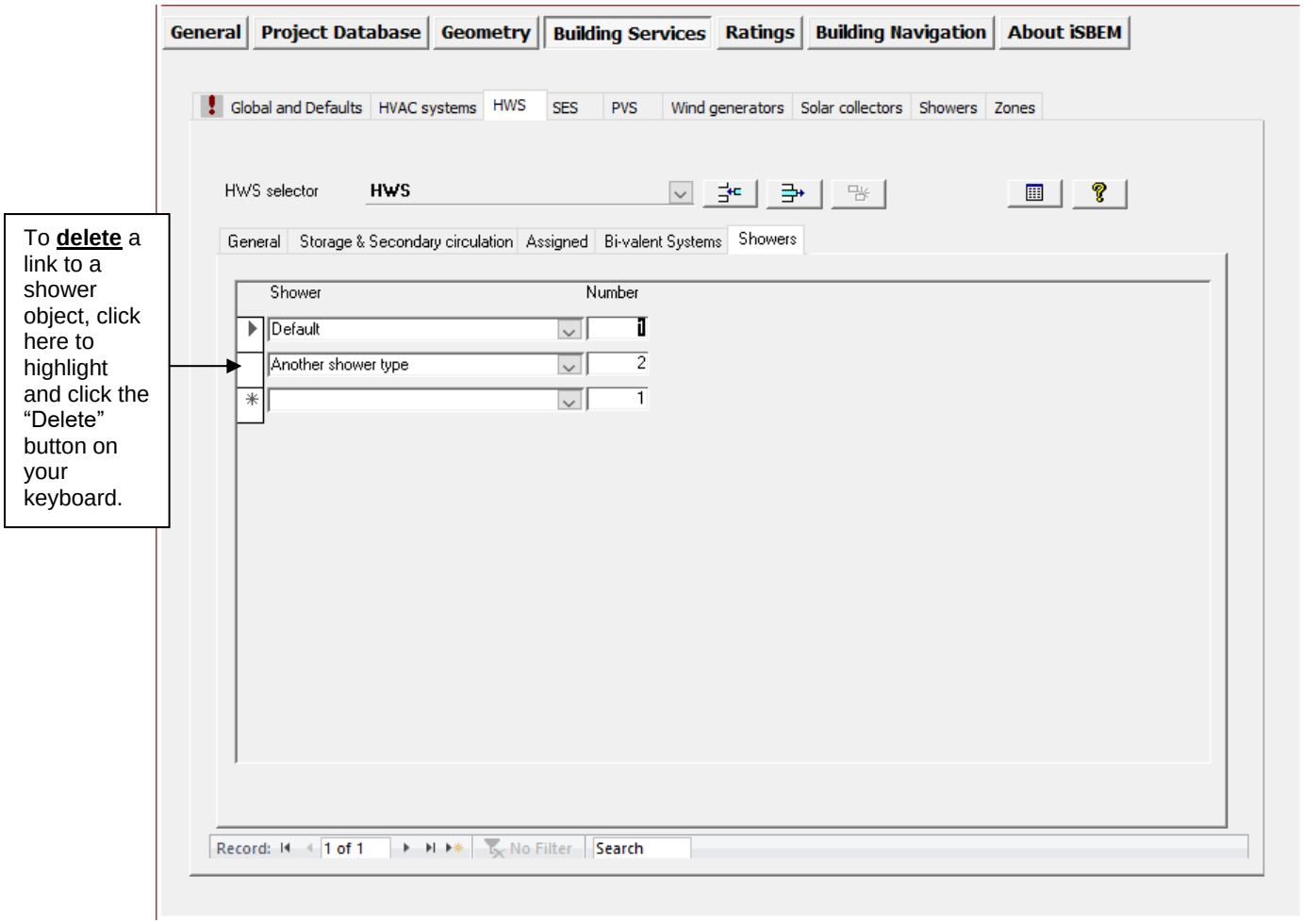


Figure 41: HW Showers sub-tab

Assigned sub-tab:

The zones assigned to the HWS can be viewed in the *Assigned* sub-tab of the *HWS* tab, shown in Figure 42.

Task 15: Define the HWS

Details can be found in Section A.1 under Systems. Click into the *HWS* tab in the *Building Services* form. There is only one type of HWS in this building, and it needs to be named and defined here.

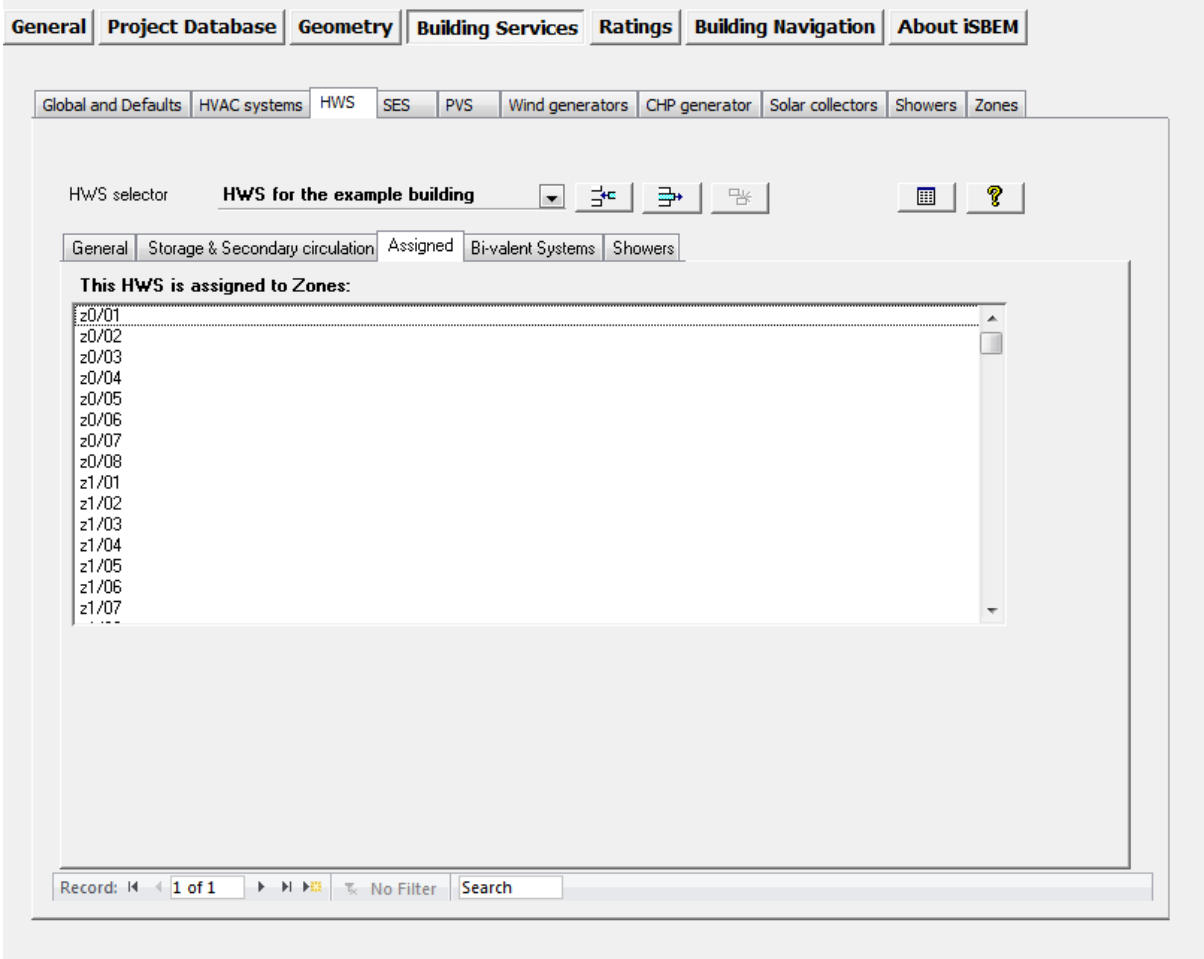


Figure 42: The Assigned sub-tab shows Zones to which the HWS has been assigned

3.5.4. Defining Solar Energy Systems (SES) – SES tab

There are three sub-tabs in the *SES* tab:

- **Collector Parameters** sub-tab
- **Solar Storage & Collector Loop** sub-tab
- **Auxiliary Energy & Distribution Losses** sub-tab

NB: The overall performance of solar thermal systems depends on how the hot water system is used, e.g., daily draw-off patterns and the use of other water heating devices such as a back-up boiler or an immersion heater. The procedure followed in SBEM is not suitable for detailed design for a particular case. It is intended to give a representative value of the solar contribution to water heating over a range of users. The calculation methodology implemented in SBEM is based on the f-chart method and has been adopted from the standards EN 151316-4-3:2007 *Heating systems in buildings – Method for calculation of system energy requirements and system efficiencies – Part 4-3: Heat generation systems, thermal solar systems*.

Collector Parameters sub-tab:

The parameters required to define an SES in this sub-tab (see Figure 43) are:

1. Name – Give it a unique name.
2. Multiplier – Indicate how many SES systems identical to this one are associated with the selected HWS.
3. In HWS - Select the HWS that this SES connects to, i.e., serves.

NB: It is important to assign the SES to the relevant hot water system. The drop-down list contains all the hot water systems that you have already defined in the *HWS* tab. If the SES is not assigned to the HWS, it will not be linked to the building, and any solar contribution to the hot water demand will not be accounted for in the calculation.

NB: If a solar energy system is connected to a HWS, then hot water storage is expected to exist.

4. Area – Aperture area of solar collector(s), in m^2. It refers to the solar collector maximum projected area through which un-concentrated solar radiation enters the collector. The collector aperture area should not be confused with the collector gross area which refers to the projected area of the complete collector.
5. Orientation - Select from the drop-down list: S, SE, SW, E, W, NE, NW, or N. The orientation and inclination of the solar collectors are needed for SBEM to calculate the solar radiation at the solar collector surface.
6. Inclination – Select from the drop-down list from between 0-90^o in 15^o intervals. The inclination of the solar panels is in degrees from the horizontal where 0 stands for a horizontal surface and 90 for a vertical surface. The orientation and inclination of the solar collectors are needed for SBEM to calculate the solar radiation at the solar collector surface.
7. Do you know the collector performance parameters according to EN 12975-2? – The preferred source of performance data for solar collectors is from a test on the collector concerned according to EN 12975-2: *Thermal solar systems and components – Solar collectors – Part 2: Test methods*. If test data are not available (e.g., for an existing installations), then the default values should be used by selecting:

    - No, use the default values from – you then need to select the collector type from the drop-down menu, and SBEM will use the corresponding default values as shown in Table 9.

Collector type in drop-down menu	η_0	a_1	a_2	IAM
Unglazed	0.9	20	0	1
Flat plate	0.75	6	0	0.94
Evacuated tube	0.65	3	0	0.97

Table 9: Default solar collector performance parameters

On the other hand, if the performance parameters are known, then you should select:

- Yes, the values are – you then need to enter the following parameters which will become active:

    a) η_0 – (sigma-zero) the zero-loss collector efficiency factor from the collector test standards EN 12975-2 and related to the aperture area.

b) a_1 – the collector heat loss coefficient, in W/m^{2}K, from the collector test standards EN 12975-2 and related to the aperture area.

c) a_2 – the temperature dependence of the heat loss coefficient, in W/m^{2}K^2, from the collector test standards EN 12975-2 and related to the aperture area.

d) IAM – the incidence angle modifier of the collector from the collector test standard EN 12975-2 when the test angle of incidence between it and the direct solar radiation for the test condition is 50°.

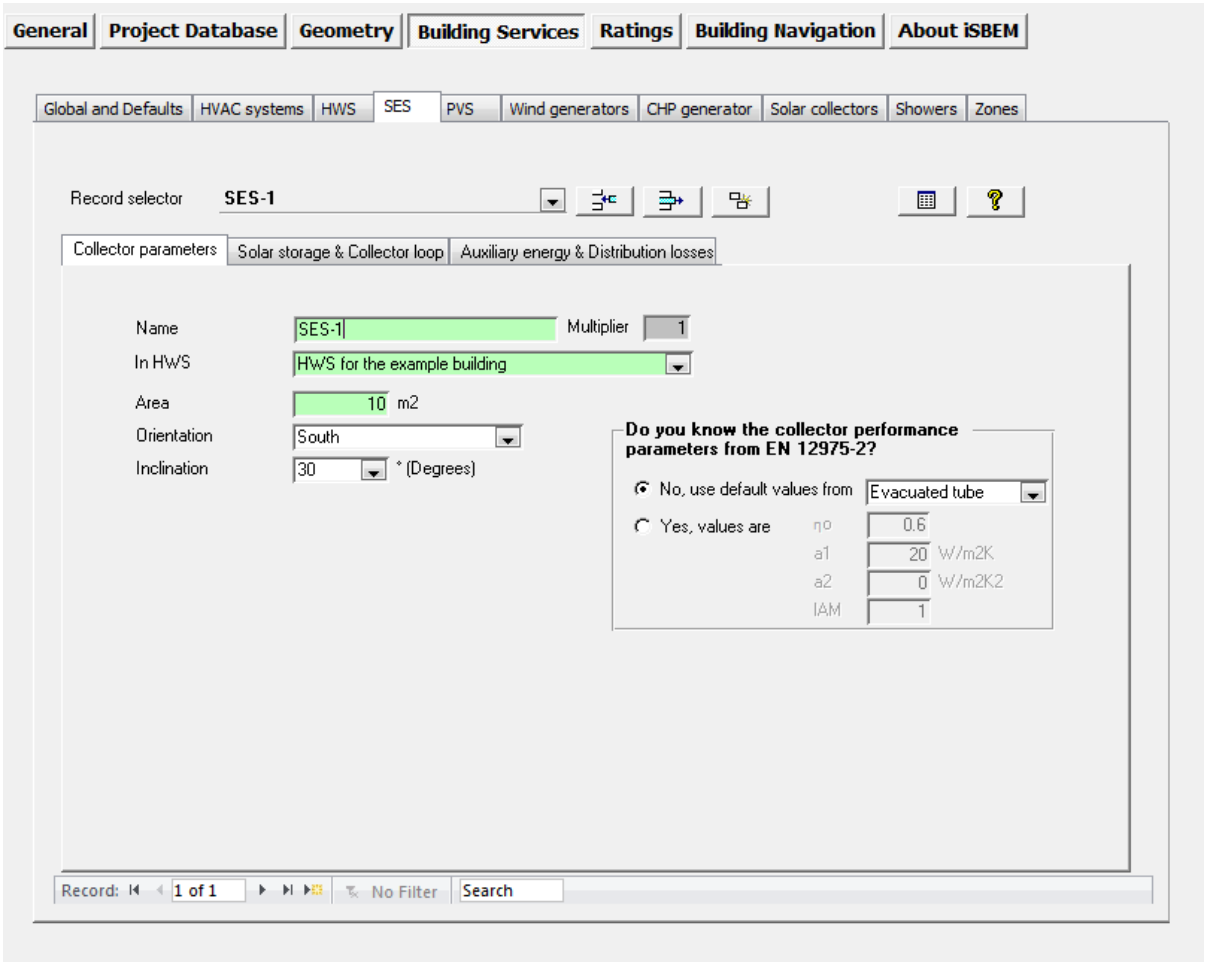


Figure 43: Defining a Solar Energy System in the Collector Parameters sub-tab

Solar Storage & Collector Loop sub-tab:

The parameters required to define an SES in this sub-tab (see Figure 45) are:

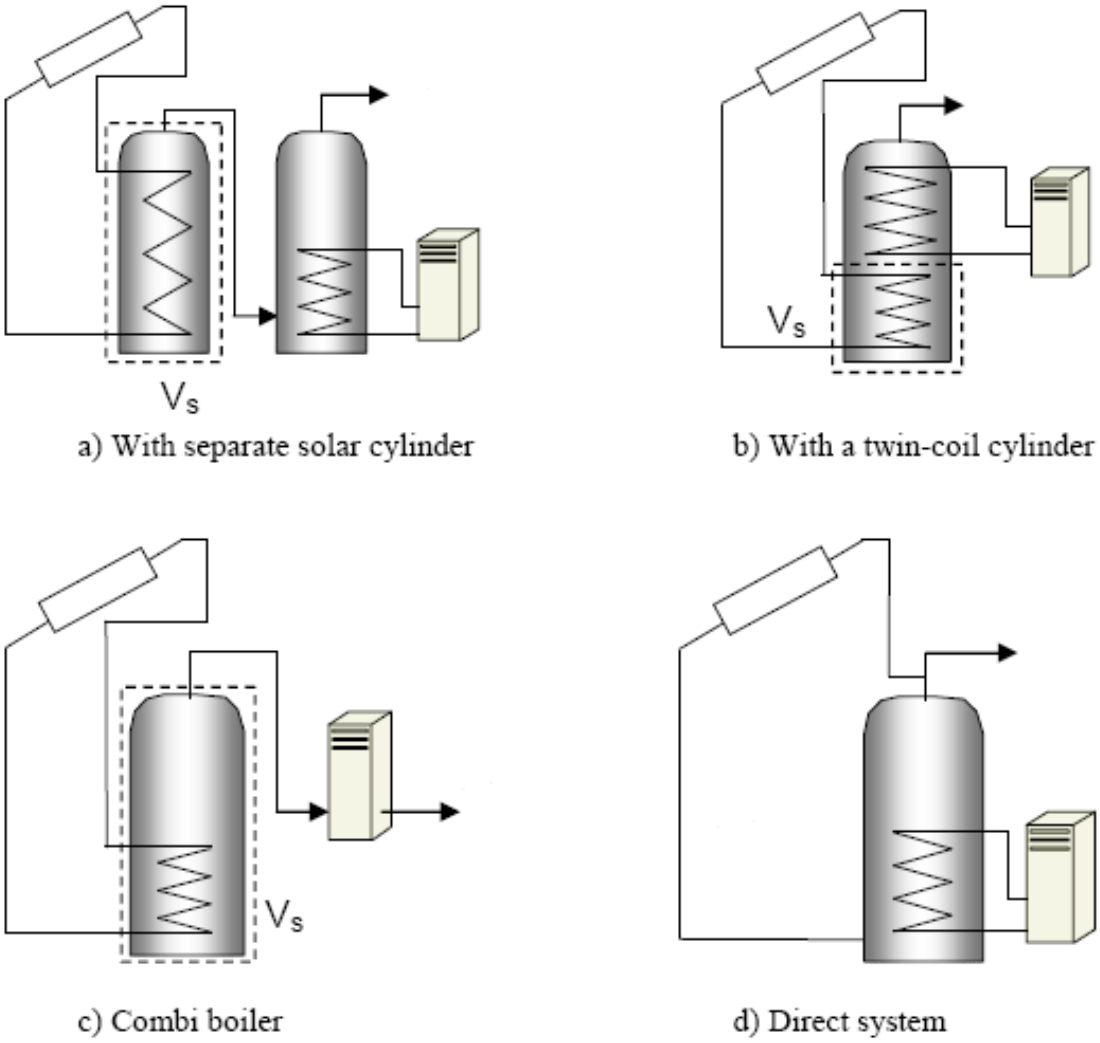
1. Solar storage volume - refers to the dedicated solar storage volume, in litres, and it should be calculated according to the arrangements for solar pre-heating as indicated in the schematic in Figure 44 and the guidance below:
   - in the case of one or more separate pre-heat tanks, such as arrangements a) or c) in Figure 44, the solar storage volume is the volume of the pre-heat tank(s).
   - in the case of a combined cylinder, such as arrangement b) in Figure 44, the solar storage volume is the volume between the bottom of the lowest back-up

element (electric element or heat exchanger) to the lowest element of the solar primary.

- in the case of a thermal store (hot water only) where (only) the solar coil is within the thermal store, the solar storage volume is the volume of the dedicated thermal storage.
- in the case of a direct system, such as arrangement d) in Figure 44, the solar volume should be calculated as 0.3 times the volume of the cylinder.

NB: The schematic examples reflected in the Figure 44 are unlikely to represent all types of commercial solar thermal installations. Where necessary, and for more complex systems, an accredited dynamic simulation tool can be used.

NB: The dedicated solar volume of a solar thermal installation varies depending on the control and timing strategy of the of the back-up system. To optimise the performance of the solar thermal system, the back-up system should be prevented from operating during and prior to the period of the day where the solar radiation is strong enough to contribute to the hot water requirements. Where it can be demonstrated that the dedicated solar volume should be calculated following a different approach to the guidelines given here, alternative calculations can be used as long as they are in agreement with the UK Micro Certification Scheme standards in effect at that time. The detail and justifications of the calculations undertaken will need to be submitted to the Building Control officer.



V_s (indicated by the dashed line) is the dedicated solar storage volume.

Figure 44: Schematic examples of arrangements for solar pre-heating (*These schematics are not intended to show safety measures or devices needed to make the systems safe.*) – Adapted from SAP2005

2. Solar pre-heating type – you need to select an option from the drop-down menu as follows:
   - Separate solar cylinder - when there is one or more dedicated solar storage vessels that are heated with the solar collectors only and that do not contain any other heating sources, i.e., the solar energy system has a storage cylinder that is independent of that for the hot water system storage.
   - Combined cylinder - the solar storage is combined in a hot water cylinder with one or more back-up sources, i.e., the solar energy system shares the same storage vessel with the hot water system.

   If the solar pre-heating type selected is 'Separate solar cylinder', then the following parameter becomes active:

   a. Insulation type (on the solar storage cylinder) – selected from the drop-down menu. If the option selected is <u>not</u> "Uninsulated", then the following parameter becomes active:

i. Insulation thickness (on the solar storage cylinder) in mm.

3. Do you know the heat transfer rate of the heat exchanger(s) in the collector loop? – you need to select one of the following options:

   - There is no heat exchanger - For solar thermal direct systems in which the solar primary transmission fluid and the consumed water are the same, i.e., arrangement d) in Figure 44, you should select this option. Otherwise, for indirect systems where the primary circuit fluid is different to that of the secondary side of the system, there will be one or more heat exchangers in the storage vessel, and you should select one of the other two options below.
   - No, use the default value.
   - Yes, the value is – you need to input the heat transfer rate, in W/K, in the box that will become active. For small systems, the heat transfer rate of the heat exchanger in the solar loop can be obtained from test results according to the standards EN 12975-3 - *Performance characterisation of stores for solar heating systems*. For large systems, the value can be taken from the heat exchanger performance data sheet provided by the manufacturer. For systems with more than one heat exchanger, using an intermediary or tertiary arrangement such as with a thermal store, an equivalent heat transfer rate can be input by the user (alternatively, dynamic simulation compliance tools can be used).

   NB: The solar collector loop refers to all elements located between the solar collector and the point where the back-up heating source supplies the hot water system with energy.

4. Do you know the overall heat loss coefficient of all pipes in the collector loop? – you need to select one of the following options:

   - No, use the default value.
   - Yes, the value is – you need to input the heat loss coefficient, in W/K, in the box that will become active. This is the overall heat loss coefficient of all pipes in the solar loop, including pipes between collectors and array pipes between the collector array and the solar storage tank(s). If the pipe and insulation for the solar loop are known, the overall heat loss coefficient of all the pipes in the solar loop can be calculated accordingly (see for instance *John A. Duffie and William A. Beckman: Solar Engineering of Thermal Process. Wiley-Interscience ed., 1991*).

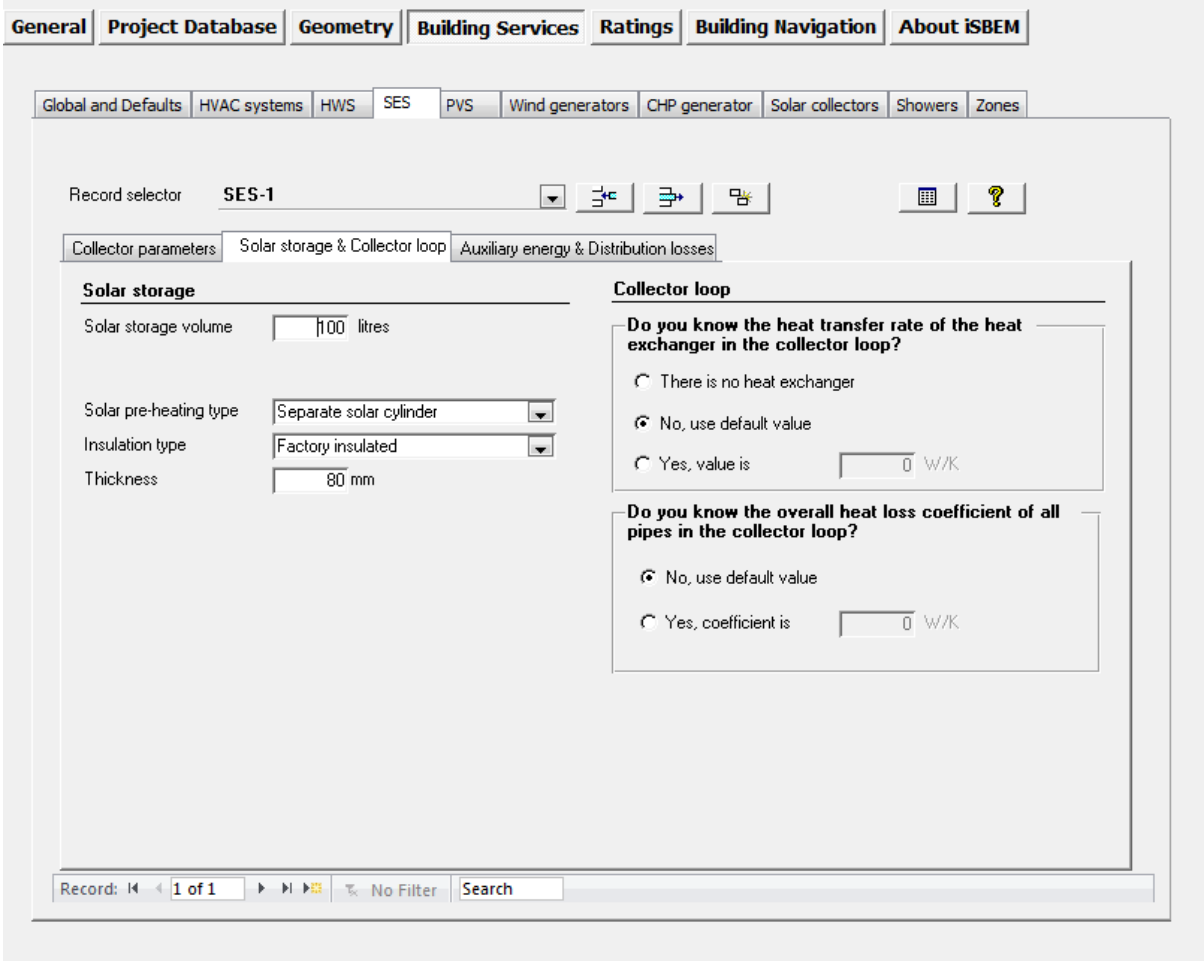


Figure 45: Defining a Solar Energy System in the Solar Storage & Collector Loop sub-tab

Auxiliary Energy & Distribution Losses sub-tab:

The parameters required to define an SES in this sub-tab (see Figure 46) are:

1. Are the distribution pipes between the solar energy system and the back-up system insulated? – you need to select either yes or no. If there are pipes between the solar thermal system and the back-up heating system, this parameter is used to estimate the thermal losses of the distribution between the solar thermal system and back-up heater. This parameter becomes active only if the “Solar pre-heating type” parameter in the *Solar Storage & Collector Loop* sub-tab has been set to ‘Separate solar cylinder’.
2. Circulation system – you need to select one option from the drop-down menu. If the option selected is ‘forced circulation system with no PV’, then the following parameter becomes active:
    i. Do you know the nominal power of the pumps? – you need to select one of the following options:
        - No, use the default value.
        - Yes, the value is – you need to input the nominal power, in W, in the box that will become active.

    NB: The auxiliary energy consumption required by the circulation pumps in the solar system is calculated according to the type of circulation system. For thermosiphon

systems and forced circulation systems assisted with photovoltaics, the auxiliary energy consumption is zero. For forced circulation systems that require grid-electricity for the circulation pump in the solar loop, the user needs to enter the nominal input power of the pumps, which is the power stated on the pumps label. For a multi-stage pump, the power corresponding to the typical operation mode should be chosen.

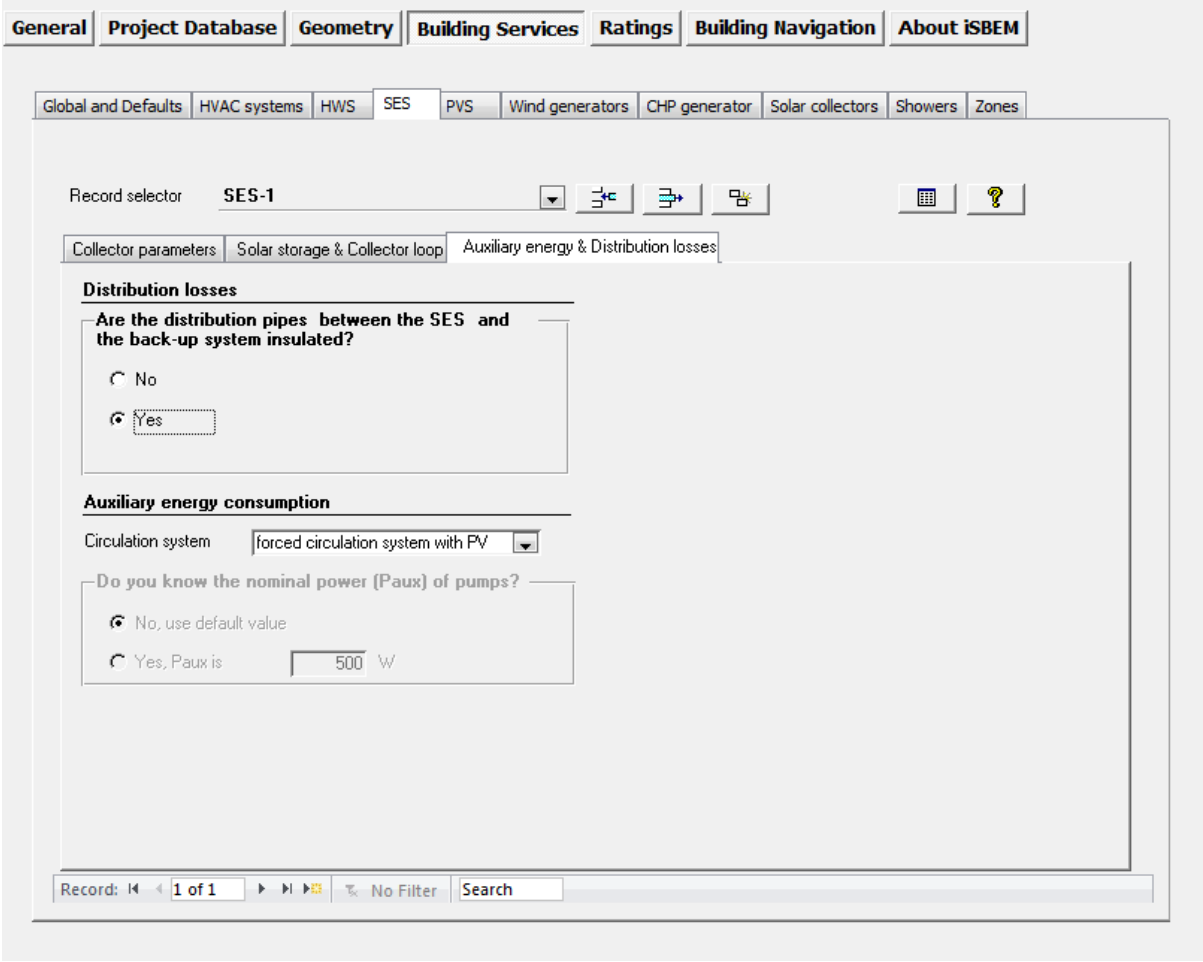


Figure 46: Defining a Solar Energy System in the Auxiliary Energy & Distribution Losses sub-tab

NB: There are no SESs in the Example building so there is no task here.

3.5.5. Defining a Photovoltaic system (PVS) – PVS tab

iSBEM allows the user to define a PVS installed on the building in order to provide a percentage of the electrical demand of the building (see Figure 47) by displacing grid-supplied electricity. There is only one sub-tab in the *PVS* tab:

- **General** sub-tab

General sub-tab:

The definition of a PVS requires:

1. Name – Give it a unique name
2. Multiplier – Indicate how many PVS identical to this one exist in the building.

Depending on the selected radio button indicating whether or not you know the peak power of the PV array:

3. Peak power – Input the peak power of the PV array, in kWp. If this is not known, then you need to define the module type and the area of the array instead in the next two fields so that SBEM can calculate the peak power.
4. Type – Choose from the drop-down list whether it is: Monocrystalline silicon, Polycrystalline silicon, Amorphous silicon, or Other thin films. **NB:** Not needed if the peak power has been input.
5. Area – Area of the photovoltaic panel (m^2). **NB:** Not needed if the peak power has been input.
6. Orientation - Select from the drop-down list: S, SE, SW, E, W, NE, NW, or N.
7. Inclination – Select from the drop-down list from between 0-90^o in 15^o intervals. The inclination of the photovoltaic panels is in degrees from the horizontal where 0 stands for a horizontal surface and 90 for a vertical surface.
8. Over-shading – Select from the drop-down list the level of over-shading of the PV array. The over-shading level refers to the percentage of the sky that is blocked by obstacles (see Table 10). It should be assessed taking into account the inclination of the panels.
9. Ventilation strategy – Select from the drop-down list the ventilation strategy for the PV array, aided by the definitions in Table 11.

Level of over-shading	% of sky blocked by obstacles
None or very little	<20%
Modest	20-60%
Significant	60-80%
Heavy	>80%

Table 10: PV array over-shading levels

Ventilation Strategy	Definition
Strongly ventilated or forced ventilated modules	It refers to those situations where there is no thermal interaction between the PV modules and the surface where they are mounted. This could apply for instance to stand-alone system mounted on a flat roof.
Moderately ventilated modules	There is an air gap between the PV modules and the surface where they are mounted. This would apply to roof slope systems where a suitable air gap between the PV module and the roof has been allowed for.
Unventilated modules	There is no air gap between the PV modules and the surface where they are mounted

Table 11: PV array ventilation strategy definitions

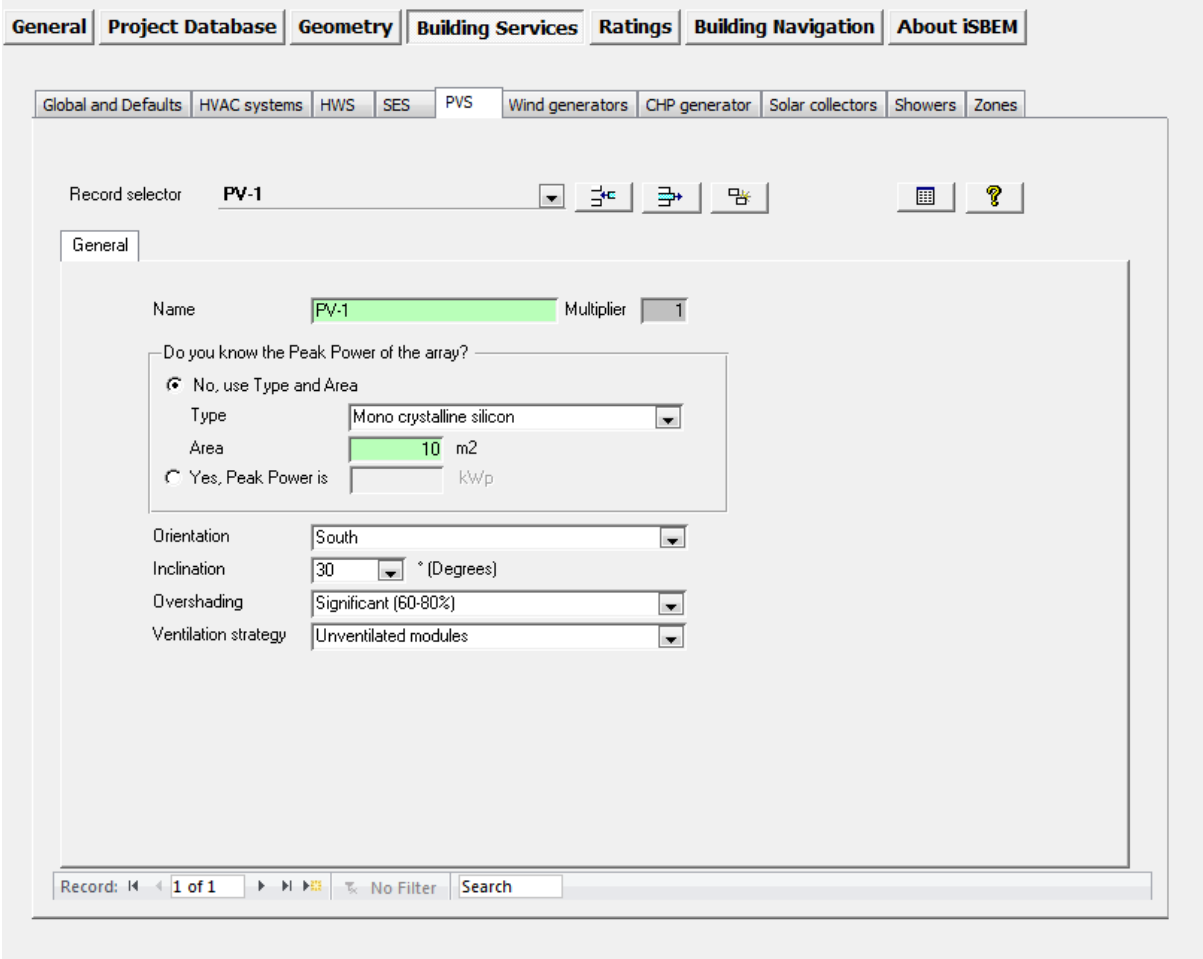


Figure 47: Defining a PVS

NB: There are no PVSs in the Example building so there is no task here.

3.5.6. Defining a wind generator – Wind Generators tab

iSBEM allows the user to define a wind turbine connected to the building in this tab. The electricity produced by the wind turbine can displace the grid-supplied electricity used within the building. There is only one sub-tab in the *Wind Generators* tab:

- **General** sub-tab

General sub-tab:

The parameters needed to define a wind generator are (see Figure 48):

1. Name – Give it a unique name.
2. Multiplier – Indicate how many wind generators identical to this one are connected to the building.
3. Terrain type – This indicates the type of terrain where the wind turbine is located. Select from: Smooth flat country (no obstacles), Farm land with boundary hedges, Suburban or industrial area, and Urban with average building height > 15m.

4. Radio button to indicate whether the wind turbine has a horizontal axis or not. If it is a horizontal axis turbine, you are asked to enter:

    - Diameter – Wind turbine rotor diameter, in m. iSBEM will use the entered diameter to calculate the area swept by the rotor blades.

    If the wind turbine does not have a horizontal axis, e.g., it is a vertical axis wind turbine, then you are instead asked to enter:

    - Area – area swept by the rotor blades, in m^2.

    NB: The swept area of a wind turbine is used to calculate the area of air intercepted by the turbine rotor. For axial horizontal wind turbines, you can enter the rotor diameter, D, in m, and the swept area, A, is automatically calculated by iSBEM as the area of the circle delineated by the turbine's blades, and it is calculated as:

    $$A = \frac{\pi \times D^2}{4}$$

    For any other type of wind turbines, including vertical axis wind turbines, you need to enter the area swept by the rotor, in m^2. Contact the turbine manufacturer if in any doubt.

5. Hub height – The wind turbine hub height, in m.

    NB: The height of the turbine is used to adjust the wind speed values (obtained from the weather database) during the calculation. For axial horizontal wind turbines, this corresponds to the turbine hub height measured from the ground. For other rotor types, including vertical axis wind turbines, use the geometric centre of the turbine rotor.

6. Power – The wind turbine rated power (electrical power delivered at rated wind speed), in kW.

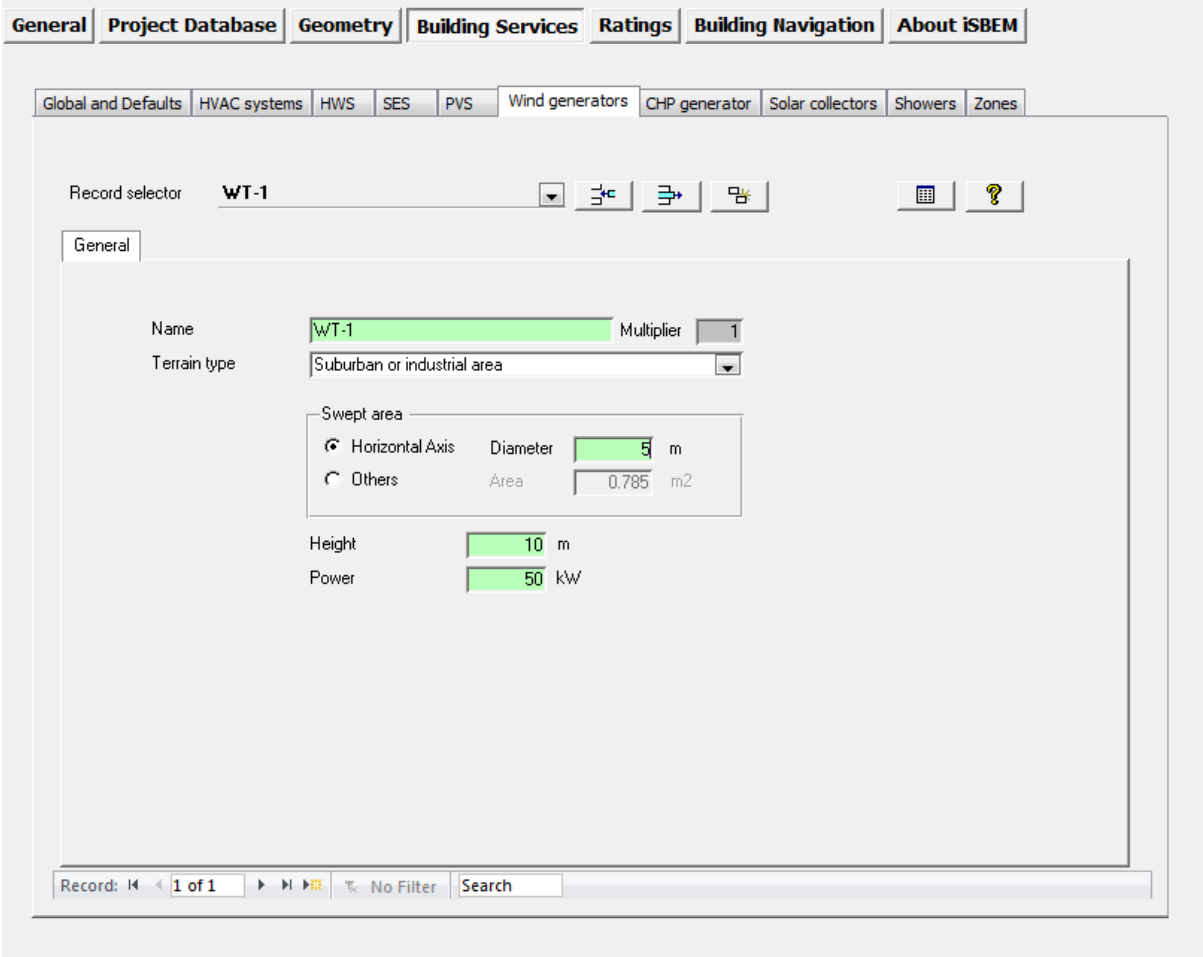


Figure 48: Defining a wind generator

NB: There are no wind generators in the Example building so there is no task here.

3.5.7. Defining a CHP generator – CHP Generator tab

This tab only appears if one of the HVAC systems, defined in the *HVAC Systems* tab, is specified to use a Combined Heating and Power (CHP) generator for provision of hot water, space heating, and electrical power, or a Combined Cooling, Heating, and Power (CCHP) generator for provision of hot water, space cooling, space heating, and electrical energy (i.e., the relevant box is ticked).

There is only one sub-tab in the *CHP Generator* tab:

- **General** sub-tab

General sub-tab:

The parameters required to describe the CHP generator in iSBEM are (see Figure 49):

1. Fuel type – Select from: Natural gas, LPG, Biogas, Oil, Coal, Anthracite, Smokeless fuel (inc coke), Dual fuel appliances (mineral + wood), Biomass, and Waste heat.

2. Heat efficiency – the seasonal thermal efficiency of the CCHP generator, defined as the total annual useful heat supplied by the generator divided by the total annual fuel energy input to the generator (using the gross calorific value).
3. Electrical efficiency - it is calculated as the total annual electric power output by the CHP divided by the total annual fuel energy input (using the gross calorific value).

NB: Values for the heat and electrical efficiencies are entered as ratios into iSBEM, not as percentages. For instance, a 30% electrical efficiency should be entered as 0.3 into iSBEM.

NB: The heat to power ratio is automatically calculated by iSBEM as the heat efficiency divided by the electrical efficiency of the CHP.

4. CHPQA Quality Index - an indicator of the energy efficiency and environmental performance of a CHP scheme relative to the generation of the same amounts of heat and power by separate alternative means.

   NB: The Quality Index (QI) provides a means of assessing the quality of CHP Schemes. In iSBEM, it is currently used for compliance checking and reporting purposes only, i.e., it is not used in the calculations. For information regarding minimum requirements for CHP and CCHP installations, please refer to the Approved Documents.

5. Proportion of space heating supplied to the building - (%). This average monthly value needs to be calculated through a detailed analysis of the building's space heating demand values and patterns. Note that the CHP unit is normally sized below the peak heating demand of the building and will also be out of service at particular times for maintenance purposes.
6. Proportion of hot water supplied to the building - (%). This average monthly value needs to be calculated through a detailed analysis of the building's water heating demand values and patterns. Note that the CHP unit is normally sized below the peak heating demand of the building and will also be out of service at particular times for maintenance purposes.

NB: The CHP can provide a proportion of the building's hot water only if the HWS generator is set to be the same as the HVAC system to which the CHP is connected.

7. Tick box to indicate whether this is a trigeneration system (i.e., it provides cooling, heating, and power) or not (i.e., it provides heating and power). If the box is ticked, the following fields become active:
   a. Proportion of space cooling supplied to the building - (%).
   b. Chiller efficiency - the seasonal chiller efficiency ratio of the generator, defined as the cooling demand divided by the cooling energy for the generator.

NB: SBEM is not a design tool. The values of the parameters entered in the *CHP Generator* sub-tab need to have come from a previous detailed analysis.

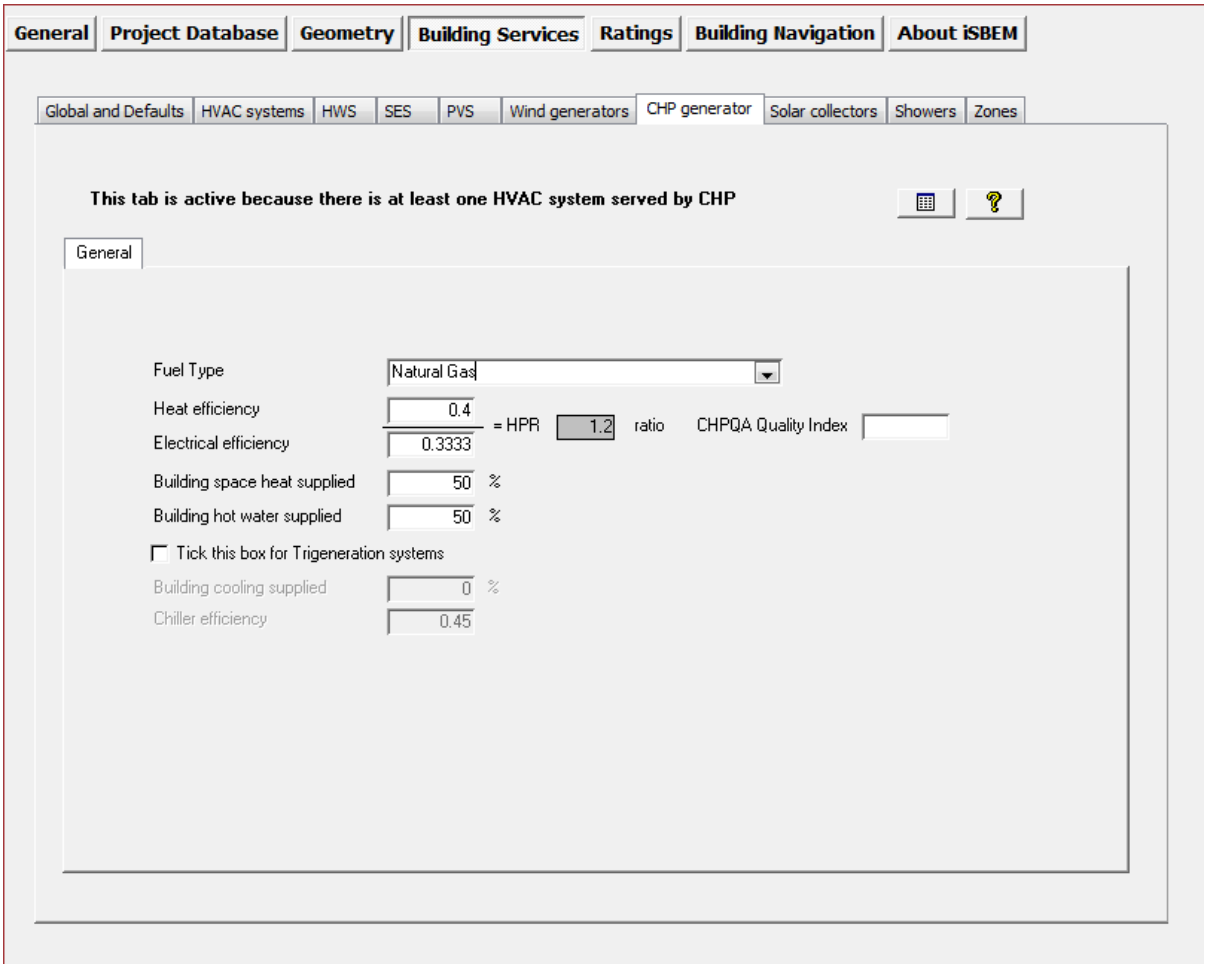


Figure 49: Defining a CHP generator: CHP Generator tab

NB: There is no CHP generator in the Example building so there is no task here.

3.5.8. Defining a Solar Collector – Solar Collectors tab

The *Solar Collectors* (SC) tab contains the following sub-tabs:

- **General** sub-tab
- **Air flows** sub-tab

General sub-tab:

In this sub-tab, the following parameters are input to describe a solar collector system (for solar pre-heating of air input into the building) in iSBEM (see Figure 50):

1. Name – Give it a unique name.
2. Collector type – Select from Transpired and Non-transpired.
3. Control type – Select from Only manual and Automatic.
4. Shading factor - the shading correction (reduction) factor for the SC system. A value of 1 means the SC system is unshaded.

If the collector is transpired (TSC), then the following parameters need to be input:

a. Type – Select from Standard operation, High temperature rise, and High air volume.

b. Operation – Type of operation of the SC system. Select from Constant flow and Variable flow.

c. Absorptivity – Select from Very high, High, Good, Moderate, and Low.

If the collector is non-transpired (NTSC), then the following parameters need to be input:

d. Collector height - the height of the SC, in m.

e. Air temperature coeff. – the air temperature coefficient of the SC, in K/(W/m^2).

f. Air flow coeff. – the air flow coefficient of the SC.

NB: Defining non-transpired solar collectors: As non-transpired solar collectors are structural elements, rather than "add-on" elements like the transpired solar collectors, they also need to be defined as a wall construction in the *Project Database* form and then assigned to the relevant wall in the *Geometry* form. Within the *Project Database* form > *Constructions for walls* tab > *General* sub-tab, when the "Import from library" option is selected, and the option selected for the "Category" parameter is "Light steel framing", there are options for non-transpired solar collectors with different thicknesses. One of them should be selected, unless the thermal parameters (U-value and kappa-m value) are known already and can be input manually. This wall construction type should then be assigned to the appropriate wall in the *Geometry* form > *Envelope* tab > *General* sub-tab as the option for the "Construction" parameter.

5. Refresh button – clicking on this button will update the following 2 values, which are visible but cannot be edited by the user in this sub-tab. They are calculated by iSBEM based on parameters input by the user in other sub-tabs as follows:

   a) Area – The total area of the SC system. This is calculated by iSBEM as the sum of the areas input by the user in the "SC area" field in the *Geometry* form > *Envelope* tab > *General* sub-tab, i.e., the total area of the SC installed on the exterior of the building's envelopes.

   b) % Assigned – The total percentage of the pre-heated air provided by the SC system that has been assigned to zones in the building. This is calculated by iSBEM as the sum of the percentages input by the user in the "% supply" field in the *Building Services* form > *Zones* tab > *SC* sub-tab. If this total exceeds 100%, the value is displayed with a red background to warn users to revise their input in the *Zones* tab.

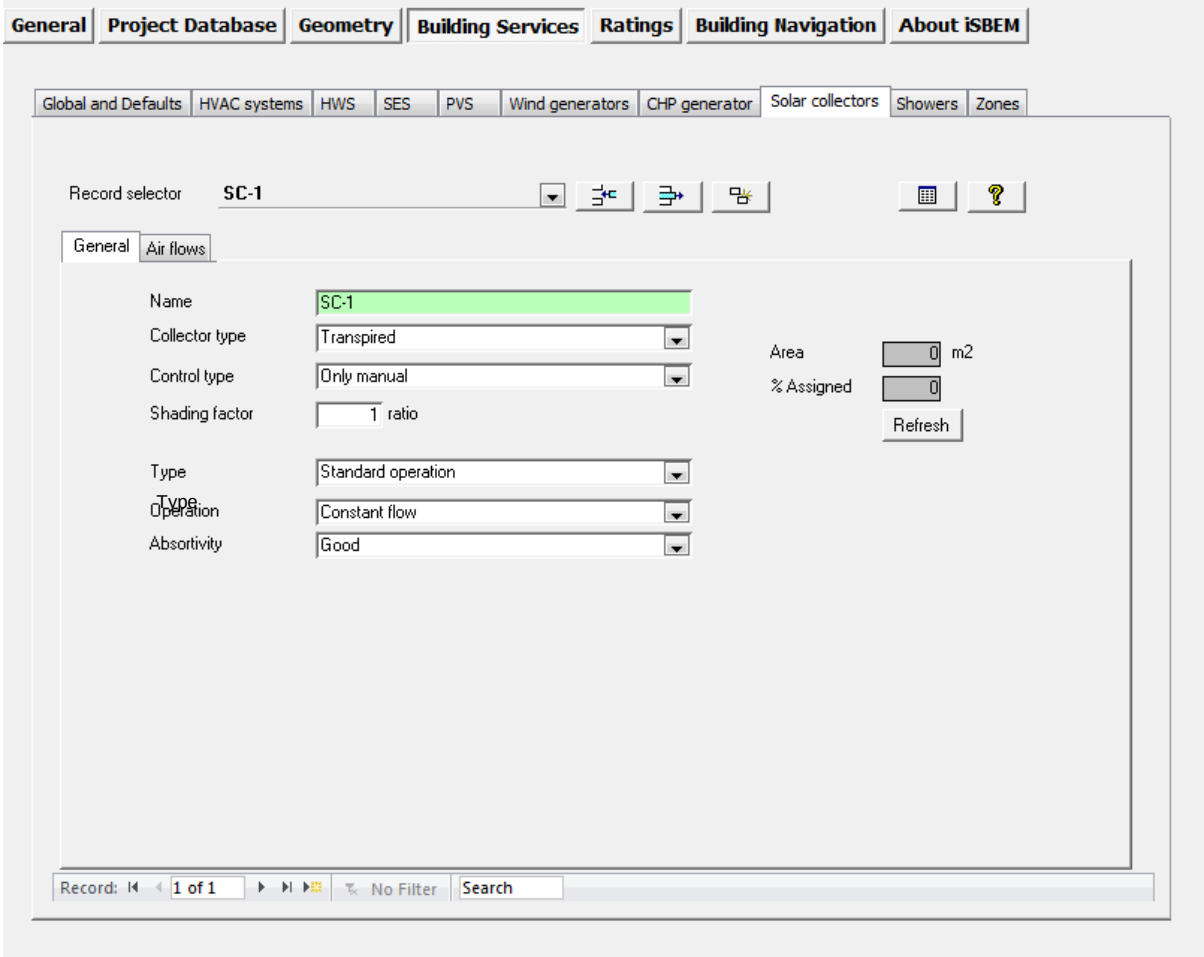


Figure 50: Defining a solar collector: Solar Collectors tab > General sub-tab

Air flows sub-tab:

In this sub-tab, the following parameters are input to describe a solar collector system in iSBEM (see Figure 51):

1. Tick box to indicate if the solar collector is provided with an independent fan. If the box is ticked, the following parameter becomes active:
    a. Supply specific fan power, in W/(l/s), for the SC system.
2. Design air flow rate, in m^3/s, for the SC system.

NB: There is no solar collectors in the Example building so there is no task here.

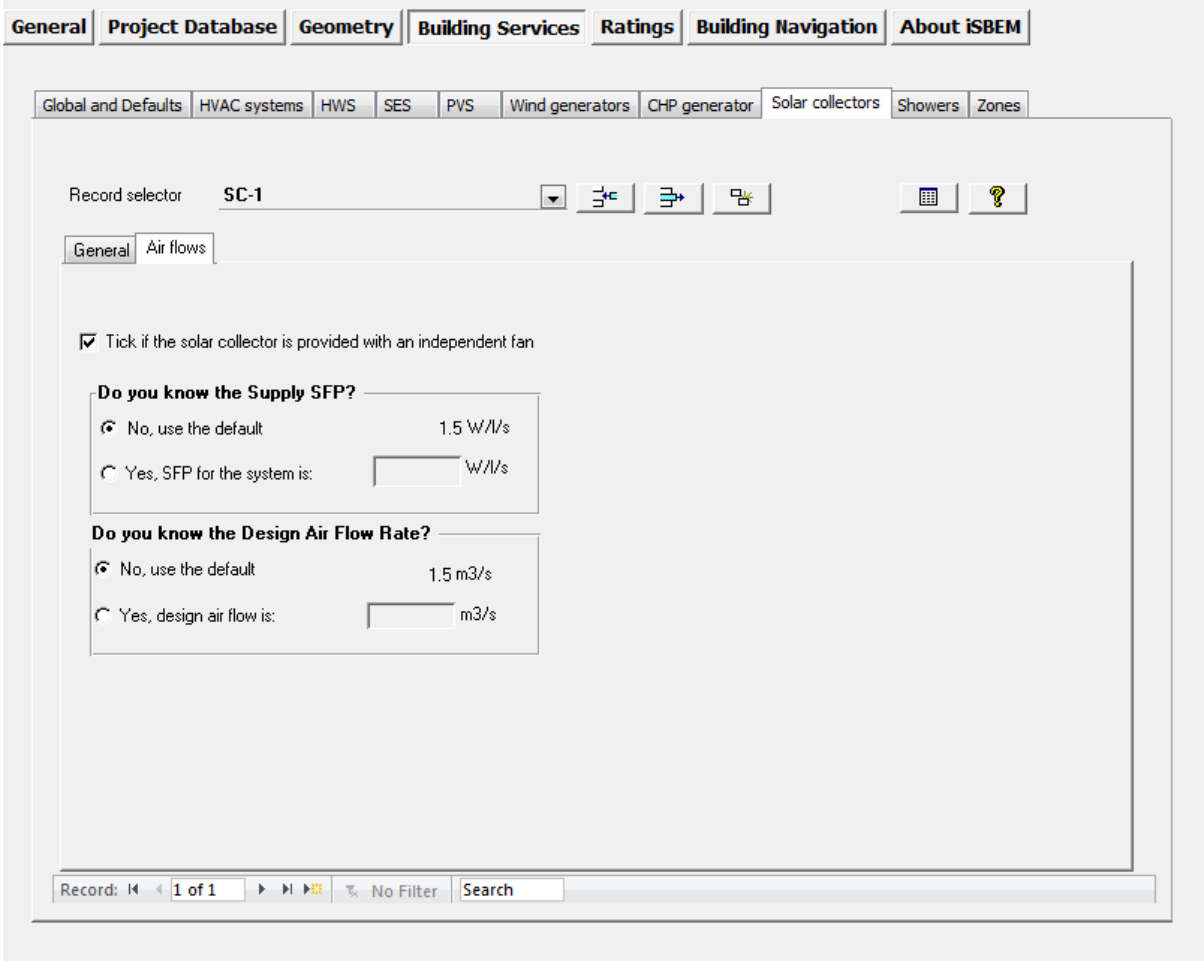


Figure 51: Defining a solar collector: Solar Collectors tab > Air flows sub-tab

3.5.9. Defining a Shower – Showers tab

The *Showers* tab contains the following sub-tab:

- **General** sub-tab

General sub-tab:

In this sub-tab, the following parameters are input to describe a shower in iSBEM (see Figure 52):

1. Name – Give it a unique name.
2. Type of shower – Select from the following options depending on the flow rate:
    - Standard flow – if the flow rate is 7 - 9 litres/minute;
    - High flow – (including power showers) if the flow rate is > 9 litres per minute (a typical value is around 13 litres/minute); or
    - Low flow – (or electric instantaneous) if the flow rate is < 7 litres/minute (a typical value for an electric shower is about 5 litres/minute).
3. Tick box to denote if the shower is above a bath.

4. Tick box to denote if the shower is fitted with a waste water heat recovery system (WWHRS). If this box is ticked, then the following parameters become active:
    a. Heat recovery seasonal system efficiency - If you know the heat recovery efficiency of the WWHRS, it can be introduced manually into the interface. Otherwise, a default value will be used by SBEM.
    b. Tick box to denote if the WWHRS uses a pump. If this box is ticked, then the following parameter becomes active:
        i. Nominal power of the pump – If you know the nominal power of the WWHRS pump, it can be introduced manually, in W, into the interface. Otherwise, a default value will be used by SBEM. **NB:** If the pump serves more than one shower unit, divide the pump power by the number of showers it serves, and enter into iSBEM the nominal power per shower unit.

NB: The methodology currently used in SBEM is for an instantaneous WWHRS so the hot water used in baths is excluded from the WWHRS calculation.

NB: Note that in iSBEM, the value for the efficiency is always entered as a ratio. For instance, a 90% efficient boiler, the efficiency should be entered as 0.9.

NB: If all the showers served by this HWS are standard-flow types, and none of them is fitted with a WWHRS, then you do not need to provide any input in this sub-tab as these are the default assumptions that will be used in the calculation. However, if some showers in the building are fitted with WWHRS, and some are not, then you need to define both types of showers and the corresponding numbers of each type that are served by the HWS so that they can be correctly accounted for in the calculation.

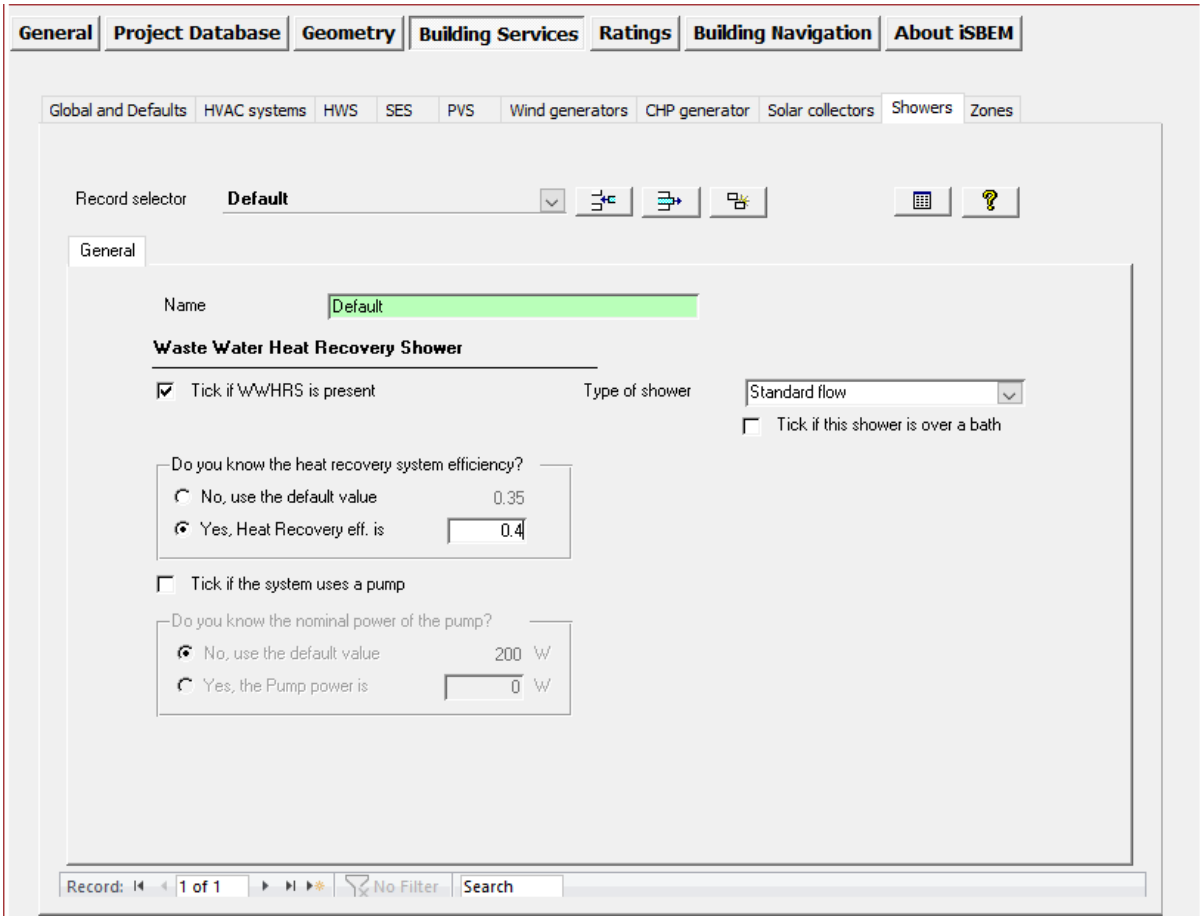


Figure 52: Defining a shower: Showers tab > General sub-tab

NB: All the showers in the Example building have standard flow and none of them is fitted with a WWHRS so there is no task here.

3.5.10. Defining the zone-specific building services- Zones tab

The zone definition is not completed within the *Zones* tab in the *Geometry* form. Some zone parameters (related to building services) are defined within the *Building Services* form, under the *Zones* tab. There are eight sub-tabs in the *Zones* tab:

- **HVAC and HWS Systems** sub-tab: This is where you assign the HVAC system and HWS which serve each zone.
- **Ventilation** sub-tab: This is where you define the local ventilation type and characteristics for each zone.
- **Ventilation (cont)** sub-tab: This is where you provide more data on the ventilation and heat recovery in the zone.
- **Exhaust** sub-tab: This is where you can define an exhaust system in a zone.
- **Lighting** sub-tab: This is where you enter details about the general lighting characteristics for each zone.
- **Lighting Controls** sub-tab: This is where you enter details about the lighting controls for each zone.

- **Display Lighting** sub-tab: This is where you enter details about display lighting characteristics and controls for each zone, if applicable.
- **Solar Collector** sub-tab: This is where you assign the solar collector that serves the zone, if applicable.

HVAC and HWS Systems sub-tab:

The sub-tab is used to specify the HVAC system and HWS for each zone. The following information is required:

HVAC System Parameters

1. HVAC Systems – Here you need to select from the drop-down list (of systems you have already defined in the *HVAC Systems* tab or the default systems) the HVAC system which serves the zone. If no HVAC system serves the space (i.e., an unconditioned zone), select 'Zones without HVAC system' (spaces which have no heating or cooling and will remain unconditioned, e.g., plant rooms, storage spaces, exposed circulation spaces).

   NB: If a zone is defined as having no heating or cooling, i.e., assigned to 'Zones without HVAC system', but the activity type selected for the zone is one which typically requires conditioning (according to the Activity Database), a red exclamation mark "**!**" will appear next to this parameter as a warning to the user, in case this was done in error. Ultimately, however, the calculation will be carried out using the data input by the user. On the other hand, if the user assigns an HVAC system (i.e., which provides heating or heating and cooling) to a zone whose activity type is typically unconditioned in the NCM Activity Database, a similar red exclamation mark "**!**" will appear next to this parameter in the interface, and if the calculation is initiated, it will be terminated by the SBEM engine. Because there are no values for heating-set-point or cooling-set-point temperatures specified in the NCM Activity Database for these unconditioned activities, no heating or cooling energy demand can be calculated by the SBEM engine for these activities.

NB: The default HVAC systems in iSBEM are representative of existing rather than new buildings and should only be used if you are running an EPC calculation for an existing building (not a compliance calculation for a new building) and do not know the type of the HVAC system in your building or its detailed parameters as the default efficiencies assumed by iSBEM for them are quite pessimistic and cannot be edited by the user.

NB: Indirectly conditioned/heated spaces - For spaces such as corridors or access areas, which are not serviced by an HVAC system (i.e., have no direct supply of heating or cooling) but are likely to be indirectly conditioned by the surrounding areas due to the high level of interaction with those spaces (allowing the heated air to move freely from the directly conditioned spaces to the indirectly conditioned ones), they should be considered heated or conditioned (indirectly) by the same HVAC system that supplies the most prevalent surrounding area. In this case, you should assign the HVAC system of the main adjacent space to that indirectly conditioned zone also (although the space is not directly conditioned, the energy to overcome any losses from or gains to it is still required via the conditioned zone and, therefore, has to be included in the calculation). An example of this would be an open corridor (to heated offices) or a stairwell next and open to offices, i.e., which might have a few envelope elements but is mostly open to the surrounding conditioned areas and which is not directly conditioned but is conditioned through the movement of air (and heat) from the adjacent offices into the corridor. Furthermore, envelope elements between a (directly) conditioned space and an indirectly conditioned space should be labelled as adjacent to a "conditioned adjoining space" and not to an "unheated adjoining space". On the other hand, if a zone is unheated and totally enclosed thus heated air cannot freely move from a heated zone into it, such as a plant room, a store room, or a toilet, you are advised to define it in iSBEM as "Zones without HVAC".

NB: If there is **more than one type of HVAC system in a space** with each system clearly meant to service a particular part of the space, e.g., one servicing the facade perimeter area and another servicing the core area, then the space should be divided into 2 separate zones in iSBEM (each served by its corresponding HVAC system) even if there is no physical separation (i.e., a wall) between the 2 zones. However, if heating is provided in a zone by two, or more, different types of heat sources, for e.g., a heat pump in a split system and a gas boiler in a wet system, you need to define the parameters of the different heat generators sharing the heating load, as described in the guidance on the bi-valent calculation in Section 3.5.2: Defining HVAC Systems – HVAC Systems tab. On the other hand, if a zone is served by, for e.g., a gas-fired wet system for heating and an electric split system for cooling, then the systems can be approximated in iSBEM by defining your HVAC system type as "split or multisplit", the heat source as "LTHW boiler", and fuel type as "natural gas", and then define the appropriate seasonal efficiency for the heating and energy efficiency ratio for the cooling. SBEM will use natural gas for the heating and grid-supplied electricity for the cooling. If applicable, you then need to define the mechanical ventilation at zone level (for all the zones served by this system) with a suitable ventilation SFP, and heat recovery, if applicable.

2. Are there destratification fans in the zone? (Tick box) - Destratification fans provide additional air recirculation in the zone to ensure even temperature distribution (while these would help reduce heating loads, they would increase auxiliary energy loads).

NB: Destratification may be achieved by several means, for each of which minimum flow rates should be ensured. (Where destratification and heating is provided by the same system, higher flow rates may be needed to avoid excessive air supply temperatures):

- Cased fans installed at high level. The volume of air handled by the fans should be at least equivalent to two room volumes per hour. Total air movement will be higher than this because additional airflow will be induced.
- Open blade “sweep fans”. In this case, air speeds will be lower, and the volume of air handled should be at least the equivalent of 6 room volumes per hour.
- High velocity induction nozzles with a temperature rise through the heater of at least 45ºC. The volume of primary air from the nozzles should be at least equivalent to 0.15 room volumes per hour. Total air movement will be significantly higher because of the additional airflow induced by the nozzles.

NB: If your HVAC system is a high velocity forced-convection air heating (induction nozzle system), which does the job of mixing the air in the zone in a similar manner to destratification fans, then you can model this in iSBEM by first selecting the appropriate HVAC system type (flued or unflued) and then ticking the above box relating to destratification fans in the zones served by that system. The system should follow the flow rate guidelines given for destratification systems shown above. You will then need to justify this to Building Control using the necessary documentation for your system's functions.

Hot Water System

3. HWS - A HWS needs to be selected for:
    1. All occupied zones - Depending on the activity and building type selected for the zone, a standard hot water demand is assumed in the NCM Activity Database. For example, there is a demand assumed to arise from the occupants of an office for activities such as washing hands and washing up cups. This demand is associated with the office rather than the toilet or tea room next door. Thus, the demand from each space needs to be assigned to a HWS even if the system itself is not present (or water drawn off) in the space. If there is more than one HWS serving the building, the HWS that needs to be specified for a zone should be the generator which accounts

for the majority of its demand. A HWS needs to be assigned to every zone defined in iSBEM.

NB: If, based on the user's knowledge of the occupancy of the building, they know that the occupants of a particular zone definitely do not have access to a particular type of shower that is served by the same HWS that also happens to provide the hot water for the zone (i.e., none of the hot water demand from that zone will be diverted through that particular type of shower), the user should define a duplicate HWS (same generator, efficiency, etc., as the first one) but which is not attached to the shower type not accessed by the zone's occupants, and then define the zone as served by the duplicate HWS.

2. Any space with a deadleg within it – As described above, hot water demand is associated with occupied spaces rather than the spaces where the water is drawn off. However, if there is a deadleg within the zone, it needs to be associated with the appropriate system, through the zone it serves.

4. Deadleg length in this zone - Length of the draw-off pipe to the outlet in the space (only used for zones where the water is drawn off, such as toilets and tea rooms). This parameter is used to determine the additional volume of water to be heated because the cold water in the deadleg has to be drawn off before hot water is obtained. This assumes that the hot water system circulation maintains hot water up to the boundary of the zone, or that the pipe runs from circulation or storage vessel within the zone.

NB: Modelling trace heating in iSBEM: As an approximation, it can be considered that the energy used by trace heating is equivalent to that used by a secondary circulation. You can tick the box in the *Building Services* form > *HWS* tab > *General* sub-tab to indicate that there is a secondary circulation and then leave the rest of the secondary circulation related fields blank to be calculated by SBEM. You can also leave the deadleg at the default of 0 m.

Figure 53 shows a zone's HVAC and HWS being defined.

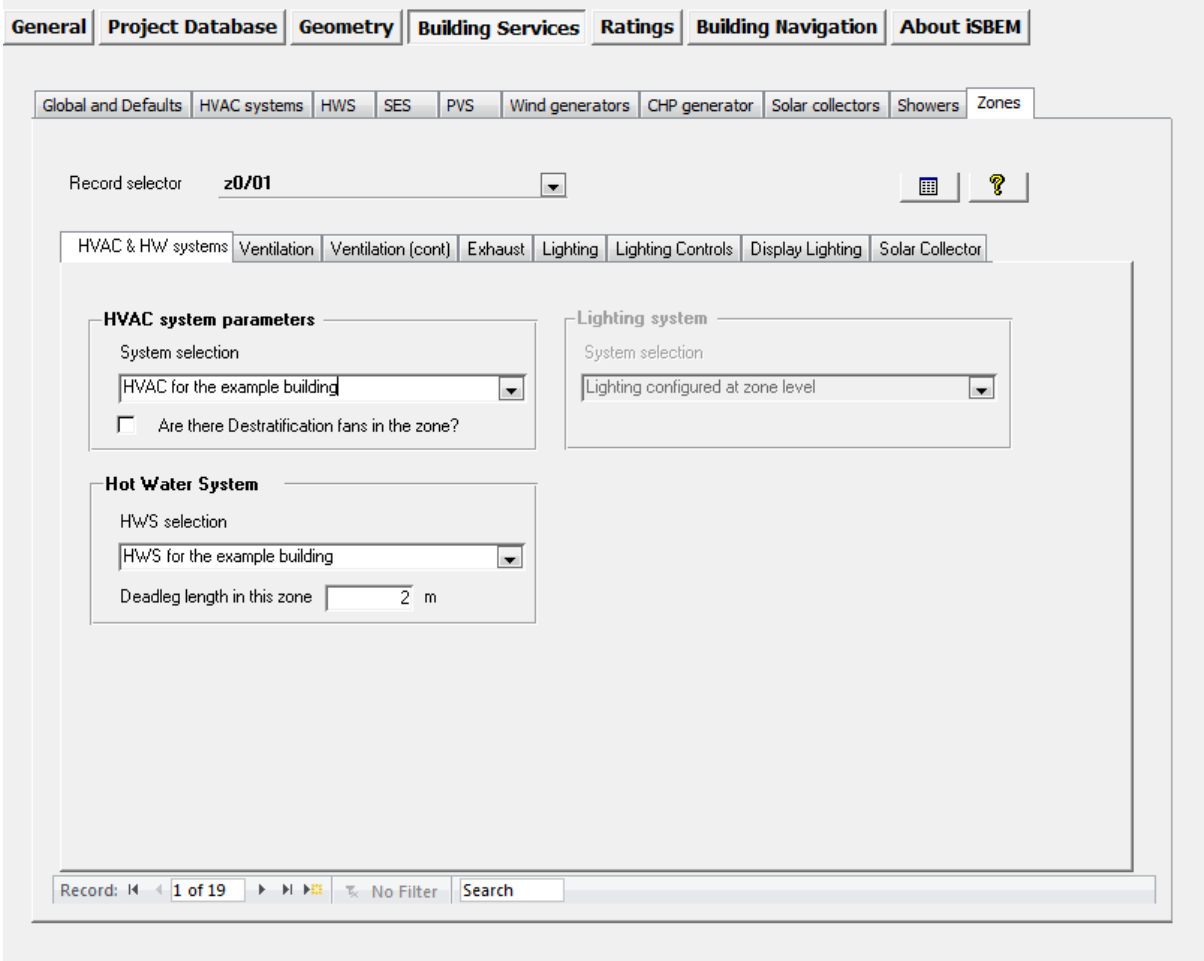


Figure 53: Selecting a zone's HVAC and HWS

Ventilation sub-tab:

This sub-tab is used to specify the type of ventilation system specific for each zone. The following information is required:

Zonal Ventilation Type

1. Zonal ventilation type – A mechanical ventilation system separate from the heating or cooling system (i.e., zonal ventilation) can be added here. If the selected HVAC system does not already include ventilation, the zonal ventilation radio buttons become active. This would be possible, for example, with radiators or under-floor heating. You need to select either: Natural or Mechanical supply & extract, according to whether there is a mechanical ventilation system present in the zone to provide fresh air.

NB: In order to ensure adequate ventilation for maintaining the concentration of CO_2 below 0.5% in spaces served by unflued heating appliances[xix], the zonal ventilation option for these spaces should be set to 'mechanical'.

NB: The supply and extract flow rate for all ventilation systems is set to take the minimum fresh air requirements value from the NCM Activity Database.

[xix] For details, please refer to BS 5925:1991: Code of Practice for Ventilation Principles and Designing for Natural Ventilation.

NB: If you change the HVAC system defined in your project from one that provides mechanical ventilation to one that does not (or vice versa), you must re-visit the Ventilation sub-tab of the Zones tab in the Building Services form for all the zones served by this HVAC System in order for all ventilation-related parameters to be updated by the tool. You may also wish to re-define whether the ventilation is natural or mechanical in these zones following the change in the HVAC type.

If mechanical supply & extract is selected, the following field becomes enabled:

1. Do you know the supply & extract specific fan power? - Here you can either use the default (conservative) value or enter your own SFP for the zonal mechanical ventilation system, in W/(l/s). The SFP of an air distribution system is defined as the sum of the design total circuit-watts, including all losses through switchgear and controls, such as inverters, of the fans in the system that supply air and extract it back outdoor (i.e., the sum of the total circuit-watts of supply and extract fans), divided by the design air flow rate through the system. For further details on the SFP and how it is calculated, see the Approved Documents. **NB:** The default SFP value may not necessarily comply with the current Building Regulations.

NB: If the SFP was calculated or measured for a mechanical ventilation system that already included heat recovery, then that is the value you enter into iSBEM. If the SFP was calculated or measured for a mechanical ventilation system before a heat recovery system was added on, then you need to add 0.15 to the SFP for a thermal wheel system, and 0.3 for any of the other heat recovery options in iSBEM, to account for the additional resistance.

Demand-Controlled Ventilation

2. If applicable, you need to select from the drop-down menu the type of demand-controlled ventilation applicable in the zone. This parameter becomes active if the zone is not served by an HVAC system that provides mechanical ventilation, i.e., the ventilation is defined at zone level. If the zonal ventilation type is defined as 'Natural', then the options available in the drop-down menu are: 'No demand-controlled ventilation' and 'Enhanced ventilation'. If the zonal ventilation type is defined as 'Mechanical', then the options available in the drop-down menu are: 'No demand-controlled ventilation', 'Demand control dependent on number of occupants', and 'Demand control dependent on gas sensors'.
3. Flow regulation type – This parameter becomes active if the demand-controlled ventilation type in the previous parameter is selected to be either 'Demand control dependent on number of occupants' or 'Demand control dependent on gas sensors'. It specifies whether the air flow regulation type for the demand-controlled ventilation in the zone is via: 'Damper control' or 'Speed control'.

High Pressure Treatment

4. Does the activity area require high pressure drop air treatment? – This option caters for activities that inherently demand the use of high pressure drop air treatment, including HEPA filtration. This may occur in hospitals (areas such as operating theatres and intensive care suites), airports (to keep aviation fumes out), some museums and libraries (with sensitive exhibits), commercial kitchens (odour filters, grease traps, filters to protect the odour filters, etc.), some industrial processes, and in buildings designed to withstand a biological attack. Here, you can either let iSBEM take this parameter from the NCM Activity Database, or you can select to tick or untick the relevant box manually.

   NB: If you do tick the box manually, you may be expected to provide justification to your claim for high pressure drops to Building Control.

Figure 54 shows a zone's ventilation characteristics being defined.

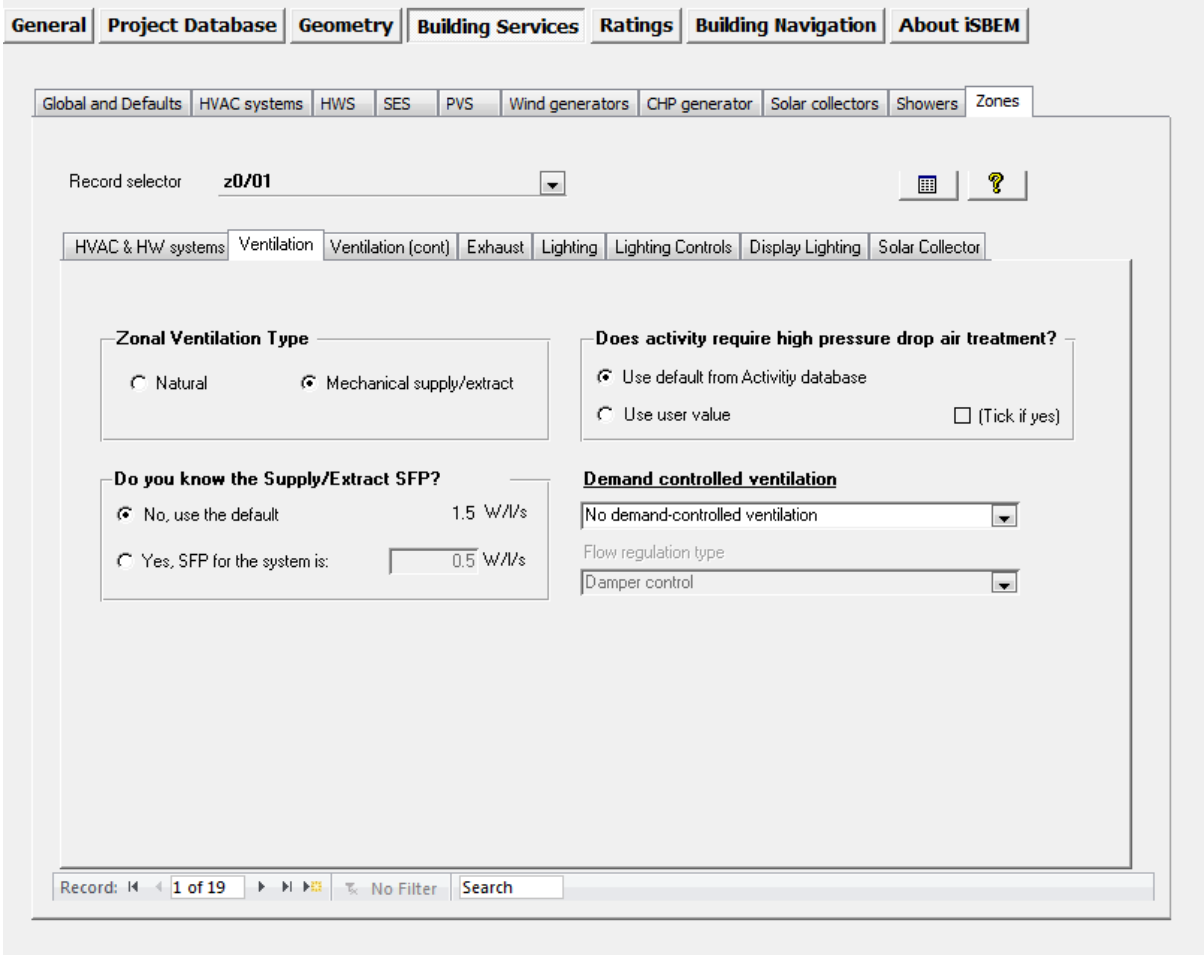


Figure 54: Defining the zone ventilation in the Ventilation sub-tab

Ventilation (cont) sub-tab:

This sub-tab is used to specify the type of heat recovery, if applicable, in the ventilation system specific for each zone. It is also used to define the SFP of the terminal unit if applicable depending on the HVAC system serving the zone. The following data can be entered:

Heat recovery

1. Heat recovery – Here you need to select from: No heat recovery, Plate heat exchanger (Recuperator), Heat pipes, Thermal wheel, and Run around coil (see Table 6 for a brief descriptions of the options). This parameter is active if the zonal ventilation type is selected to be mechanical.
2. Heat recovery seasonal efficiency - This parameter is active if a heat recovery system is selected, i.e., the previous parameter is not set to 'No heat recovery'. If you know the heat recovery efficiency, it can be introduced manually into the interface, as a ratio. Otherwise, a default value will be used by SBEM.
3. Tick box to denote whether the heat recovery system efficiency is variable - This parameter is active if a heat recovery system is selected above. This refers to whether heat recovery can be bypassed or switched off in summer.
4. Do you know the terminal unit specific fan power? - Here you can either use the default value or enter your own SFP for the terminal unit, in W/(l/s). This parameter becomes active if the HVAC serving the zone is selected to be 'Fan coil systems' or

'Indoor packaged cabinet (VAV)' in the *Building Services* form > *HVAC Systems* tab > *General* sub-tab.

NB: If the HVAC system selected is 'Fan coil systems' or 'Indoor packaged cabinet (VAV)', the SFP input in the *Building Services* form > *HVAC Systems* tab > *System Adjustments* sub-tab, should be for the central plant, and then the SFP for the terminal units can be input in this sub-tab for all the zones served by this HVAC system.

5. Tick box to denote whether a night cooling (NC) strategy operates in the zone. If this box is ticked, then the following parameters become active:
    a. Max. hours of NC per month – This is the maximum number of hours per month during which night cooling is operating in the zone.
    b. Max. flow rate during NC hours – This is the maximum air flow rate in the zone, in l/s.m^2 of floor area, during the operation of night cooling.
    c. Do you know the specific fan power for the night cooling unit? - Here you can either use the default value in iSBEM or enter your own SFP for the night cooling unit, in W/(l/s). For further details on the SFP and how it is calculated, see the Approved Documents.

NB: Note that iSBEM is not a design tool, and so should not be used to make strategic design decisions, such as deciding whether or not to install a night cooling system, or for system sizing. If the performance of a particular feature is critical to a building's design, even if it can be represented in iSBEM, the most appropriate modelling tool for design purposes should be used. Once the valid design configuration has been decided using the appropriate modelling tool, the relevant parameters can then be input into iSBEM in order to assess the building's compliance with building regulations or generate an EPC.

Figure 55 shows a zone's ventilation characteristics being defined.

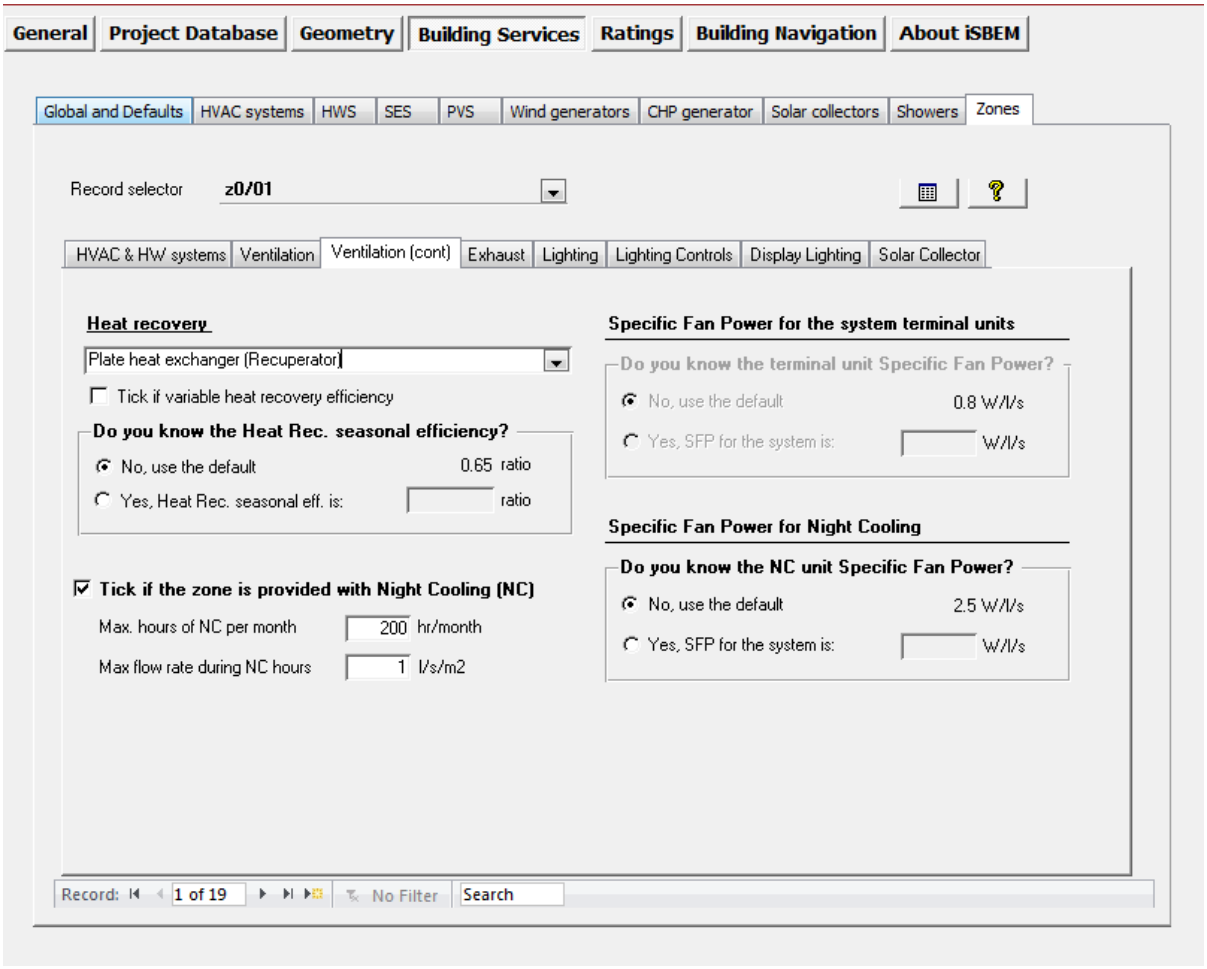


Figure 55: Defining the zone ventilation in the Ventilation (cont.) sub-tab

Exhaust sub-tab:

This sub-tab is used to specify the characteristics of a mechanical exhaust system in the zone, if applicable. The following information is required:

Local Mechanical Exhaust

1. Is there mechanical exhaust in the zone? – An example of when this would be used is in a toilet. This tick box is enabled for all types of HVAC systems serving the zone.

   If the above tick box is ticked (i.e., there is mechanical exhaust in the zone), then the following fields become active:

   a. Local mechanical exhaust - This is the flow rate of air leaving the zone, in l/s.m^2 of floor area. Guidance on typical figures for this parameter could be found in CIBSE Guide F Part A (Table 7.2, Basic fan capacity benchmarks). **NB:** iSBEM requires the exhaust flow rate in l/(s.m^2) of floor area while the values in the CIBSE Guide are given in l/(s.m^3). Use the zone height to convert the CIBSE values into the units required by iSBEM.

   b. Do you know the exhaust specific fan power? - Here you can either use the default value in iSBEM or enter your own SFP for the zonal mechanical exhaust system, in W/(l/s). **NB:** The default value may not necessarily comply with the current Building Regulations.

   c. Scope of exhaust system – Here you can use the radio buttons to specify whether the exhaust fan is remote from the zone (i.e., the exhaust system

serves multiple spaces) or within the zone (i.e., a local window/wall/roof unit such as in a toilet).

Figure 56 shows a zone's exhaust characteristics being defined.

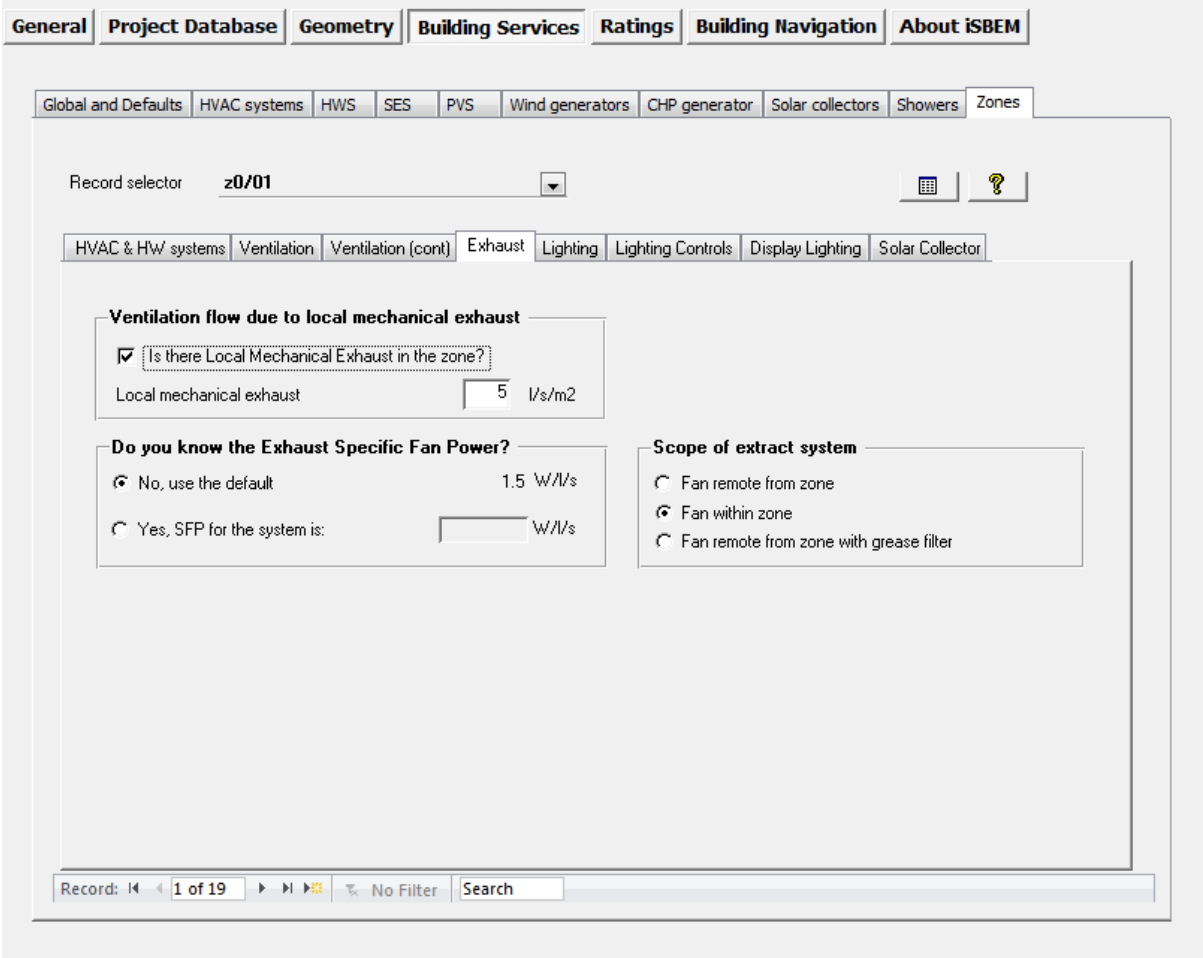


Figure 56: Defining the zone mechanical exhaust in the Exhaust sub-tab

Lighting sub-tab:

In the *Lighting* sub-tab, each zone needs to be selected in turn and the following data entered:

1. Design illuminance in Lux for that zone – Here you can input the design illuminance for the zone, if this is known, with any of the 3 options listed below.

   NB: If the Lux level is left blank, the minimum illuminance level from the NCM Activity Database will be used in the calculation, and the value of this minimum illuminance will also become visible in iSBEM to the right-hand side of the blank input box (see Figure 57).

2. What information is available on lighting? – Here, you need to choose from the following three options:

   a. Full lighting design carried out - where you need to enter the following (data usually available from the lighting design engineer for a new building):

      i. the total power in Watts

b. Lighting chosen but calculation not carried out - where you need to specify:

   i. the average initial (100 hour) light source (lamp) plus ballast efficacy for the lighting in the zone in light source -lumens per circuit-Watt and

   ii. the light output ratio (LOR) of the luminaire.

NB: If the value available is the luminous efficacy of the luminaire, rather than that of the light source, e.g., in case of some LEDs, then you can enter that value into iSBEM and enter an LOR of 1.

c. Lighting parameters not available (where you need to choose the lamp type from a drop-down list) – usually for existing buildings. The luminous efficacy used by SBEM when each of the lamp types is selected is shown in Table 12. If you cannot find your lamp type on the list, you can select the one with the closest luminous efficacy.

NB: If the first option is selected, and the wattage is left blank, a (pessimistic) default value is used by iSBEM.

NB: The luminous efficacy values used by SBEM in association with the available lamp type options are pessimistic (Table 12).

NB: If you know that the lamps are fluorescent but have no further details, you should select the option 'Fluorescent (No details)'.

Lamp Type	Luminaire lumens per circuit Watt			
	For all buildings except those specified in the next column		For modular or portable "distress purchase" buildings with a planned time of use in a single location of ≤ 2 years	
	Side-lit and not daylit activities	Top-lit activities	Side-lit and not daylit activities	Top-lit activities
LED	50.0	50.0	*55.0*	*55.0*
Tungsten and Halogen	7.5	9.0	7.5	9.0
Fluorescent - compact	22.5	27.0	22.5	27.0
T12 Fluorescent - halophosphate - low frequency ballast	25.0	30.0	25.0	30.0
T8 Fluorescent - halophosphate - low frequency ballast	27.5	33.0	*55.0*	*55.0*
T8 Fluorescent - halophosphate - high frequency ballast	32.5	39.0	*55.0*	*58.5*
T8 Fluorescent - triphosphor - high frequency ballast	36.3	43.5	*55.0*	*65.3*
Metal Halide	25.0	39.0	25.0	39.0
High Pressure Mercury	22.5	27.0	22.5	27.0
High Pressure Sodium	35.0	42.0	35.0	42.0
T5 Fluorescent - triphosphor-coated - high frequency ballast	37.5	45.0	*56.3*	*67.5*
Fluorescent (no details)	22.5	27.0	22.5	27.0

Table 12: Luminous efficacies used by SBEM in correspondence to the lamp types selected (from England's 2021 NCM Modelling Guide)

NB: Less pessimistic default luminous efficacy values are used during the calculation for some lamps only in "distress-purchase" modular and portable buildings with a planned

time of use in a single location of 2 years or less (see Table 12), as defined in England's 2021 ADL2.

NB: The total wattage value that is entered into iSBEM is for the lighting system, i.e., it should include the luminaires and ballasts (control gear).

NB: The design illuminance, in Lux, is that for which the full lighting design has been carried out. The maintained illuminance at the end of the lamp life and before cleaning of the luminaires should not be less than the design illuminance. This value will be used, along with the total wattage value, in order to determine the consequent power density values associated with the lighting system used in W/m^2 per 100 lux. This value will, in turn, be used to calculate the electrical consumption of an equivalent system which delivers, at least, the illuminance levels specified in the NCM Activity Database. The calculated lighting energy consumption will be higher than you expect if the design illuminance entered is lower than the database's minimum illuminance for the activity (see England's NCM Modelling Guide for details). Changing the activity in a zone will change the corresponding illuminance retrieved from the NCM Activity Database. You can download the NCM Activity Database from the NCM website if you wish to view the illuminance values associated with each activity type.

3. Are air-extracting luminaires fitted? – Select: Yes or No/don't know.

Figure 57 shows the lighting characteristics of a zone being defined.

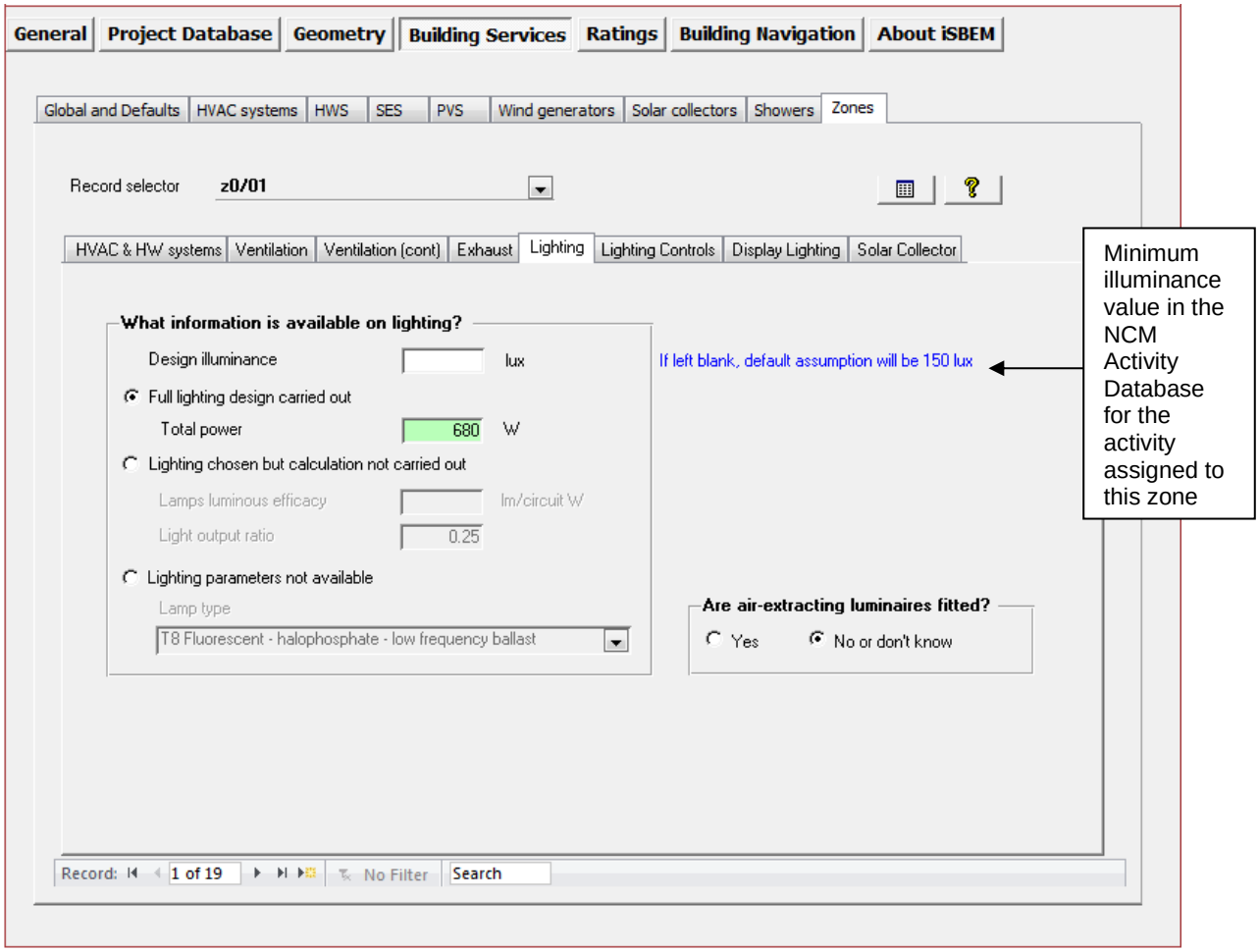


Figure 57: Defining the zone lighting characteristics in the Lighting (General) sub-tab

Lighting Controls sub-tab:

In this sub-tab, each zone needs to be selected, and the controls relating to its lighting need to be defined:

1. Light controls - Here you need to indicate, by ticking the relevant boxes, whether there are: No local controls (i.e., the lighting is centrally controlled according to the occupancy schedules from the NCM Activity Database for the activity selected for this particular zone), Local manual switching, and/or Photoelectric controls present by ticking none, both, or one of the two tick boxes, or constant illuminance control.

   NB: Local manual switching is where the occupants can control their own luminaries individually, and each light switch must be less than six metres from the luminaries it controls (it could be a hand-held controller such as infra-red).

   NB: Constant illuminance control: In installations where a dimmable lighting system is provided, it is possible to automatically control and reduce the initial luminaire output to just provide the required maintained illuminance. Such schemes are known as "controlled constant illuminance" systems. These schemes will also benefit from reduced energy use. As the light output decays with time, the controls raise input power to the luminaire to compensate. When the power demand equals the installed power, the lighting system requires maintenance such as cleaning luminaires, changing lamps, cleaning room surfaces, etc. [BS EN 15193:2007 - *Energy performance of buildings — Energy requirements for Lighting*].

   If the "Photoelectric option" is ticked, the following fields become active:

   a. Photoelectric options - Here you need to choose between: Switching and Dimming.

   b. Indicate whether there is a different sensor to control the lighting in the back half of the zone (tick box), i.e., the half furthest from the window.

   c. Select the type of photoelectric sensors from the available options: Stand-alone sensors or (digitally) addressable systems.

   If either the "Photoelectric" option, "constant illuminance control" option, or both are ticked, the following field becomes active:

   d. Parasitic power for photoelectric controls and/or constant illuminance control – Enter the parasitic power consumption of the photoelectric and/or constant illuminance control system in W/m^2 if you know it. Otherwise, the following defaults will be used by SBEM: 0.3 W/m^2 if the type of sensors in the previous field is selected as 'Stand-alone sensors' and 0.57 W/m^2 if 'Addressable systems' is selected (digitally addressable systems are for special applications and are not particularly energy efficient).

      NB: Values for the parasitic power need to be reasonable. Otherwise, the benefits due to the use of photoelectric controls and/or constant illuminance control may be negated by the extra electrical consumption required by the controls equipment.

2. Automatic daylight zoning for lighting controls? – This parameter is active if one or both of the above tick boxes on lighting controls are ticked. If you select 'Yes', then SBEM will automatically sub-divide the zone into daylighting zones, if needed, following the zoning rules for zones with windows and rooflights, and you do not need to sub-divide it yourself. If you select 'No', then you need to specify the percentage area of the zone where the lighting is controlled so as to respond to daylight (whether by a photosensor or manual control). If that percentage is 100%, this means that the whole area of the zone has lighting controls that respond to daylight, and SBEM will perform no further sub-divisions for this zone, i.e., you have

already done the sub-division manually yourself. If the percentage value that you enter is less than 100%, for e.g., 70%, then SBEM will sub-divide the zone into two daylight zones whose areas are 70% and 30% of the total area of the zone, respectively. SBEM will then consider that the 70% daylight area will have lighting controls responding to daylight while the lighting in the 30% daylight area will not be affected by daylight.

NB: In the event that your zone has an atypical layout of windows and/or rooflights, for e.g., the glazing is not evenly distributed across the whole area of the wall or roof, then SBEM's simplified automatic sub-division might not correctly reflect the access to daylight in the zone, and you are advised to carry out the daylighting sub-division yourself in this case, following the zoning rules.

3. Occupancy Sensing – Here, you need to select what kind of occupancy sensing the zone has, if applicable, from the available options shown in Table 13. If occupancy sensing is available in the zone, the following field becomes active:

    a. Parasitic power for occupancy sensing – Enter the parasitic power consumption of the occupancy sensing in W/m^2 if you know it. Otherwise, the default value of: 0.3 W/m^2 will be used.

    NB: Values for the parasitic power need to be reasonable. Otherwise, the benefits due to the use of occupancy sensing may be negated by the extra electrical consumption required by the controls equipment.

    NB: If the zone is a corridor or other circulation area, dry sports, changing room, swimming pool, sales area, cold store, display area, or performance area (stage), then the types of occupancy sensing that can be applied are "AUTO-ON-DIMMED" and "AUTO-ON-OFF" only. If any other type is selected for these activities, SBEM will disregard it during the calculation, i.e., no benefit will be considered for the zone lighting from occupancy sensing.

Type of Occupancy Sensing Control in iSBEM	Brief Description
MAN-ON-OFF+EXT	Lights manually switched on and off, with the addition of an automatic extinction signal.
AUTO-ON-DIMMED	Lights automatically switched on whenever people enter a room and dimmed to a low level when no movement has been detected for a set time (usually 5-15 minutes).
AUTO-ON-OFF	Lights automatically switched on whenever people enter a room and switched off when no movement has been detected for a set time (usually 5-15 minutes).
MAN-ON-DIMMED	Lights manually switched on and automatically dimmed to a low level when no movement has been detected for a set time (usually 5-15 minutes).
MAN-ON-AUTO-OFF	Lights manually switched on and automatically switched off when no movement has been detected for a set time (usually 5-15 minutes).
NONE	No occupancy sensing

Table 13: Types of occupancy sensing controls available in iSBEM

Figure 58 shows the lighting controls in a zone being defined.

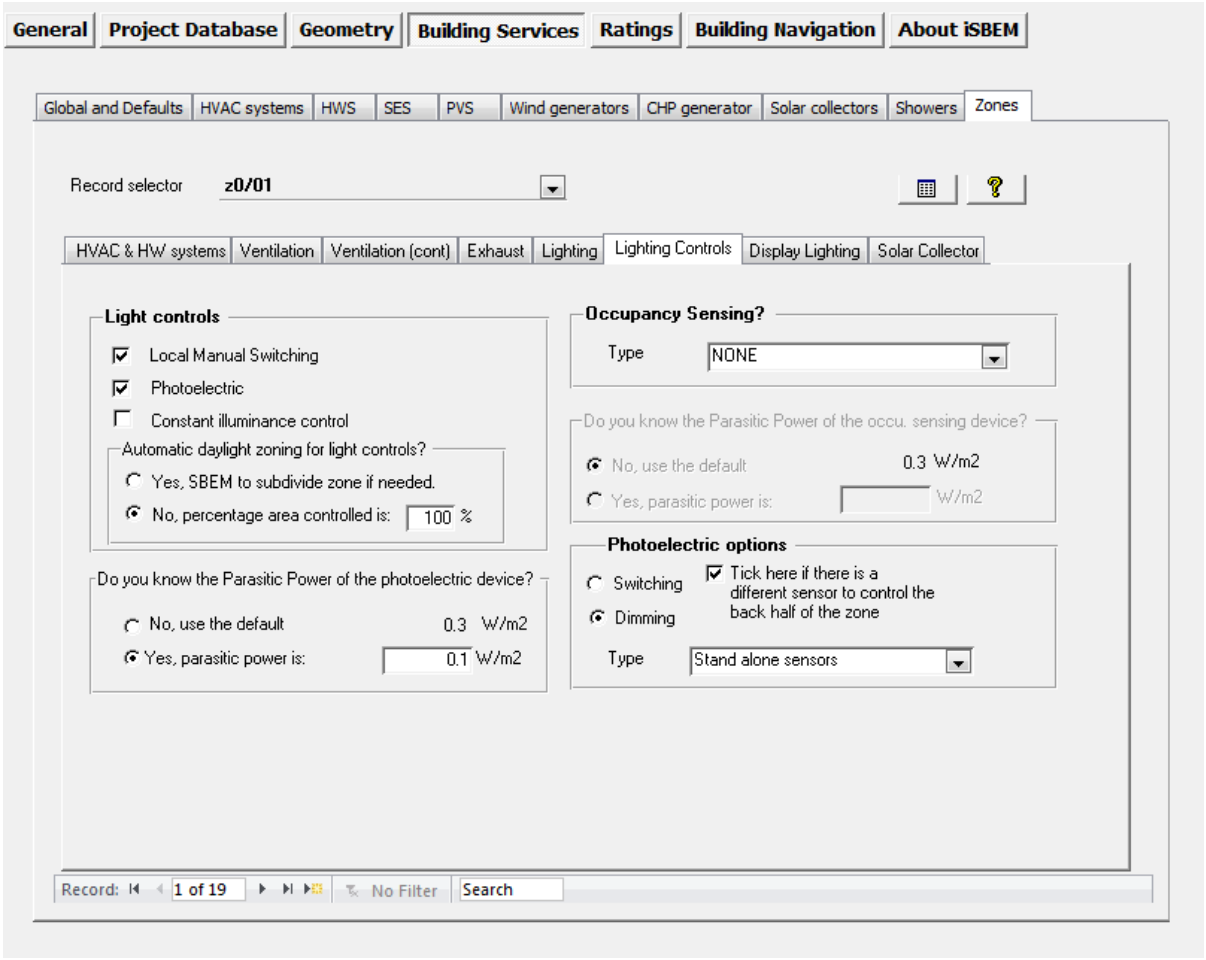


Figure 58: Defining the lighting controls characteristics of a zone

Display Lighting sub-tab:

This sub-tab is active for a particular zone only if by nature of the activity selected for the zone, display lighting is applicable as per the NCM Activity Database, e.g., retail. In the *Display Lighting* sub-tab, each zone needs to be selected in turn and the following data entered:

1. Does display lighting use efficient light sources (lamps)? – Select: Yes or No/don't know. If "Yes" is selected, then the average light source and ballast efficacy in light source-lumens per circuit wattage needs to be entered for the display lighting (only applies if there is display lighting in the space by nature of its selected activity).

   NB: For the purposes of the lighting calculations in SBEM, efficient display lighting is one with a light source and ballast efficacy better than 15 light source-lumens per circuit-Watt. Examples of efficient display lighting light sources include: metal halide, compact fluorescent, and white SON (high pressure sodium).

2. Time Switching for display lighting? - Select: Yes or No/don't know.

Figure 59 shows the display lighting characteristics and controls for a zone being defined.

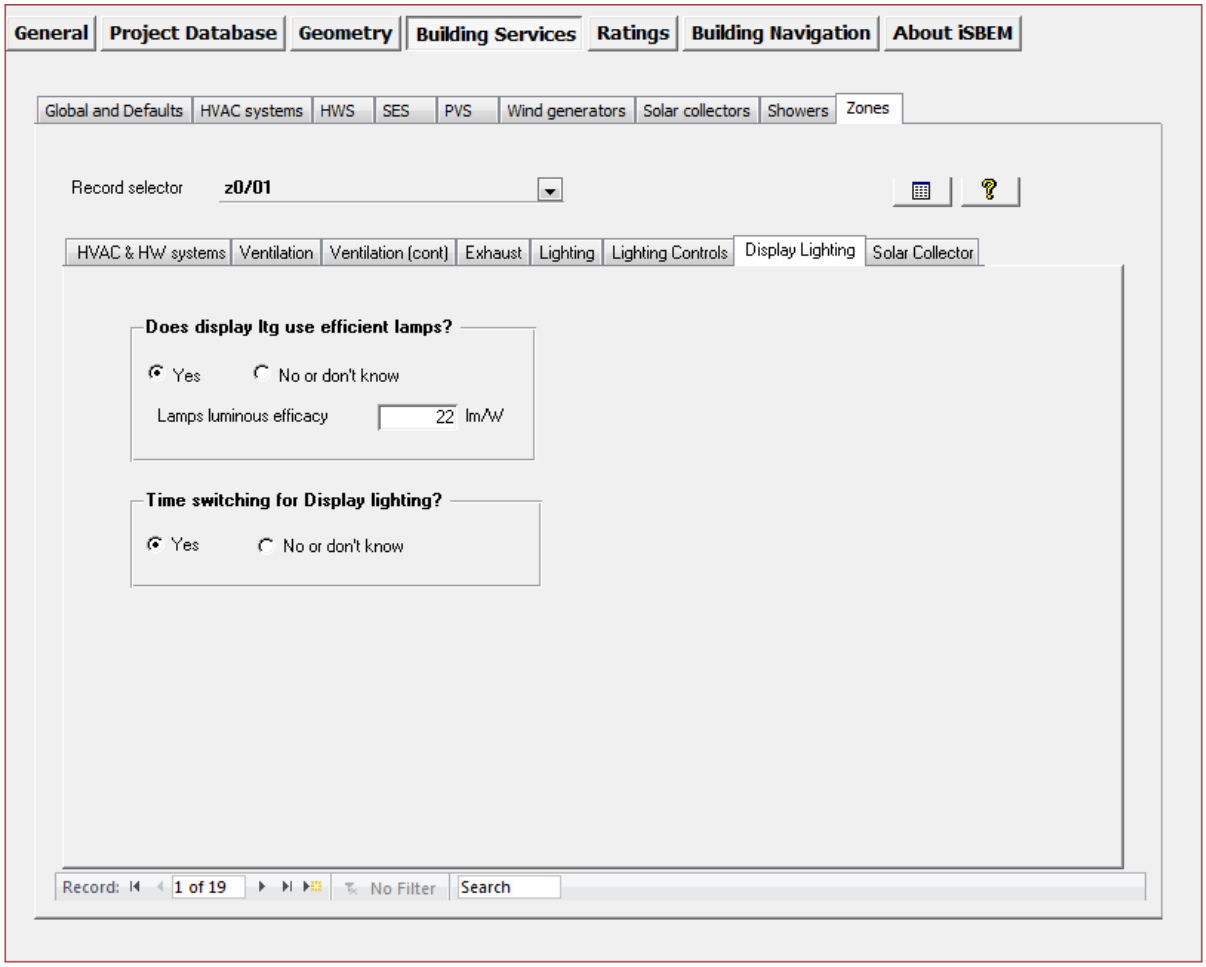


Figure 59: Defining the zone display lighting in the Display Lighting sub-tab

Solar Collector sub-tab:

The sub-tab (see Figure 60) is used to specify the solar collector (SC) system serving the zone, if applicable. The following information can be input:

3. You need to select from the drop-down list (of the solar collector systems you have already defined in the *Building Services* form > *Solar Collector* tab) the name of the SC system which serves the zone, if applicable.
4. Percentage of the total air pre-heated by the SC system that is supplied to this zone. The sum of the values input for the zones in the building connected to the SC system should not exceed 100%.

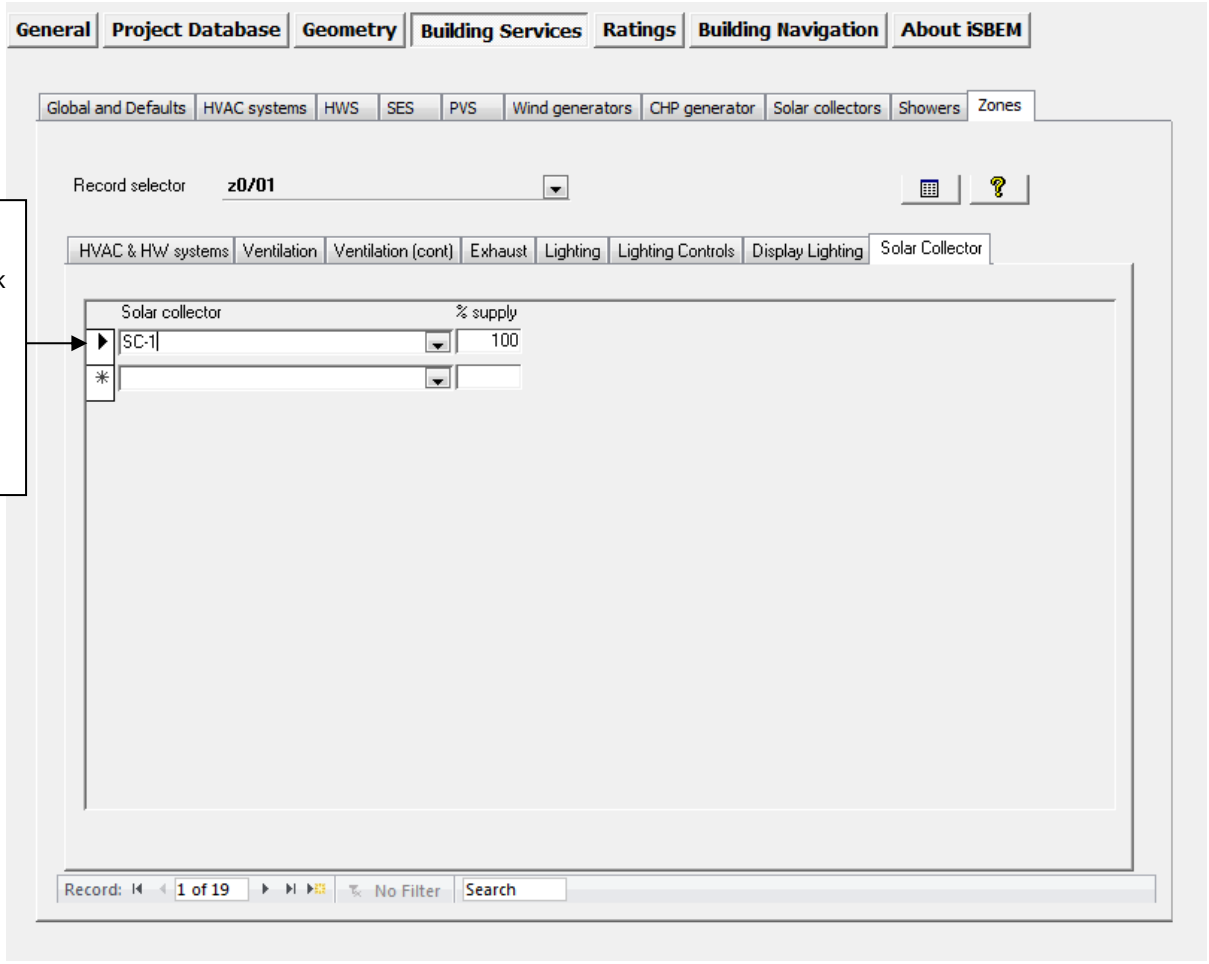


Figure 60: Defining contribution to a zone from a solar collector in the Solar Collectors sub-tab

Task 16: Assign each zone to the appropriate HVAC and HWS, and define the ventilation and lighting strategies for each of the zones

Details can be found in Section A.1 under Systems. For each zone, click into the *Zones* tab in the *Building Services* form. Select each of the zones in turn using the record selector and enter the required information.

3.6. Building Navigation form

This form allows the user to navigate through the project in order to view summaries of the different types of building objects that have been defined, as well as some detailed information about individual objects. This form contains 2 tabs:

1. **Selections** tab
2. **Object Properties** tab

3.6.1. Selections tab

In this tab (Figure 61), depending on which radio button is selected in the 'Objects' section, you can choose to view either: HVAC systems only, HVAC systems and zones only, HVAC

systems, zones, and envelopes only, or HVAC systems, zones, envelopes, windows, and doors. Depending on which radio button is selected in the 'Assignment Status' section, you can choose to view either: Assigned objects only, Unassigned objects only, or both. Also, by ticking the box in the 'Objects' section, you can choose to also view other building objects, such as constructions, HWSs, SES, etc. The objects are then listed in the left-hand side 'Object Tree' window in terms of their names and types. The 'Key to Objects' section contains the key to the symbols used to denote the types of objects.

There is a 'Refresh' button which you can click on in order to manually initiate the refreshing of the contents of the *Building Navigation* form, if the relevant tick box in the *General* form > *File Options* tab > *System Configuration* sub-tab is unticked. It the box is ticked, the contents of the *Building Navigation* form will be refreshed automatically with any changes in the objects properties that might have been performed since the *Building Navigation* form was last accessed (see Section 3.2.1: File Options tab).

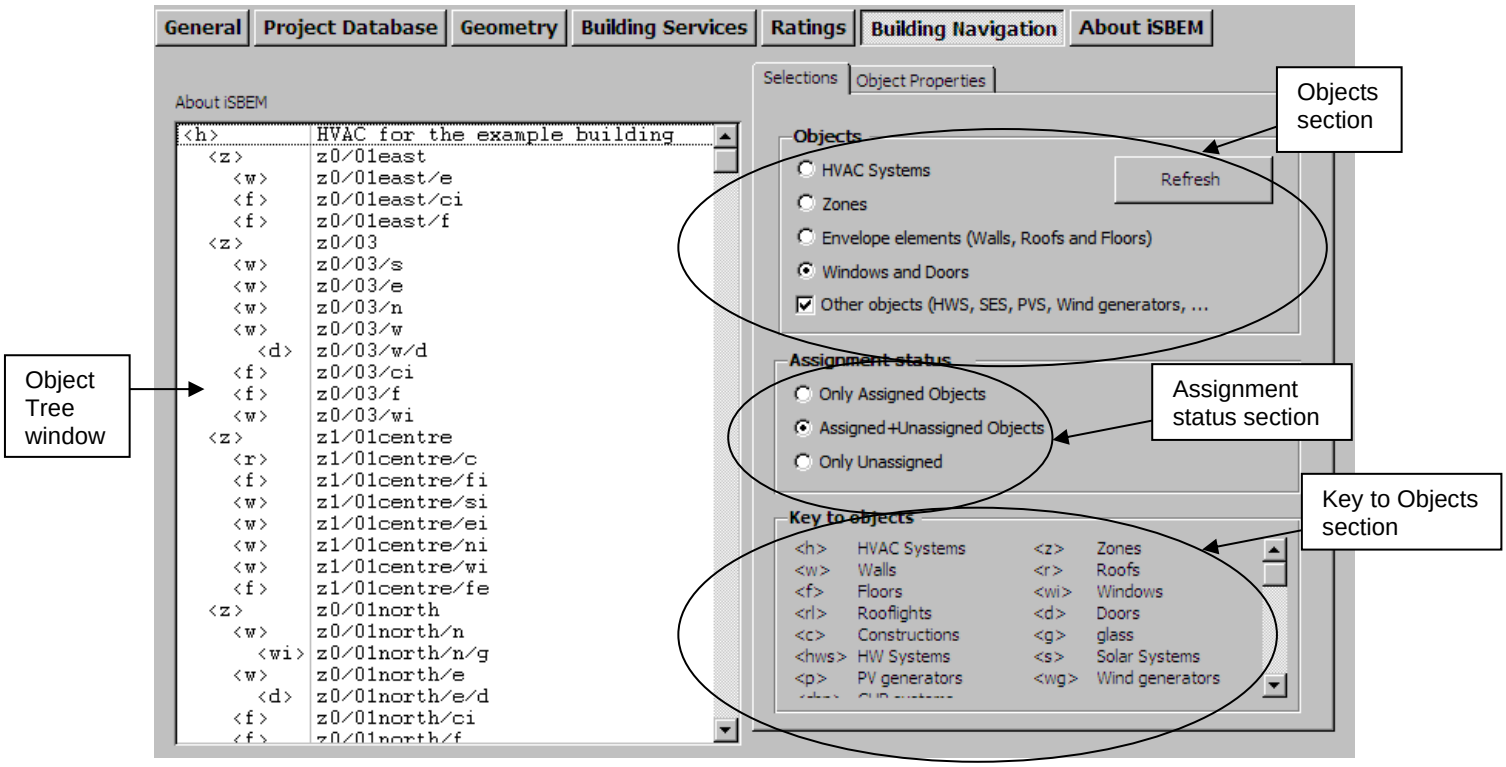


Figure 61: Selections tab in the Building Navigation form

3.6.2. Object Properties tab

In this tab (Figure 62), if any of the objects listed in the 'Object tree' window is highlighted, more details about that object's properties appear in the 'Objects properties' window on the right. For example, if the highlighted object is an envelope, the details displayed will be its area, construction, and the condition of the adjoining space, etc.

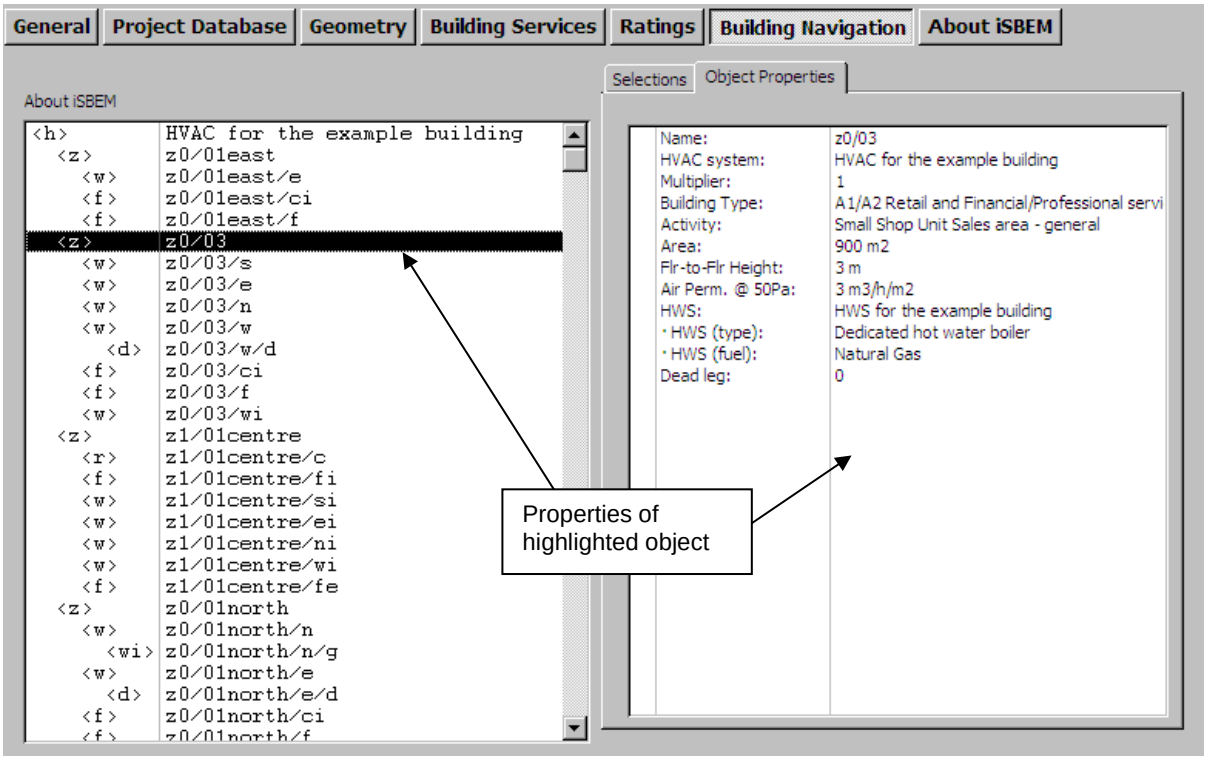


Figure 62: Objects Properties tab in the Building Navigation form

3.7. About iSBEM form

This form displays information about the iSBEM software, licensing conditions, and acknowledgement. There is no data entry in this form.

3.8. Double-checking the data

It is advisable to always double-check the data entered for any project, in order to ensure that the building is modelled correctly, before running the energy performance calculation and compliance checking. There are several tools within iSBEM to facilitate this:

- **The Objects reports** - These reports can be accessed from all of the forms in the interface by pressing the *Object Reports* button:  This can be found at the top right-hand side of all the tabs in the *Project Database*, *Geometry*, and *Building Services* forms, the bottom of the *Building Regulations Check* tab in the *Ratings* form, and in the *File Options* tab in the *General* form. There are two reports available in iSBEM to help the users check their data entry.
    1. **The Unassigned Objects report** which lists all the objects which have been created/defined but not assigned to any other object.
    2. **The Data Summary report** which provides a hierarchical summary of all the building objects that have been defined and assigned along with key details on some of the objects.
- **The Assigned sub-tabs** - Wherever objects in iSBEM require that they be assigned to another object, there is usually a sub-tab which lists which objects have been assigned.

- **The Summary sub-tabs** – Similar to the *Assigned* sub-tabs and used for objects defined in the *Geometry* form.
- **The Building Navigation form** – Provides a hierarchical summary of all the objects that have been defined in the project, assigned and unassigned, along with key details on some of the objects.

3.8.1. The Unassigned Objects Report

The *Unassigned Objects* Report is a simple list of all the objects which have been created but not assigned. They are grouped into two categories: *Unassigned Building Objects* and *Other Unassigned Objects*.

The *Unassigned Building Objects* (in **red** text) include all the zones, envelope elements, windows, doors, HVAC systems, HWSs, and SESs that have been created in iSBEM but not assigned. These are critical unassignments, i.e., you should not run the calculation until they are addressed.

The *Other Unassigned Objects* (in **blue** text) include any construction or glazing types which have been created but not assigned to any of the envelope elements, windows, or doors. These are non-critical unassignments, i.e., you can still run the calculation.

Figure 63 shows that there are 5 zones which have not been assigned to an HVAC system. The user would then need to go into the *Geometry* form > *Zones* tab or the *Building Services* form > *Zones* tab in order to assign each zone to an HVAC system. The figure also shows that there are no non-critical unassignments.

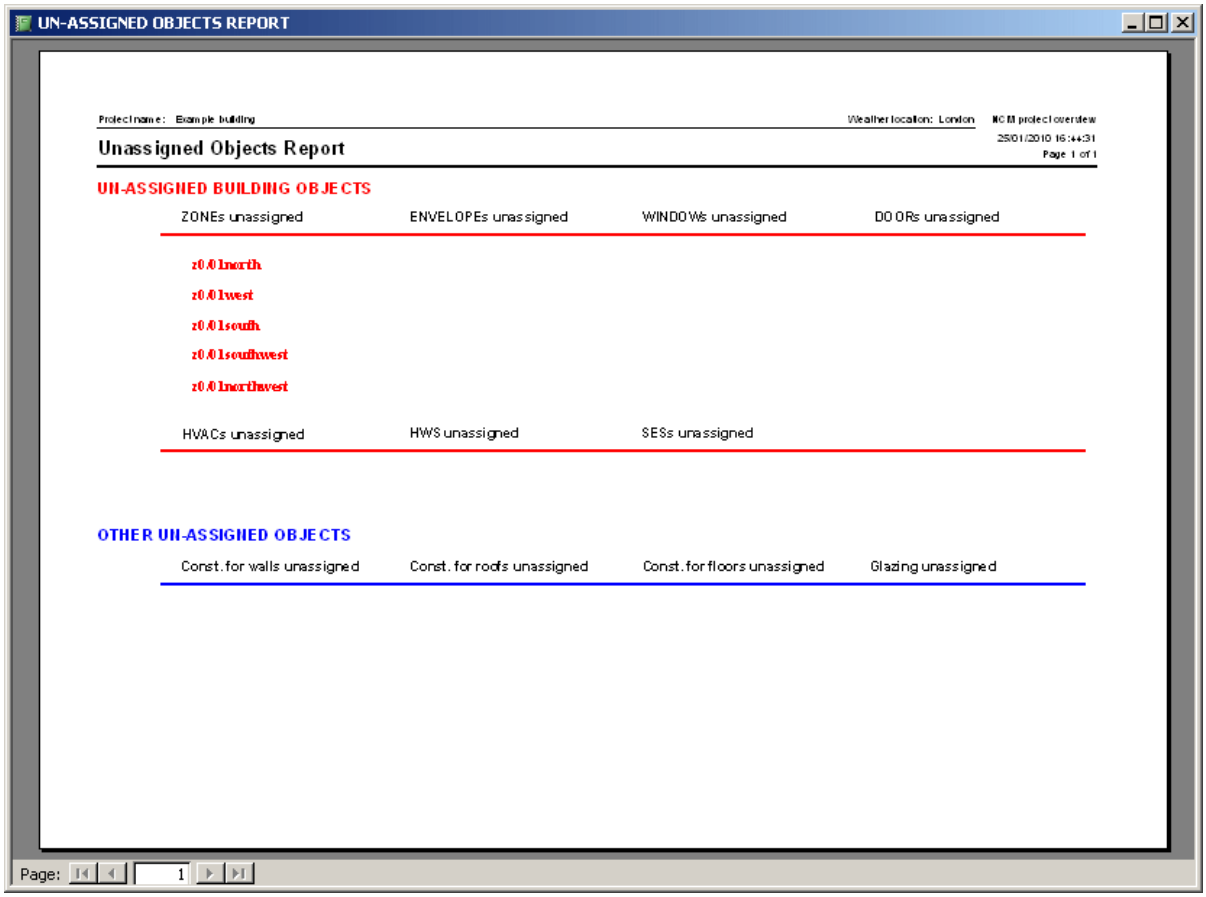


Figure 63: The Unassigned Objects Report

3.8.2. The Data Summary Report

The *Data Summary* Report has a double layer structure:

- The first layer is in **black** text and is a tree structure of all the building objects that have been defined and assigned, reflecting the hierarchical relationship of the building objects (HVAC -> Zone -> Envelope -> Window / Door / Envelope Thermal bridge).
- The second layer is in **blue** text and provides key information about each of the listed objects.

The assignment tree structure (black):

The first column lists the HVAC system status of the zone, the highest element in the hierarchy. The next column lists all of the zones that are assigned to that HVAC system. All the zones that have no HVAC system are listed first (see Figure 64) followed by those that do (Figure 65). The next column lists all of the zone's envelope elements, followed by the envelope elements' additional thermal bridges, windows, the windows' additional thermal bridges, and finally any doors with their additional thermal bridges.

Summary information (blue):

To the right of each zone, envelope element, and window or door name is a selection of its key parameters/details. For example, to the right of any zone, you will find its activity type

and its area. To the right of an envelope element, you will find which type of envelope it is (wall, roof, ceiling/floor), what sort of space it adjoins, its construction type, and its area. To the right of a window, you will find its glazing type and its area, and for a door, its construction and its area.

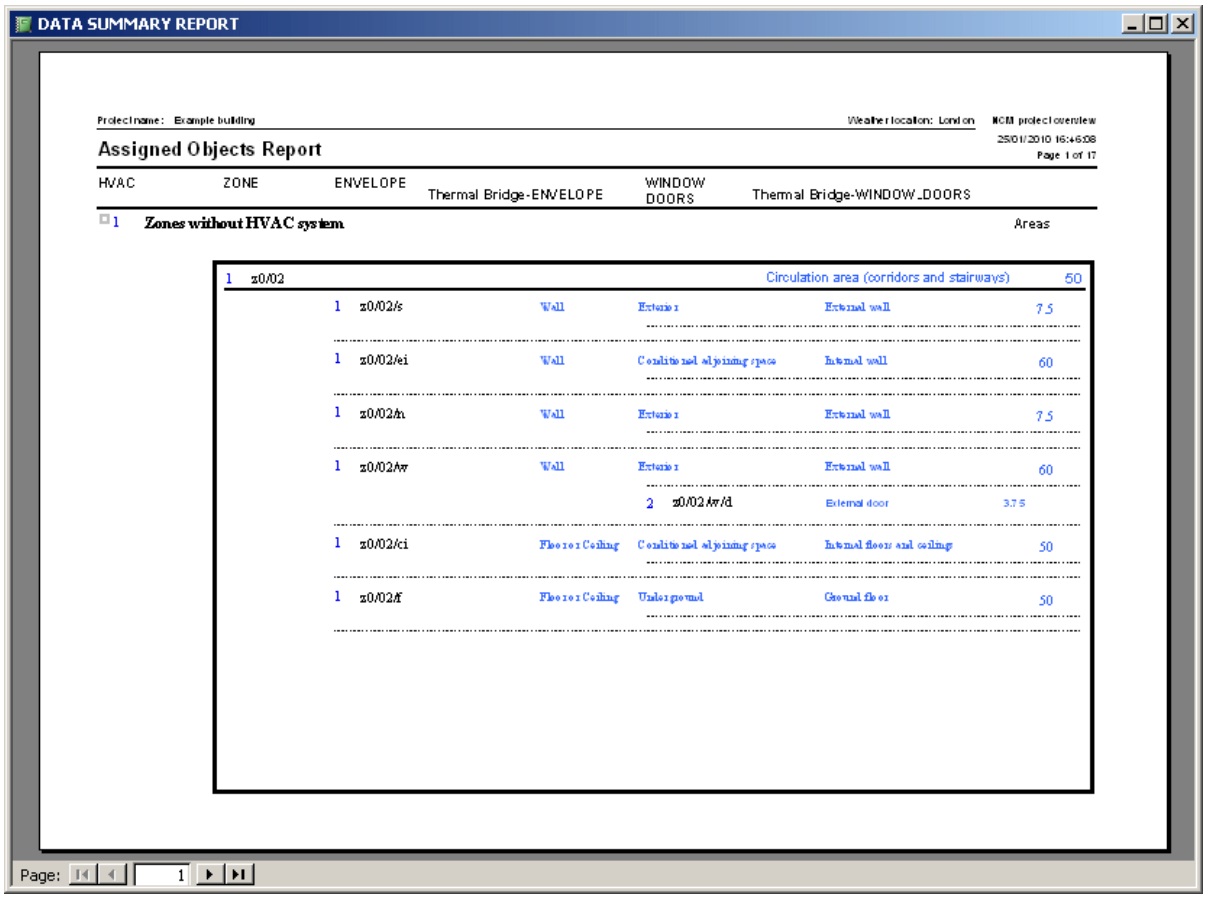


Figure 64: Data Summary Report: Zones without HVAC

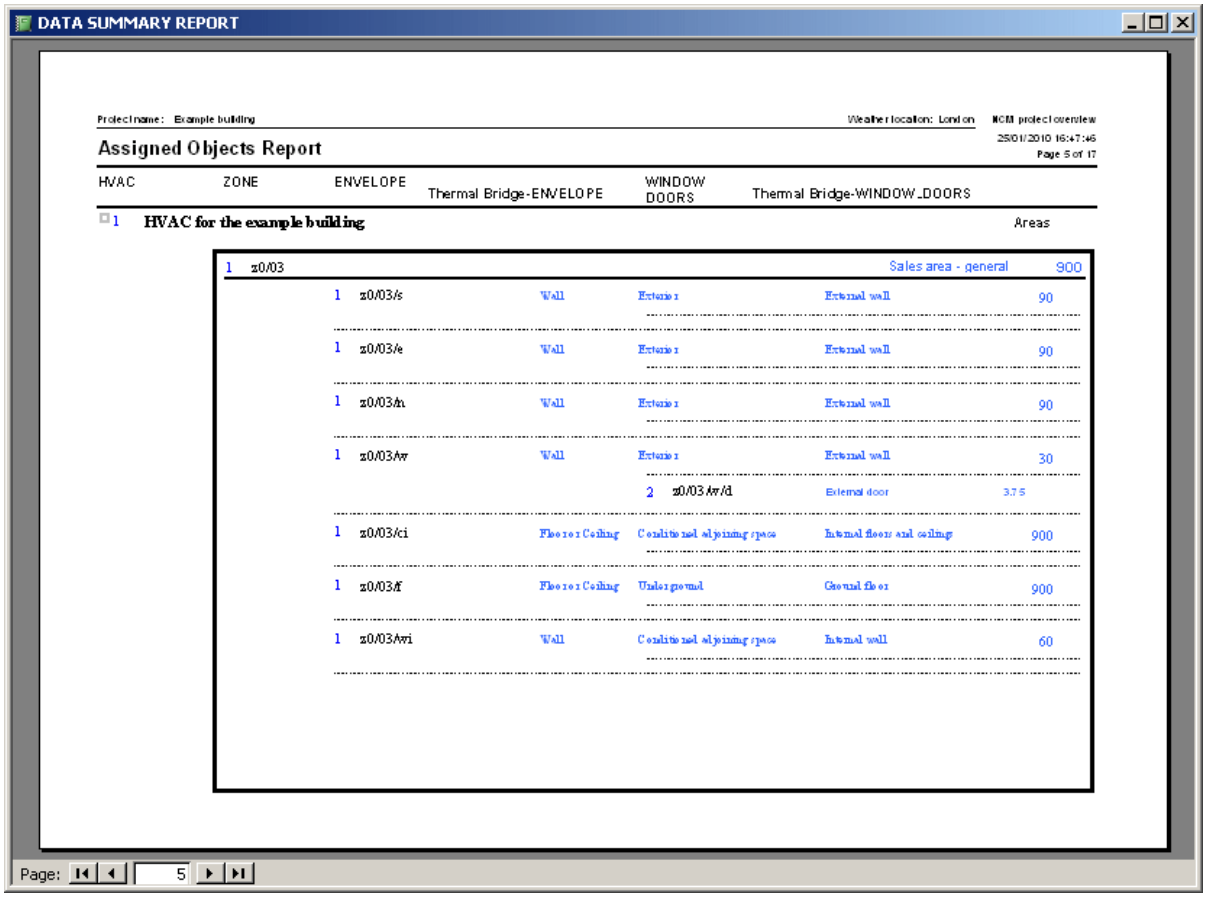


Figure 65: Data Summary Report: Zones with HVAC

Task 17: Check your data entry and assignments using the Data Summary report and Unassigned Objects Report

Now that all the zones have been assigned to HVAC systems, they should all appear in the *Data Summary* Report. Click on the *Objects Report* button in the top right-hand corner of any of the sub-tabs and view the *Assigned Objects* Report. You should now be able to see the hierarchy of the building objects you have created. The HVAC system should have 16 zones assigned to it. Each zone should have its respective walls, floors, ceilings/roofs assigned, and certain walls should have windows and/or doors assigned. Double-check that the assignments are correct before proceeding.

3.8.3. The Assigned sub-tabs

The *Assigned* sub-tabs display the parent objects which the object in question has been assigned to. There are six *Assigned* tabs in the interface:

- **The Walls Assigned sub-tab** - in the *Project Database* form > *Construction for Walls* tab - displays all of the envelopes to which the wall construction selected in the record selector has been assigned.
- **The Floors Assigned sub-tab** - in the *Project Database* form > *Construction for Floors* tab - displays all of the envelopes to which the floor construction selected in the record selector has been assigned.

- **The Roofs Assigned sub-tab** - in the *Project Database* form > *Construction for Roofs* tab - displays all of the envelopes to which the roof construction selected in the record selector has been assigned.
- **The Glazing Assigned sub-tab** - in the *Project Database* form > *Glazing* tab - displays all of the windows or rooflights to which the glazing selected in the record selector has been assigned.
- **The Doors Assigned sub-tab** - in the *Project Database* form > *Construction for Doors* tab - displays all of the doors to which the door construction selected in the record selector has been assigned.
- **The HWS Assigned sub-tab** - in the *Building Services* form > *HWS* - displays all of the zones to which the HWS selected in the record selector has been assigned.

All the above *Assigned* tabs cannot be edited. They are for viewing only.

3.8.4. The Summary sub-tabs

The *Summary* sub-tabs show which sub-objects have been assigned to the object in question. There are three *Summary* sub-tabs in the interface:

- **The Envelopes Summary sub-tab** - in the *Geometry* form > *Zones* tab shows which envelopes have been assigned to each respective zone (see Section 3.4.3: Defining zones).
- **The Windows & Doors Summary sub-tab** - in the *Geometry* form > *Envelopes* tab shows which windows and doors have been assigned to which envelope (see Section 3.4.4: Defining envelopes – Envelope tab).
- **The Zone Summary sub-tab** - in the *Building Services* form > *HVAC Systems* tab shows which zones have been assigned to which HVAC system (see Section 3.5.2: Defining HVAC Systems).

Task 18: Check your data entry and assignments using the Summary and Assigned sub-tabs

Double-check that the assignments are correct before proceeding.

4. CALCULATING AND VIEWING THE ENERGY PERFORMANCE OF THE BUILDING - THE RATINGS FORM AND OUTPUT REPORTS

The energy performance of the building is calculated and compliance with the building regulations is assessed via the *Ratings* form. The key results are then displayed in this form while further details on Building Regulations compliance and a more detailed analysis of the energy used and CO_2 emitted from the building are given in the iSBEM output reports. This chapter describes how to calculate the results and access the various outputs.

4.1. The Ratings form

The *Ratings* form allows the user to run the entered building model through SBEM and the Compliance Checking Module (BRUKL) to calculate the energy consumption, CO_2 emissions, and primary energy (or delivered energy, as relevant to the Building Regulations) of the building (and those of the Notional building) and determine whether it complies with Building Regulations (relevant to the option selected as the "Purpose of Analysis" in the *General* form > *General Information* tab > *Project Details* sub-tab). You can do this by pressing the "Check Regulations" button in the *Building Regulations Check* tab > *Building Rating* sub-tab.

NEW

NB: You will be able to monitor on the screen the progress of the calculation process as it is carried out for the different building objects.

In this form, the user can also:

1. View the key results within the interface.
2. Access the following output reports: the *Building Regulations Compliance* document ('Specification Information' for Scottish Building Regulations), the *SBEM Main Output* report, and 2 *Data Reflection* Reports for the Actual and Notional buildings.

The *Ratings* form is composed of one tab, which is:

- **Building Regulations Check** tab: displays the CO_2 emissions, in kg per m^2 of building area, for the Actual (BER) and Notional buildings as well as the target (TER), and an assessment of whether the building complies with the carbon dioxide emissions requirement in the Approved Documents. It also displays a break-down of the annual energy consumption by end-use for both the Actual and Notional buildings in kWh/m^2.

  For the England and Wales the Building Regulations, this tab also reports the building's calculated primary energy rate (BPER) and the target primary energy rate (TPER) in kWh/m^2.year, and it shows whether the building's primary energy rate is less than or equal to the target value, and hence whether the building complies with the primary energy requirement in the Approved Documents.

  NEW

  For the Scotland Building Regulations, this tab also reports the building's calculated delivered energy rate (BDER) and the target delivered energy rate (TDER) in kWh/m^2.year, and it shows whether the building's delivered energy rate is less than or equal to the target value, and hence whether the building complies with the delivered energy requirement in the Approved Documents.

4.1.1. Building Regulations Check tab

This tab has four sub-tabs:

- **Building Rating** sub-tab
- **Calculation Logs** sub-tab
- **Calculation Errors** sub-tab
- **Supporting Documents** sub-tab

Building Rating sub-tab:

Building Regulations compliance is assessed by clicking on the "Check Regulation" button in the *Building Rating* sub-tab. This initiates the data processing through the SBEM calculation engine and the Compliance Checking Module (BRUKL). The following calculated information is then displayed in this sub-tab as follows:

1. The energy used per unit floor area (kWh/m^2) annually by the Actual building and the Notional building for heating, cooling, auxiliary energy, lighting, and hot water.
2. The total energy used per unit floor area (kWh/m^2) annually by the Actual building and the Notional building in terms of both electricity and fuel use. **NB:** If applicable, this total value includes any energy consumed by a CCHP generator to provide space heating, space cooling, and/or water heating, and it is net of any electrical energy displaced by the CCHP generator.
3. The Actual Building Emission Rate (BER) – This is the annual CO_2 emissions per unit floor area for the Actual building, in $kgCO_2/m^2$.
4. The Notional Building Emission Rate – This is the annual CO_2 emissions per unit floor area for the Notional building, in $kgCO_2/m^2$.
5. The Target Emission Rate (TER) in ($kgCO_2/m^2$) - for more details on the derivation of the TER, see section 2.1: UK Building Regulations Compliance and England's NCM Modelling Guide.
6. Pass CO_2 - If the BER≤TER, the building passes the CO_2 emissions requirement in the Approved Documents, where applicable. Otherwise, it does not. **NB:** For the Scotland Building Regulations, there are cases where the comparison of the BER with the TER is not required (when no direct emission systems are used in the Actual building). See Scotland's Approved Document and NCM Modelling Guide for details.

NEW

For the England and Wales Building Regulations:

7. The Actual Building Primary Energy Rate (BPER) – This is the annual primary energy rate per unit floor area for the Actual building, in kWh/m^2.
8. The Target Primary Energy Rate (TPER) – This is the annual primary energy rate per unit floor area for the Notional building, in kWh/m^2. For more details on the derivation of the TPER, see England's NCM Modelling Guide.
9. Pass PE - If the BPER≤TPER, the building passes the primary energy requirement in the Approved Documents. Otherwise, it does not.

For the Scotland Building Regulations:

NEW

10. The Actual Building Delivered Energy Rate (BDER) – This is the annual delivered energy rate per unit floor area for the Actual building, in kWh/m^2. For more details on the derivation of the TDER, see Scotland's NCM Modelling Guide.

NEW

11. The Target Delivered Energy Rate (TDER) – This is the annual delivered energy rate per unit floor area for the Notional building, in kWh/m^2. For more details on the derivation of the TDER, see Scotland's NCM Modelling Guide.

NEW 12. Pass DE - If the BDER≤TDER, the building passes the delivered energy requirement in the Approved Documents. Otherwise, it does not.

Checks regarding other Building Regulations compliance requirements, such as U-value checks and building services efficiencies checks can be found in the *Building Regulations Compliance* document (see Section 4.2.2: BRUKL Output Document: Compliance with Building Regulations) which can be accessed from the *Building Rating* sub-tab.

Also accessible from this sub-tab is the *Main SBEM Output* report and the *Data Reflection* Reports. See Sections 4.2.1: SBEM Main Output Document, 4.2.2: BRUKL Output Document: Compliance with Building Regulations, 4.2.3: Data Reflection Report – Actual Building, and 4.2.4: Data Reflection Report – Notional Building.

NB: The Data Reflection Reports in html format are generated, and the related access buttons become visible in the *Ratings* form, only if the relevant box has been ticked in the *General* form > *File Options* tab > *System Configuration* sub-tab.

NB: If any changes are made to a project, the "Check Regulation" button needs to be clicked on again upon returning to this sub-tab in order to update the results as the results figures cannot be refreshed unless the calculation is re-run.

NB: You must close all output files before re-running the calculation (so the software can over-write them). Otherwise, an error message will be produced.

Unassignment alert

If you have omitted to assign any objects in the interface, you will be notified at the bottom of the *Building Regulations Check* tab. You will be able to view the *Unassigned Objects* Report by clicking on the 'Objects Report' button. You will see one of the following two messages at the bottom of the screen:

"Click to check object assignments, there are no CRITICAL un-assignments in this project".

"Please check (#) CRITICAL UNASSIGNMENTS before proceeding with final rating" (where # is the number of critical un-assignments detected in the project).

NB: CRITICAL refers to "building object" un-assignments rather than construction or glazing un-assignments.

Figure 66 shows the *Building Rating* sub-tab in the *Building Regulation Check* tab of the *Ratings* form for England, and Figure 67 and Figure 68 show the same for Wales and Scotland, respectively. The message at the bottom of the screen indicates that there are no critical un-assignments detected in the project. If there were, the user would need to click on the "Objects Report" button, identify the un-assignment, make the correction in the appropriate part of iSBEM, then return to this page, and then click on the "Check Regulation" button.

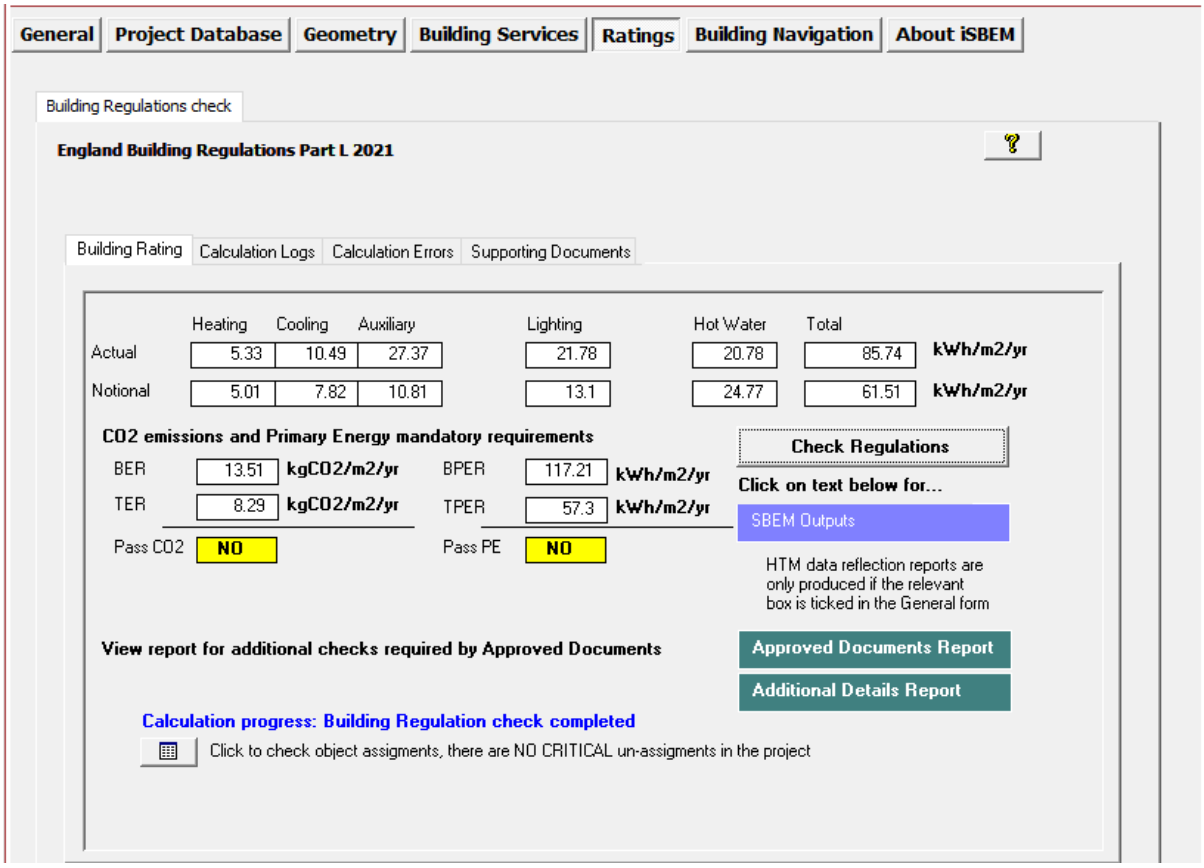


Figure 66: Using the interface to check compliance with Building Regulations in the Building Regulation Check tab of the Ratings form for England

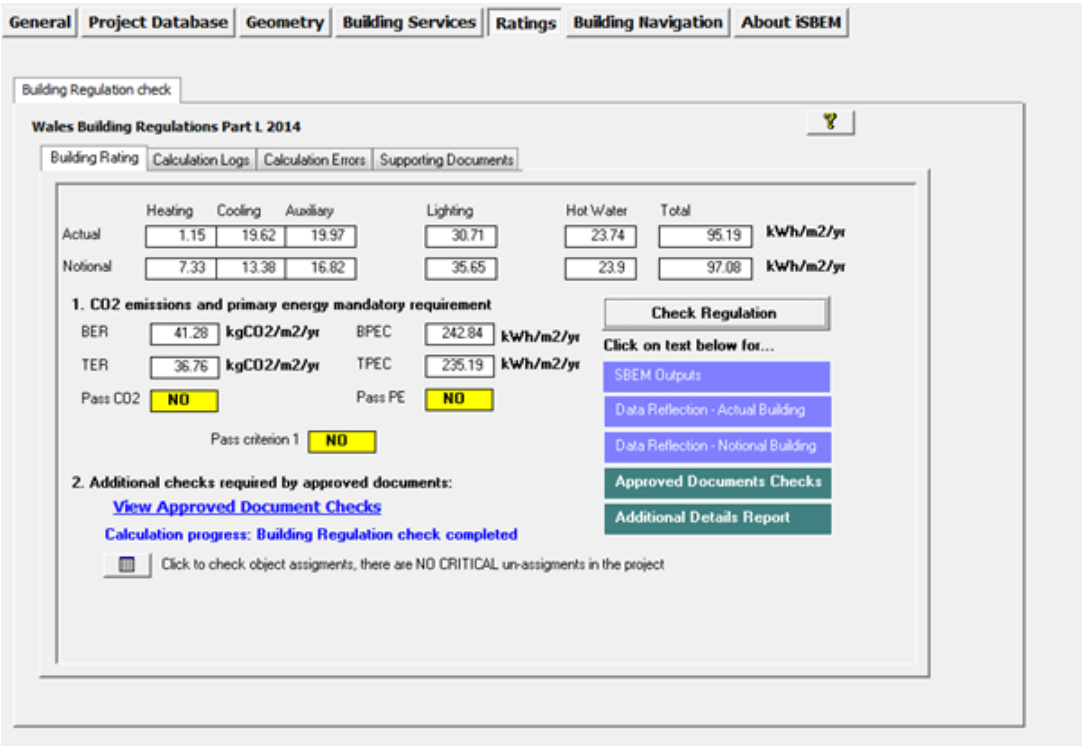
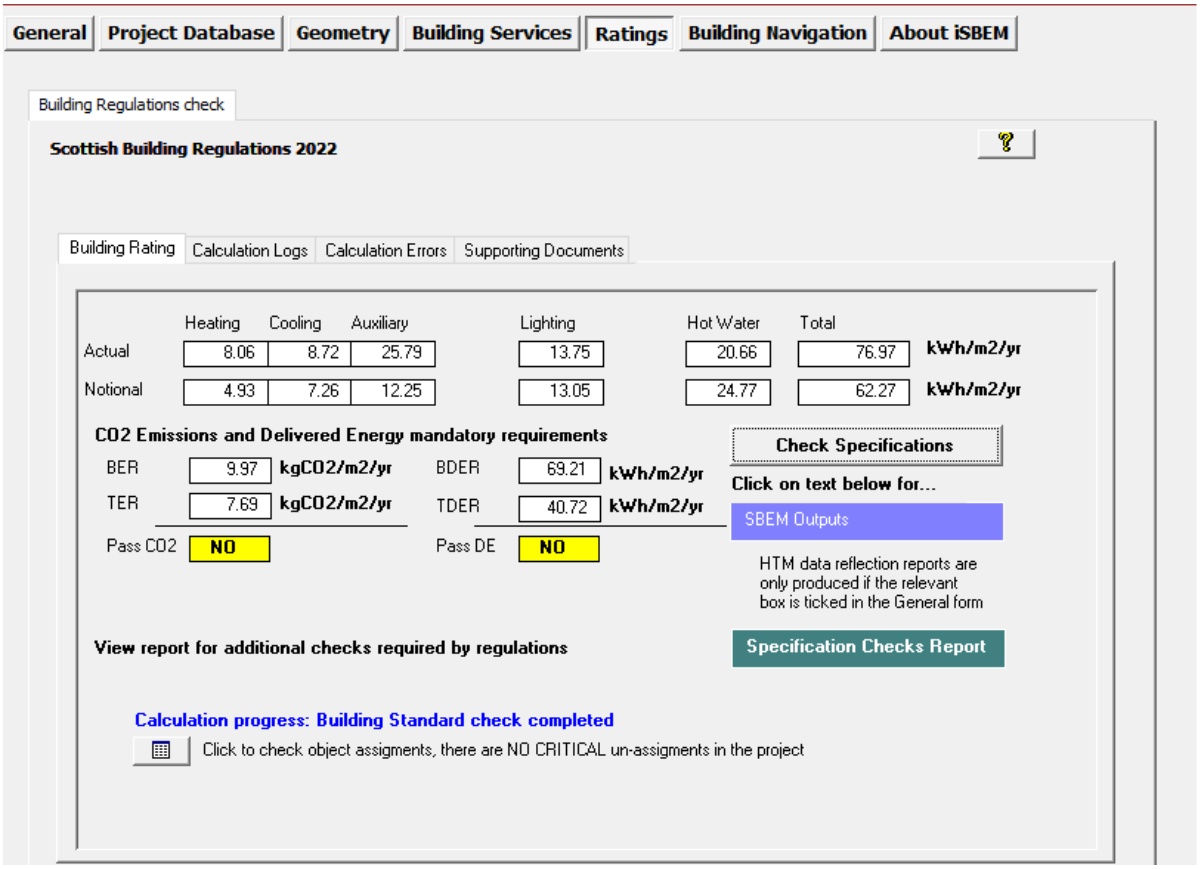


Figure 67: Using the interface to check compliance with Building Regulations in the Building Regulation Check tab of the Ratings form for Wales



Modified

Figure 68: Using the interface to check compliance with Building Regulations in the Building Regulation Check tab of the Ratings form for Scotland

Calculation Logs sub-tab:

Log files for the SBEM calculation (SBEM.log) and the compliance checking module, BRUKL, (BRUKL.log) can be viewed in this sub-tab (Figure 69).

Calculation Errors sub-tab:

Error files for the SBEM calculation (SBEM.err) and the compliance checking module, BRUKL (BRUKL.err) can be viewed in this sub-tab (Figure 70). If the calculation crashes, you can refer to these files for any error messages produced during the calculation.

Supporting Documents sub-tab:

This sub-tab (Figure 71) contains buttons that allow access to the following supporting (non-official) documents produced by SBEM: the *Main SBEM Output* report (section 4.2.1: SBEM Main Output Document) and the *Data Reflection* Reports (sections 4.2.3: Data Reflection Report – Actual Building and 4.2.4: Data Reflection Report – Notional Building).

NB: The Data Reflection Reports in html format are generated, and the related access buttons become visible in the *Ratings* form, only if the relevant box has been ticked in the *General* form > *File Options* tab > *System Configuration* sub-tab.

NB: You must close all output files before re-running the calculation (so the software can over-write them). Otherwise, an error message will be produced.

Task 19: Check compliance with Building Regulations

If you ensure that the “Purpose of Analysis” parameter is set to ‘England Building Regulations Part L 2021’, in the *General* form > *General Information* tab > *Project Details* sub-tab, and click into the *Ratings* form, you should find yourself in the *Building Rating* sub-tab of the *Check Building Regulations* tab. Check that the message at the bottom of the screen says that there are no critical un-assignments in this project, and then click on the “Check Regulation” button. Once the calculation is completed, you will be able to view the *Building Regulations Compliance* document and *Main SBEM Output* Report (samples of which are included in APPENDIX A:).

FINAL TASK: You only need to do this task when you have finished your session.

Go to the *General* form and click on “Exit iSBEM”. When you are asked whether you would like to save your project, click on “OK”.

You have now completed this tutorial.

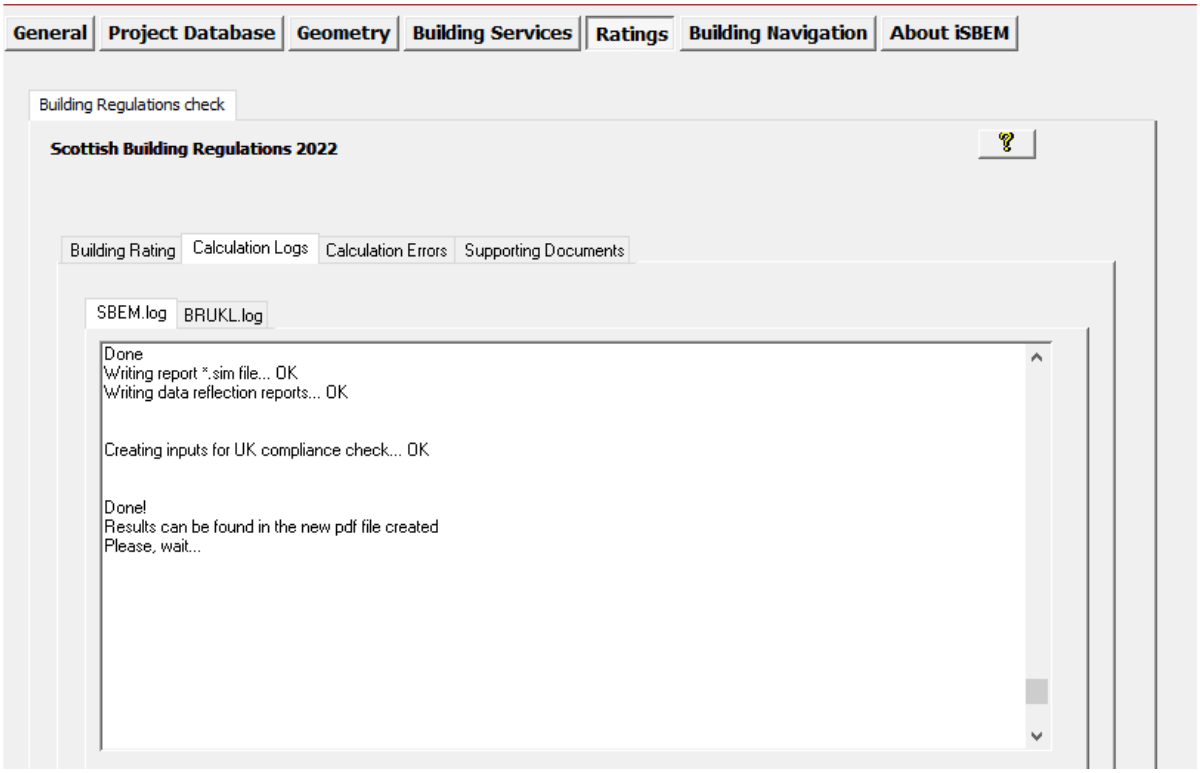


Figure 69: The Calculation Logs sub-tab in the Building Regulations Check tab of the Ratings form

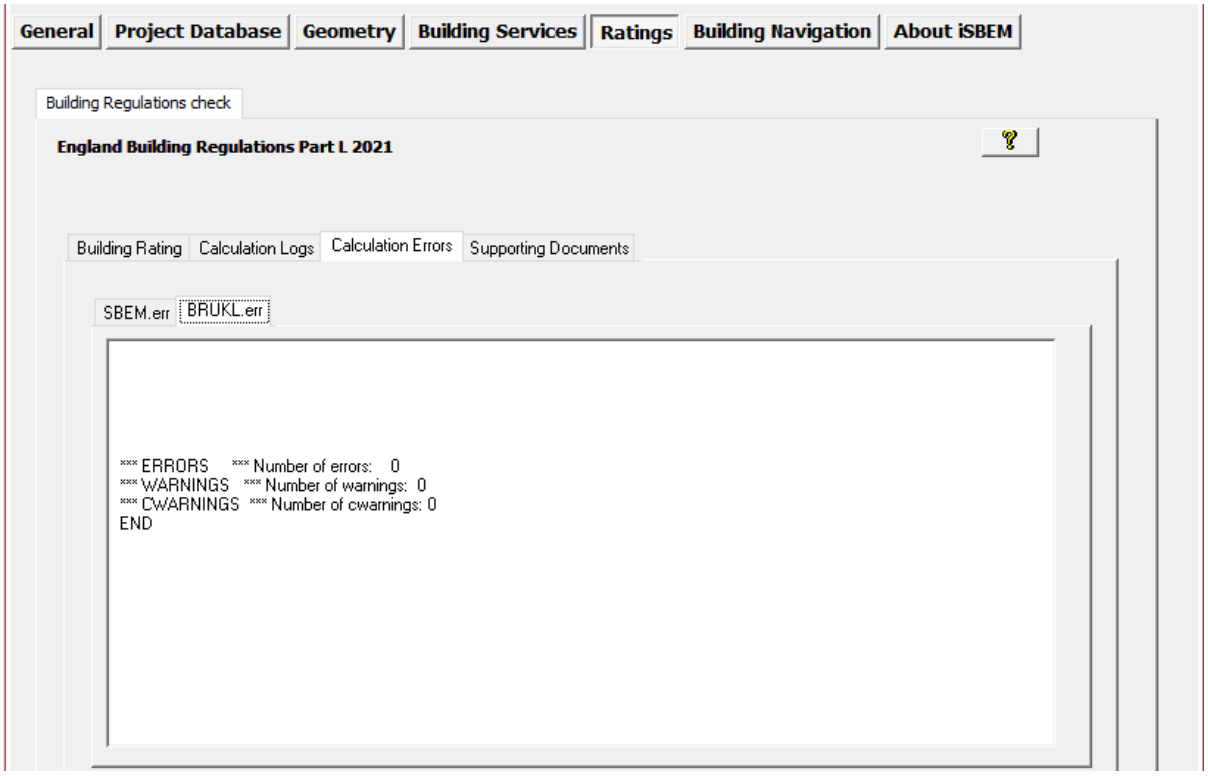


Figure 70: The Calculation Errors sub-tab in the Building Regulations Check tab of the Ratings form

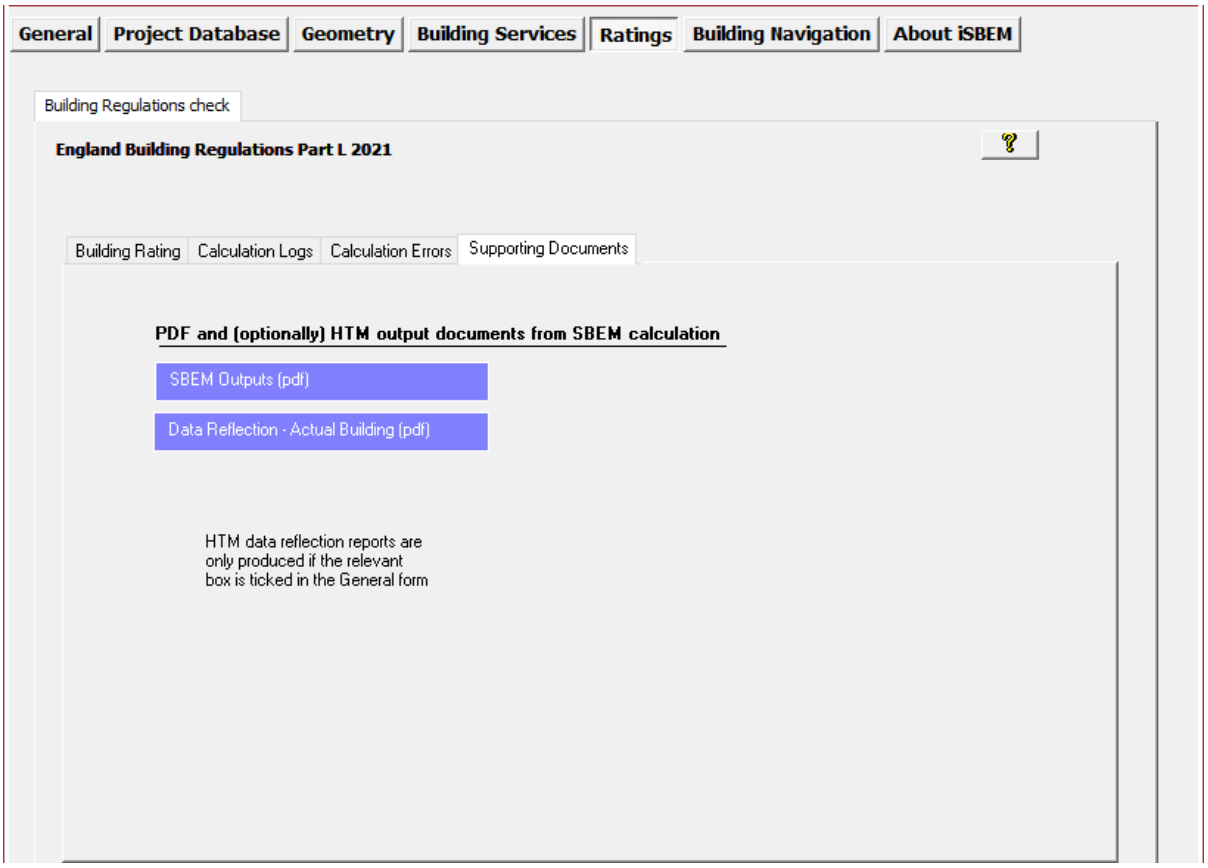


Figure 71: The Supporting Documents sub-tab in the Building Regulations Check tab of the Ratings form

4.2. iSBEM Output reports

Output reports when running iSBEM for building regulations compliance checking:

If either 'England Building Regulations Part L', 'Scottish Building Regulations', or 'Northern Ireland Building Regulations Part F' were selected as the "Purpose of Analysis" in the *General* form > *General Information* tab > *Project Details* sub-tab, and the calculation was run successfully to check compliance with building regulations, then iSBEM produces the following output reports, the first four of which can be accessed from the *Ratings* form > *Building Regulations Check* tab > *Building Rating* sub-tab (see Figure 66):

1. SBEM Main Calculation Output Document
2. BRUKL Output Document: Compliance with Building Regulations ('Specification Information' for Scottish Building Regulations)
3. Data Reflection Report – for the Actual Building
4. Data Reflection Report – for the Notional Building
5. Technical Output Report – for the Actual Building
6. Technical Output Report – for the Notional Building

The following additional report is also produced but only for building regulations compliance checks for England, Wales, and Northern Ireland.

7. BRUKL supplementary document: Additional Details on Project Parameters as Input by the Certifier

As described in the previous section, the first four reports are accessible from within iSBEM, using the appropriate buttons or hyperlinks in the *Ratings* form > *Building Regulations Check* tab > *Building Rating* sub-tab. These reports are all stored in the same location as the project files, along with the *Technical Output* Reports, which can only be accessed from the "Projects" folder. The default location for the project files is within the specific project folder (created when the project was first created, see the User Guide volume "**How to use iSBEM: Basics - UK**") within the iSBEM_v6.1.d folder, e.g., C:\NCM\iSBEM_v6.1.d\ Projects\Example building - Complete.

4.2.1. SBEM Main Output Document

This report can be accessed from the *Ratings* form > *Building Regulations Check* tab > *Building Rating* sub-tab when checking compliance with building regulations by clicking on the "SBEM Outputs" button, and it is stored in the same location as the project files as described in Section 4.2.7: Accessing the reports from the project folder. The file is in "pdf" format.

This report gives a summary of the energy consumption and CO_2 emissions of the building. It provides:

- The name and type of the building.
- A bar chart showing the annual CO_2 emissions from the building, in kg/m^2, due to fuel and electricity consumptions. It also shows the amount of annual CO_2 emissions displaced by renewables, if applicable, and the building area, in m^2.
- A bar chart showing the annual energy consumption of the building for the different end uses, in kWh/m^2.
- A bar chart showing the variation of the monthly energy consumption by the different end uses along the year, in kWh/m^2.

- A pie chart displaying the percentage of the total annual energy consumption that is due to each of the end uses, with the energy consumed by equipment excluded from the total.
- A pie chart displaying the percentage of the total annual energy consumption that is due to each of the end uses, with the energy consumed by equipment included in the total.

See APPENDIX A: A.6 for the *SBEM Main Output* Document for the Example building.

NB: You must close all output files before re-running the calculation (so the software can over-write them). Otherwise, an error message will be produced.

4.2.2. BRUKL Output Document: Compliance with Building Regulations

This report can be accessed from the *Ratings* form > *Building Regulations Check* tab > *Building Rating* sub-tab by clicking on the "Approved Documents checks" button or hyperlink, and as with the *SBEM main output report*, it is stored in the same location as the project files, as described in Section 4.2.7: Accessing the reports from the project folder. The file is in "pdf" format.

BRUKL's *Building Regulations Compliance* Document ('Specification Information' for Scottish Building Regulations, which has slight differences in format) will form part of the submission by designers to Building Control to demonstrate compliance, for e.g., with the England Building Regulations Part L 2021. The *Building Regulations Compliance* Document currently follows, in format, the compliance requirements found in England's Approved Document Part L, volume 2. Where SBEM can be used to demonstrate compliance, SBEM+BRUKL will fill in the appropriate sections of the document. On the other hand, where compliance should be demonstrated in separate supporting documents (i.e., it cannot be performed through SBEM), the *Compliance Document* will state that, for e.g., in the case of a LENI calculation (see Section 3.5.1: Global and Defaults tab).

This compliance document contains the following sections:

- Administrative Information: This section gives information about the project's address, and the building's certifier including name, telephone number, and address. It also gives information about the certification tool used to generate the results
- Emissions and energy consumption: This section of the report contains information about the building's estimated CO_2 emission rate (BER) and the target CO_2 emission rate (TER) in kg/m^2.year. It then states whether the building's emission rate is less than or equal to the target value. If relevant for the Building Regulations, this section also includes information about the building's calculated primary energy rate (BPER) and the target primary energy rate (TPER) in kWh/m^2.year, and it states whether the building's primary energy rate is less than or equal to the target value. Similarly, if relevant for the Building Regulations, this section also includes information about the building's calculated delivered energy rate (BDER) and the target delivered energy rate (TDER) in kWh/m^2.year, and it states whether the building's delivered energy rate is less than or equal to the target value. **NB:** For the Scotland Building Regulations, there are cases where the comparison of the BER with the TER is not required (when no direct emission systems are used in the Actual building). See Scotland's Approved Document and NCM Modelling Guide for details.

NEW

NEW

- Fabric and building services: This section of the report contains information about the building fabric, including the construction U-values, air permeability, and the building services systems. Then, the report states whether the building's U-values are better than the design limits for each construction type, whether the air

permeability of the building is better than the worse acceptable standard, and whether any of the relevant building services parameters exceed the limiting standards in the Approved Documents.

NB: Note that the Building Regulations compliance check regarding U-values will be applied by the tool to all envelopes which are not adjacent to a 'Conditioned adjoining space' or 'Same space'. Also note that the tool will not check the U-values of elements in unconditioned zones for compliance.

NB: According to the Approved Documents, buildings with less than 500 m^2 total useful floor area may avoid the need for a pressure test provided that the air permeability is taken as 15 $m^3/(h.m^2)$ at 50 Pa. iSBEM is able to acknowledge this during the compliance checking.

NB: The area-weighted average U-value displayed in the BRUKL document is calculated using the U-values of the different envelope elements and their areas as follows:

$$U_{avg} = \frac{\sum(A_i \times U_i)}{\sum A_i}$$

where U_{avg} = area-weighted average U-value, A_i = area of envelope i, and U_i = U-value of construction of envelope i.

NB: The U-value that is checked for compliance against the limiting standards in the Approved Documents relates to the performance of the unit in the vertical orientation for windows and roof windows, and in the horizontal orientation for rooflights[ii].

NB: Please note that neither iSBEM nor other approved calculation software can "pass" or "fail" a building. They simply provide information to the relevant Building Control Body, on the basis of which, it, not the tool, can make decisions. As such, you need to direct all compliance and policy queries to the Building Control Body to which the documents for your project need to be submitted.

- Solar gains: This section of the report contains information about whether the solar gains limit is exceeded in each of the zones where the solar gains check is applicable.
- Regulation 25A: This section covers the consideration of alternative energy systems, as defined in Regulation 25A, in the new building design.
- Technical Data Sheet (Actual Vs. Notional Building): This section displays some information about the overall energy performance of the building (Actual and Notional) and some specific information on the HVAC systems in the building (Actual and Notional). It also lists some general information, such as the weather location of the building and the percentages of total building floor area occupied by the different activity types.
- Key Features: This section highlights any items in the building fabric definitions whose specification is better than typically expected values and to which, according to the Approved Documents, Building Control is advised to give particular attention. (This section is no longer included for England's Part L calculations.)

See APPENDIX A: A.7 for a sample England *Building Regulations Compliance* document and A.9 for a sample Specification Information Document for Scottish Building Regulations.

NB: You must close all output files before re-running the calculation (so the software can over-write them). Otherwise, an error message will be produced.

An additional supplementary report is also produced but only for building regulations compliance checks for England, Wales, and Northern Ireland. Certifiers can input their own free text within special fields in this pdf report regarding any additional details on the project parameters. This report can then be printed and included, along with the BRUKL compliance document, within the package submitted to Building Control. If the user has “pdf writer” software on their computer, this report can be re-saved electronically with the certifier’s added text. Otherwise, we recommend that certifiers save their text in a separate document (for e.g., in an MS WORD file) for future reference (to enable them to copy and paste rather than having to re-type).

4.2.3. Data Reflection Report – Actual Building

This report contains all the data that SBEM uses to calculate the energy performance of the building, along with some general details about the building (as input by the user) and can be attached to the building’s “Log Book”. The information is presented in the following order:

- General details
- Building fabric details
- All systems other than HVAC
- HVAC system 1
    - Zone 1 in HVAC system 1
        - Envelope 1 of Zone 1
            - Window 1 in Envelope 1 of Zone 1
            - Door 1 in Envelope 1 of Zone 1
        - *Etc. for all other zones in HVAC system 1*

    Etc.. for all other HVAC systems

- Compliance Check Summary details

The html report contains hyperlinks (in blue) to aid in navigation around the report (which can quite large depending on the project). See Figure 72 for a screen shot of one of the *Data Reflection* reports and for examples of the hyperlinks.

The data in this report for the Actual building is also produced in a more compact layout in pdf format (Figure 73). This report is more printer-friendly than the html one, and it can be printed either on A4 or A3 paper, for e.g., to be carried around by Building Control while surveying the building.

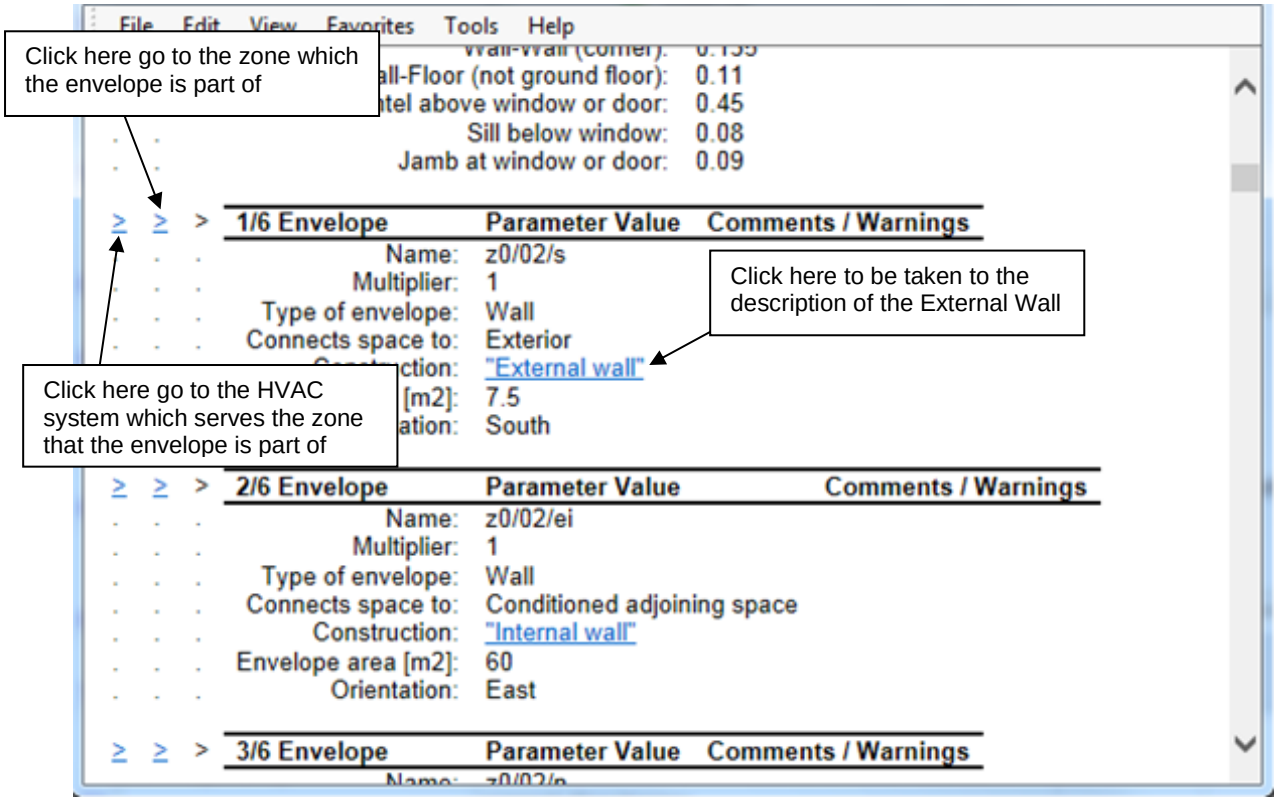
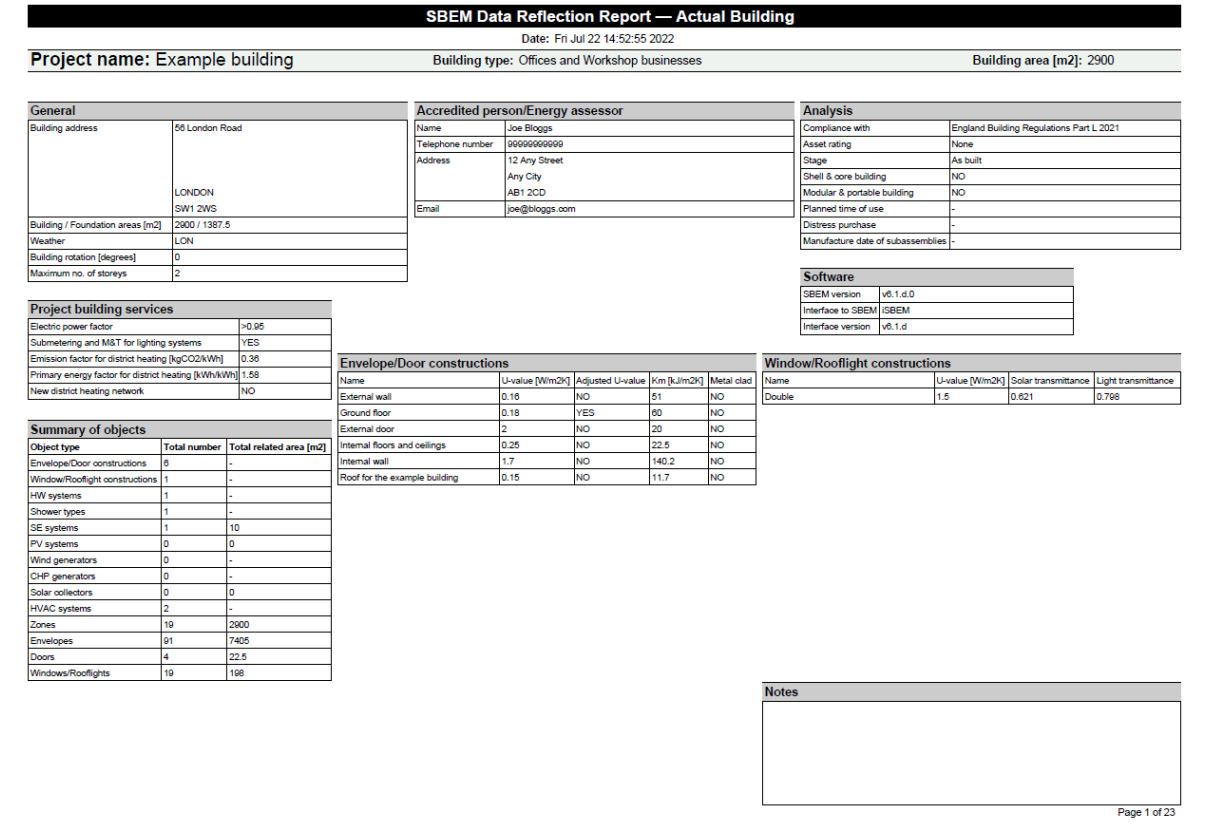


Figure 72: Data Reflection report in html format

NB: The *Data Reflection* Reports in html format are generated, and the related access buttons become visible in the *Ratings* form, only if the relevant box has been ticked in the *General* form > *File Options* tab > *System Configuration* sub-tab.



SBEM Data Reflection Report — Actual Building

Date: Fri Jul 22 14:52:55 2022

Project name: Example building | **Building type:** Offices and Workshop businesses | **Building area [m2]:** 2900

General

Building address	56 London Road LONDON SW1 2WS
Building / Foundation areas [m2]	2900 / 1387.5
Weather	LON
Building rotation [degrees]	0
Maximum no. of storeys	2

Accredited person/Energy assessor

Name	Joe Bloggs
Telephone number	99999999999
Address	12 Any Street Any City AB1 2CD
Email	joe@bloggs.com

Analysis

Compliance with	England Building Regulations Part L 2021
Asset rating	None
Stage	As built
Shell & core building	NO
Modular & portable building	NO
Planned time of use	-
Distress purchase	-
Manufacture date of subassemblies	-

Software

SBEM version	v6.1.d.0
Interface to SBEM	iSBEM
Interface version	v6.1.d

Project building services

Electric power factor	>0.95
Submetering and M&T for lighting systems	YES
Emission factor for district heating [kgCO2/kWh]	0.36
Primary energy factor for district heating [kWh/kWh]	1.58
New district heating network	NO

Envelope/Door constructions

Name	U-value [W/m2K]	Adjusted U-value	Km [kJ/m2K]	Metal clad
External wall	0.16	NO	51	NO
Ground floor	0.18	YES	60	NO
External door	2	NO	20	NO
Internal floors and ceilings	0.25	NO	22.5	NO
Internal wall	1.7	NO	140.2	NO
Roof for the example building	0.15	NO	11.7	NO

Window/Rooflight constructions

Name	U-value [W/m2K]	Solar transmittance	Light transmittance
Double	1.5	0.621	0.798

Summary of objects

Object type	Total number	Total related area [m2]
Envelope/Door constructions	6	-
Window/Rooflight constructions	1	-
HW systems	1	-
Shower types	1	-
SE systems	1	10
PV systems	0	0
Wind generators	0	-
CHP generators	0	-
Solar collectors	0	0
HVAC systems	2	-
Zones	19	2900
Envelopes	91	7405
Doors	4	22.5
Windows/Rooflights	19	198

Notes

Page 1 of 23

Figure 73: Data Reflection report in pdf format for the Actual building

4.2.4. Data Reflection Report – Notional Building

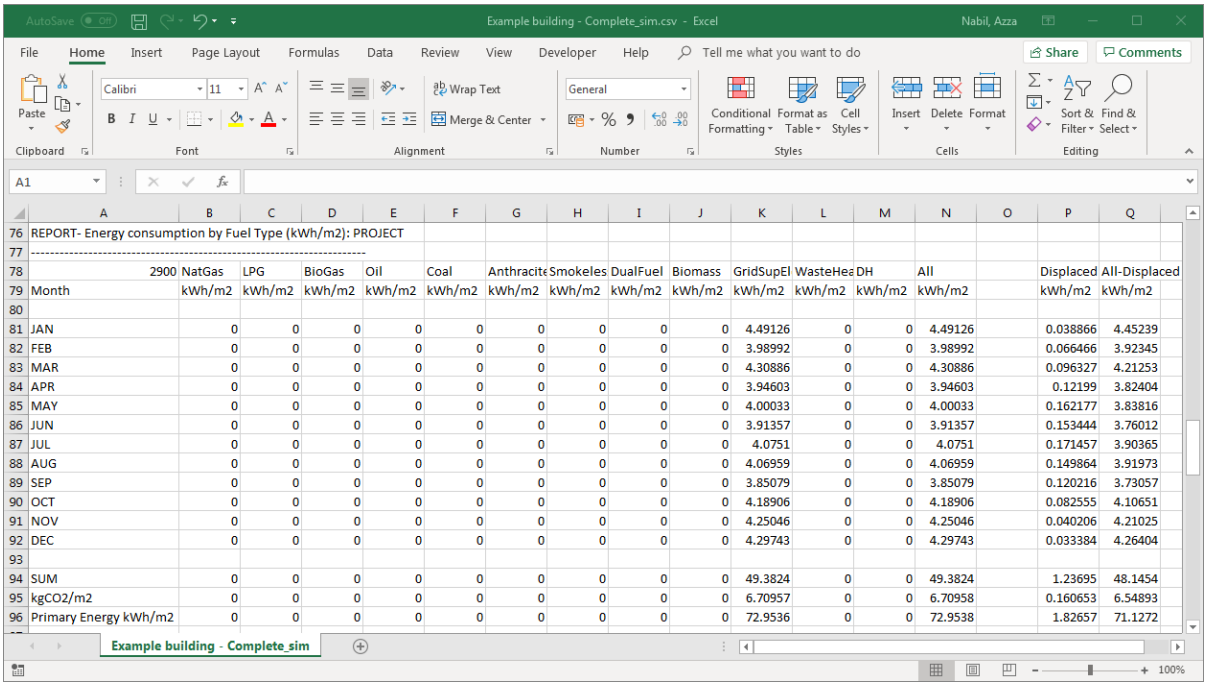
This report contains all the details on the Notional building created by SBEM to compare with the Actual building. It has the same structure and functionality as the *Data Reflection* report in html for the Actual building described above.

NB: The *Data Reflection* Reports in html format are generated, and the related access buttons become visible in the *Ratings* form, only if the relevant box has been ticked in the *General* form > *File Options* tab > *System Configuration* sub-tab.

4.2.5. Technical Output Report – Actual Building

This is a comma-separated-values '.csv' file (which can be opened using Microsoft Excel) and is intended for those who wish to do a more in-depth analysis of the results and create their own graphs and tables. It is accessible from the project folder, as described in Section 4.2.7: Accessing the reports from the project folder. It contains the calculated values for (Figure 74):

- Monthly and annual energy use by fuel type (in MJ/m^2 and kWh/m^2).
- Monthly and annual energy use by end use (in MJ/m^2 and kWh/m^2).
- Annual CO_2 emissions by fuel type (in kgCO_2/m^2).
- Annual primary energy by fuel type (in kWh/m^2).
- Monthly and annual energy production (in MJ/m^2 and kWh/m^2), primary energy (kWh/m^2), and CO_2 emissions (in kgCO_2/m^2) displaced by renewables, if applicable.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
76	REPORT- Energy consumption by Fuel Type (kWh/m2): PROJECT																
77	----------																
78	2900	NatGas	LPG	BioGas	Oil	Coal	Anthracite	Smokeless	DualFuel	Biomass	GridSupEl	WasteHea	DH	All		Displaced	All-Displaced
79	Month	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2		kWh/m2	kWh/m2
80																	
81	JAN	0	0	0	0	0	0	0	0	0	4.49126	0	0	4.49126		0.038866	4.45239
82	FEB	0	0	0	0	0	0	0	0	0	3.98992	0	0	3.98992		0.066466	3.92345
83	MAR	0	0	0	0	0	0	0	0	0	4.30886	0	0	4.30886		0.096327	4.21253
84	APR	0	0	0	0	0	0	0	0	0	3.94603	0	0	3.94603		0.12199	3.82404
85	MAY	0	0	0	0	0	0	0	0	0	4.00033	0	0	4.00033		0.162177	3.83816
86	JUN	0	0	0	0	0	0	0	0	0	3.91357	0	0	3.91357		0.153444	3.76012
87	JUL	0	0	0	0	0	0	0	0	0	4.0751	0	0	4.0751		0.171457	3.90365
88	AUG	0	0	0	0	0	0	0	0	0	4.06959	0	0	4.06959		0.149864	3.91973
89	SEP	0	0	0	0	0	0	0	0	0	3.85079	0	0	3.85079		0.120216	3.73057
90	OCT	0	0	0	0	0	0	0	0	0	4.18906	0	0	4.18906		0.082555	4.10651
91	NOV	0	0	0	0	0	0	0	0	0	4.25046	0	0	4.25046		0.040206	4.21025
92	DEC	0	0	0	0	0	0	0	0	0	4.29743	0	0	4.29743		0.033384	4.26404
93																	
94	SUM	0	0	0	0	0	0	0	0	0	49.3824	0	0	49.3824		1.23695	48.1454
95	kgCO2/m2	0	0	0	0	0	0	0	0	0	6.70957	0	0	6.70958		0.160653	6.54893
96	Primary Energy kWh/m2	0	0	0	0	0	0	0	0	0	72.9536	0	0	72.9538		1.82657	71.1272

Figure 74: Technical output report

4.2.6. Technical Output Report – Notional Building

This is a comma-separated-values '.csv' file (which can be opened using Microsoft Excel) for the Notional building similar in format to the technical output report for the Actual building described above.

4.2.7. Accessing the reports from the project folder

All of the above reports are accessible from the specific project folder (created when the project was first created, see the User Guide volume "**How to use iSBEM: Basics - UK**"). The default location for this folder is within the main **Projects** folder within the **iSBEM_v6.1.d** folder, e.g., "C:\NCM\iSBEM_v6.1.d\Projects\Example building - Complete". The reports have the following file names and extensions:

Output reports when running iSBEM for building regulations compliance checking:

1. SBEM Main Output Document – "project name"_**sbem.pdf**
2. BRUKL Output Document: Compliance with Building Regulations ('Specification Information' for Scottish Building Regulations) – "project name"_**brukl.pdf**
3. Data Reflection Report - Actual Building – "project name"_**dr.pdf**
4. Data Reflection Report - Actual Building – "project name"_**dr.htm**
5. Data Reflection Report - Notional Building – "project name"_**not_dr.htm**
6. Technical Output Report - Actual Building – "project name"_**sim.csv**
7. Technical Output Report - Notional Building – "project name"_**not_sim.csv**

If the compliance check is for England, Wales, or Northern Ireland, the following supplementary report is also produced by BRUKL:

8. Additional Details on Project Parameters as Input by the Certifier – “project name”_**brukl_2.pdf**

The project folder for the “Example building – Complete” file is shown in Figure 75 with the output reports highlighted when running iSBEM for building regulations compliance checking.

Also highlighted is **the “.nct” file which is the file that is read by iSBEM and where all the input data for your project has been stored when you saved you project.** If you need to share a project with your colleagues (or with a support Helpdesk), this is the *only* file you need to send them. They will be able to open it through iSBEM and generate all the other files.

Other files highlighted in Figure 75 are 3 error files (with the extension **.err**) which you should check for any warnings or error messages generated by SBEM or BRUKL during the calculation. These are text files which can be opened by any text editor on your computer, for e.g., MS Notepad. The contents of these files can also be viewed in the *Calculation Errors* sub-tab in the *Ratings* form.

You will also notice that there are 2 further *Data Reflection* Reports with the extension ‘.csv’. These files contain the same data as in the *Data Reflection* ‘.htm’ files described above but in a comma-separated-values format (which can be opened using Microsoft Excel).

NB: You must close all output files before re-running the calculation (so the software can over-write them). Otherwise, an error message will be produced.

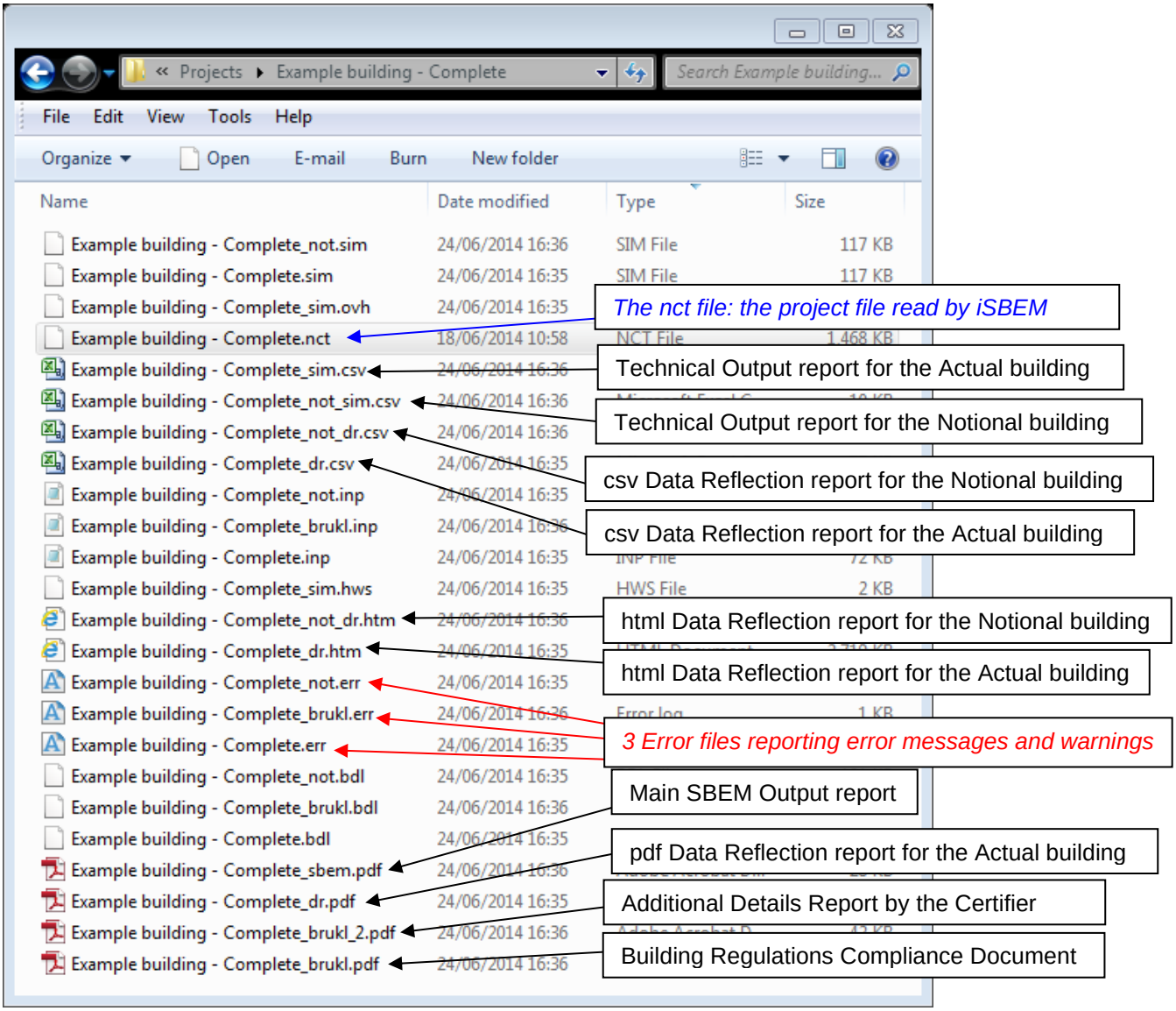


Figure 75: Contents of the Projects folder showing the iSBEM output reports when running iSBEM for building regulations compliance checking

APPENDIX A: Tutorial building details and iSBEM output documentation

A.1. Building description

The building is located in London. It is rectangular in shape with dimensions of 50 m x 30 m. It provides space for offices, a supermarket, and a coffee shop.

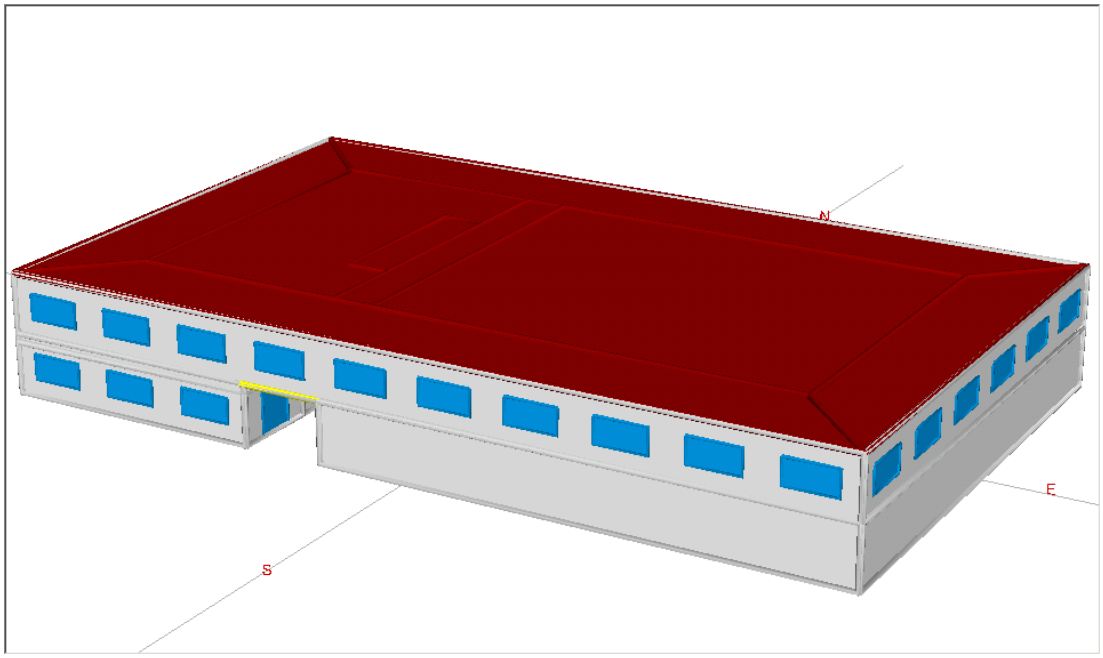


Figure 76: 3D view of the Example building

It has two floors. The supermarket and the coffee shop are located on the ground floor, with an outdoor passage between them, and the offices are located on the first floor. The first floor is accessible by stairs and lifts.

Height inside the building:

Ground floor: 3 m floor to floor

First floor: 3 m floor to soffit

All windows are set-back by 30 cm. This equates to a transmission factor of 0.8. The window sill height is 1 m. The doors are 2.5 m high.

The foundation area of the building is 1387.5 m^2.

The supermarket has an auxiliary room (see drawings), and there are another two auxiliary rooms in the coffee shop. There are toilets serving the offices on the first floor.

A.2. Constructions

- **Roof:** U-value = 0.15 W/m^{2}K, κ_m = 11.7 KJ/m^2
- **Ground floor:** U-value = 0.18 W/m^{2}K (already adjusted for insulation), κ_m = 60 KJ/m^2
- **Internal floor/ceiling:** U-value = 0.25 W/m^{2}K, κ_m = 22.5 KJ/m^2
- **Internal Walls:** U-value = 1.7 W/m^{2}K, κ_m = 140.2 KJ/m^2
- **External Wall:** U-value = 0.16 W/m^{2}K, κ_m = 51 KJ/m^2
- **Glazing**: U-value = 1.5 W/m^{2}K, T-Solar = 0.821 and L-Solar = 0.898
- **Doors:** U-value = 2 W/m^{2}K, κ_m = 20 KJ/m^{2}K.

The **air permeability** of the building at 50pa is 8 m^3/h.m^2.

A.3. Systems

HVAC: System is a single duct VAV system powered by an electric ground-source heat pump with a seasonal heating efficiency of 4 and seasonal cooling energy efficiency ratio of 5.4. It has heat recovery (Thermal wheel) with a seasonal efficiency of 0.75 (variable). The HVAC system has provision for metering and has M&T with alarms for “out of range” values. The ductwork leakage meets the CEN standard Class D, and the AHU has been tested and meets the CEN standard Class L1. The specific fan power is 1.2 W/(l/s).

The HVAC system serves all the zones in the building except for the circulation spaces and the toilets.

Lighting: Full lighting design has been carried out for lighting in the zones. There is manual switching and photoelectric dimming with a back sensor in the coffee shop and the office. The sensors are stand-alone with a parasitic power of 0.1 W/m^2. There is manual switching in all other areas. The lighting in the building has provision for metering and has M&T with alarms for “out of range” values. Display lighting in the coffee shop and the supermarket uses light sources with 22 lumens/circuit watt and time switching.

Hot water: Dedicated hot water boiler fuelled by natural gas with a seasonal efficiency of 0.94. There is a solar hot water system consisting of 10 m^2 of evacuated tube solar panels, orientated towards the south with a tilt angle of 30°. The circulation is forced powered by PVs. There is manual switching in all other areas. The lighting in the building has provision for metering and has M&T with alarms for “out of range” values.

Ventilation: Toilets have mechanical exhaust with 5 l/s.m^2 and SFP of 0.4 W/(l/s).

General: The electric power factor for the building is >0.95.

A.4. Zoning of the building

The building has been divided into **19** zones:

z0/01: The coffee shop on the ground floor – core and unglazed east perimeter area.

z0/04, z0/05, z0/06, z0/08 west, and z0/08: The coffee shop on the ground floor – glazed perimeter areas.

z0/02: The circulation area / staircase / lift area on the ground floor.

z0/03: The supermarket on the ground floor.

z1/01: The open plan office area on the first floor – core zone.

z1/05, z1/04, z1/11, z1/10, z1/09, z1/08, z1/07, and z1/06: The open plan office area on the first floor – glazed perimeter areas.

z1/02: The circulation area / staircase / lift area on the first floor.

z1/03: The toilets on the first floor.

As you can see in Figure 77: Ground floor plan, the supermarket and the coffee shop contain smaller (auxiliary) areas which could be considered as separate zones. For e.g., it would be possible to separate the supermarket (z0/03) into two zones: the main area and the smaller room at the west end of the space. Similarly, the coffee shop core and east perimeter zone (z0/01/east) could be split into two zones. For simplicity, however, it has been assumed that the activities of the auxiliary rooms within the supermarket and coffee shop do not vary from the activity within the main areas. Hence, these auxiliary spaces have been absorbed within the main zones. More details on zoning can be found in the User Guide volume "**How to use iSBEM: Basics - UK**".

Table 14 below shows the area information you need for entering the geometry of the zones into iSBEM. See the User Guide volume "**How to use iSBEM: Basics - UK**" for a description of the nomenclature used in this example. (e.g.: z0/04/n = external north wall of zone z0/04).

GROUND FLOOR						
Zones	**Area (m^2)**	**Envelope**	**Area (m^2)**	**Perimeter length (m)**	**Windows/Doors**	**Area (m^2)**
z0/04[xx]	54	z0/04/n	27	9	z0/04/n/g	8.1
		z0/04/e	18	6	z0/04/e/d	3.75
		z0/04/f	54	-		
		z0/04/ci	54	-		
z0/01	162	z0/01/e	54	18		
		z0/01/f	162	-		
		z0/01/ci	162	-		
z0/08	54	z0/08/s	27	9	z0/08/s/g	8.1
		z0/08/e	18	6	z0/08/e/d	3.75
		z0/08/f	54	-		
		z0/08/ci	54	-		
z0/07	36	z0/07/s	18	6	z0/07/s/g	5.4
		z0/07/w	18	6	z0/07/w/g	5.4
		z0/07/f	36	-		
		z0/07/ci	36	-		
z0/06	108	z0/06/w	54	18	z0/06/w/g	16.2
		z0/06/f	108	-		
		z0/06/ci	108	-		
z0/05	36	z0/05/n	18	6	z0/05/n/g	5.4
		z0/05/w	18	6	z0/05/w/g	5.4
		z0/05/f	36	-		
		z0/05/ci	36	-		

[xx] For a description of nomenclature used in the example, see the User Guide volume "**How to use iSBEM: Basics - UK**".

z0/02	50	z0/02/n	7.5	2.5		
		z0/02/ei	60	20		
		z0/02/s	7.5	2.5		
		z0/02/w	60	20	z0/02/w/d	2 x 3.75 =7.5
		z0/02/f	50	-		
		z0/02/ci	50	-		
z0/03	900	z0/03/n	90	30		
		z0/03/e	90	30		
		z0/03/s	90	30		
		z0/03/w	30	10	z0/03/w/d	2 x 3.75 =7.5
		z0/03/wi	60	20		
		z0/03/f	900	-		
		z0/03/ci	900	-		

FIRST FLOOR						
Zones	**Area (m^2)**	**Envelope**	**Area (m^2)**	**Perimeter length (m)**	**Windows/Doors**	**Area (m^2)**
z1/05	225.5	z1/05/n	114	38	z1/05/n/g	34.2
		z1/05/ni	7.5	2.5		
		z1/05/ei	3	1		
		z1/05/wi	3	1		
		z1/05/fe	27.5	-		
		z1/05/fi	198	-		
		z1/05/c	225.5	-		
z1/04	36	z1/04/n	18	6	z1/04/n/g	5.4
		z1/04/e	18	6	z1/04/e/g	5.4
		z1/04/fi	36	-		
		z1/04/c	36	-		
z1/11	108	z1/11/e	54	18	z1/11/e/g	16.2
		z1/11/fi	108	-		
		z1/11/c	108	-		
z1/10	36	z1/10/e	18	6	z1/10/e/g	5.4
		z1/10/s	18	6	z1/10/s/g	5.4
		z1/10/fi	36	-		
		z1/10/c	36	-		
z1/09	225.5	z1/09/s	114	38	z1/09/s/g	34.2
		z1/09/si	7.5	2.5		
		z1/09/ei	3	1		
		z1/09/wi	3	1		
		z1/09/fe	27.5	-		
		z1/09/fi	198	-		
		z1/09/c	225.5	-		
z1/08	36	z1/08/s	18	6	z1/08/s/g	5.4
		z1/08/w	18	6	z1/08/w/g	5.4
		z1/08/fi	36	-		
		z1/08/c	36	-		
z1/07	108	z1/07/w	54	18	z1/07/w/g	16.2
		z1/07/fi	108	-		
		z1/07/c	108	-		
z1/06	36	z1/06/n	18	6	z1/06/n/g	5.4
		z1/06/w	18	6	z1/06/w/g	5.4

		z1/06/fi	36	-	
		z1/06/c	36	-	
z1/01	614	z1/01/ei	54	18	
		z1/01/wi	54	18	
		z1/01/fe	20	-	
		z1/01/fi	594	-	
		z1/01/c	614	-	
		z1/01/ni	7.5	2.5	
		z1/01/si	7.5	2.5	
z1/02	50	z1/02/ni	7.5	2.5	
		z1/02/ei	60	20	
		z1/02/si	7.5	2.5	
		z1/02/wi	30	10	
		z1/02/wi.1	30	10	
		z1/02/fi	50	-	
		z1/02/c	50	-	
z1/03	25	z1/03/ni	7.5	2.5	
		z1/03/ei	30	10	
		z1/03/si	7.5	2.5	
		z1/03/wi	30	10	
		z1/03/fe	25	-	
		z1/03/c	25	-	

Zone Name	Lighting Wattage
z0/01	680
z0/02	210
z0/03	4000
z0/04	230
z0/05	140
z0/06	500
z0/07	140
z0/08	220
z1/01	2500
z1/02	210
z1/03	100
z1/04	150
z1/05	950
z1/06	150
z1/07	440
z1/08	140
z1/09	1000
z1/10	140
z1/11	470

Other information	
Window to wall (%)	**30**
Door area (m^2)	**3.75**

Table 14: Zoning summary and dimensions of the Example building

A.5. Drawings

The next figures show architectural drawings and building zoning for each floor of the Example building.

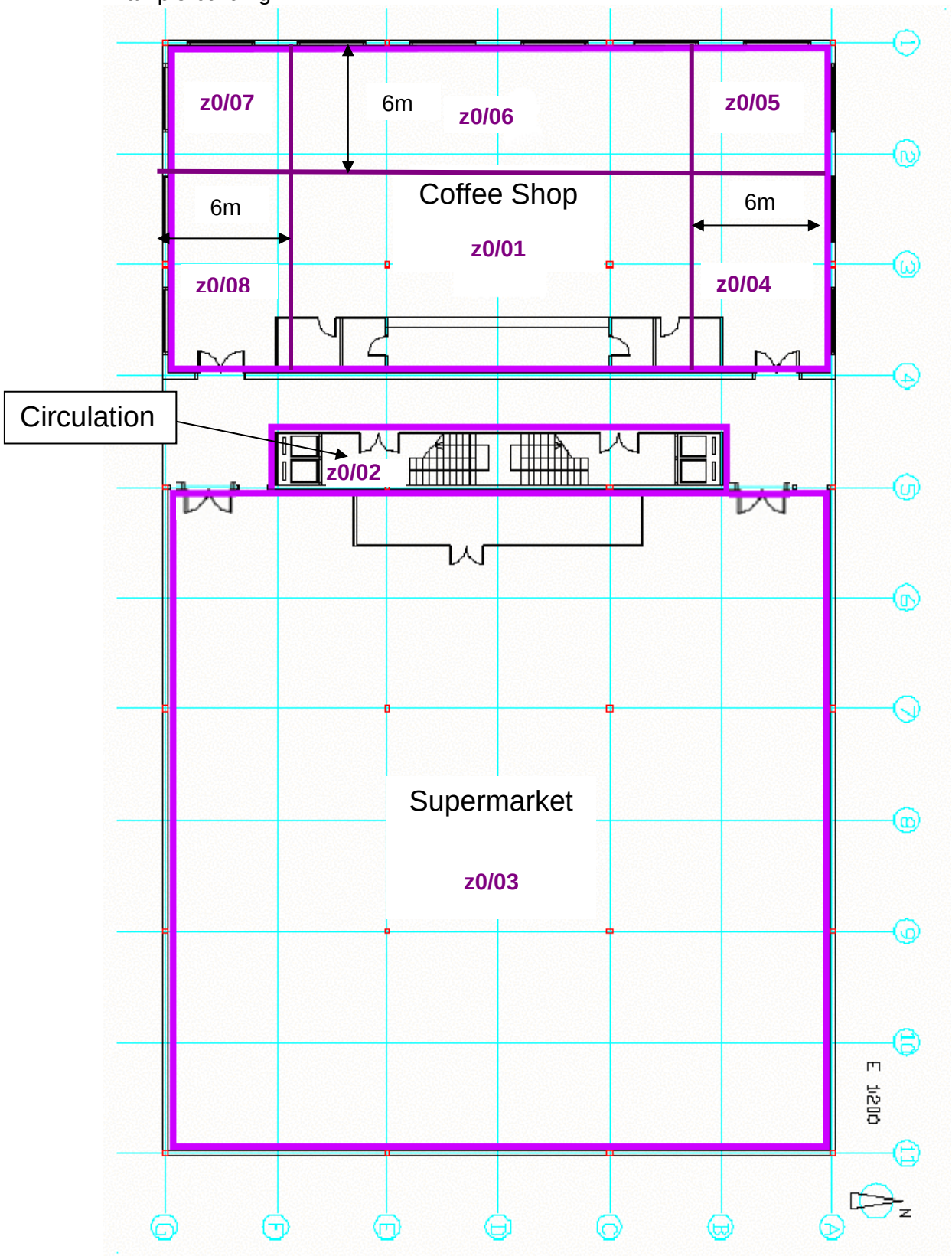


Figure 77: Ground floor plan

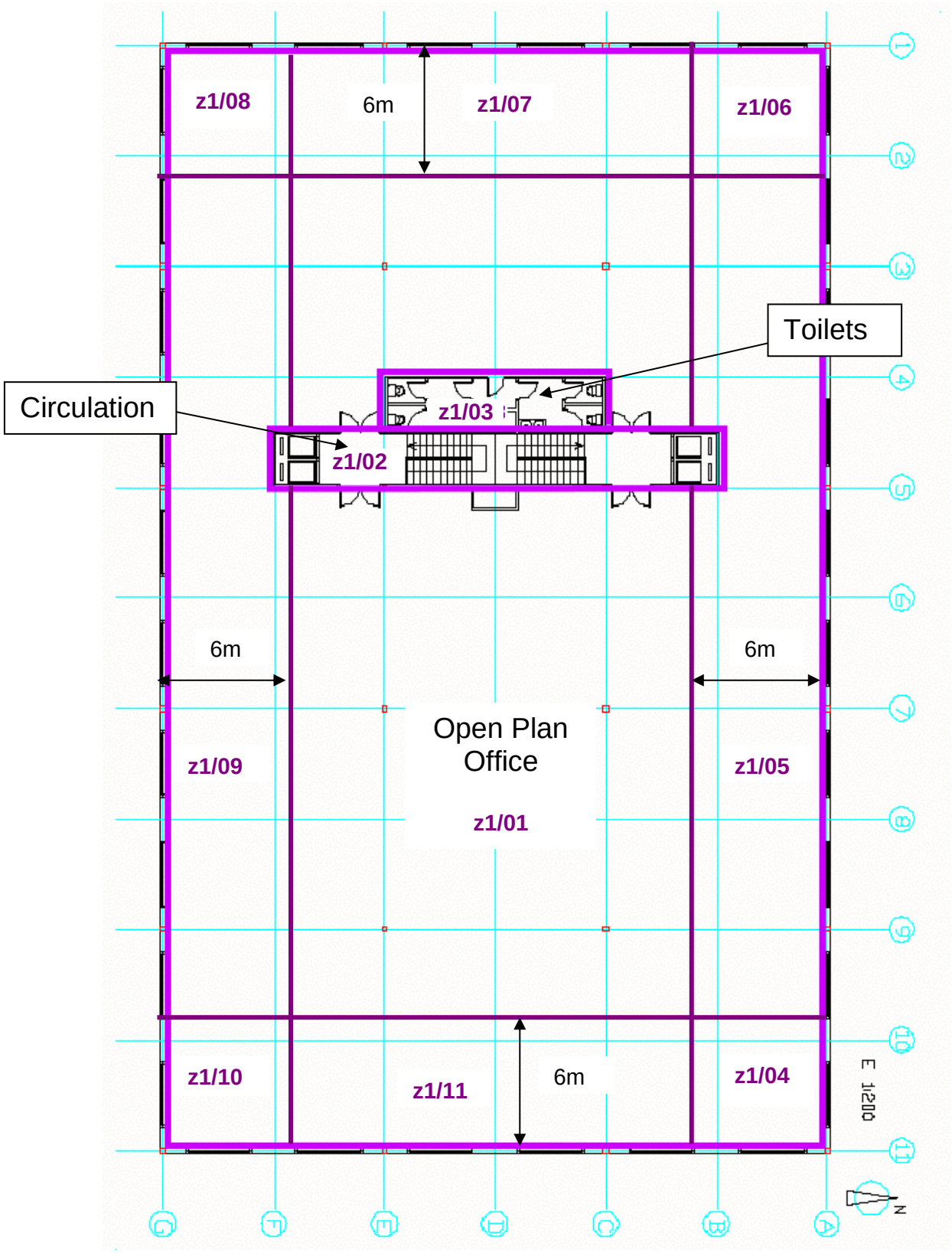


Figure 78: First floor plan

A.6. SBEM Main Output Document for Example Building

SBEM Main Calculation Output Document

Fri Jul 22 14:52:55 2022 v6.1.d.0

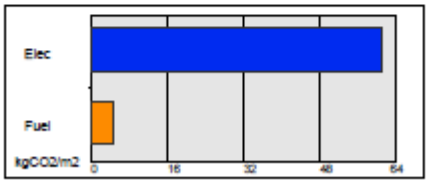
Building name

Example building

Building type: Offices and Workshop Businesses

SBEM is an energy calculation tool for the purpose of assessing and demonstrating compliance with Building Regulations (Part L for England and Wales, Section 6 for Scotland, Part F for Northern Ireland, and Building Bye-laws Jersey Part 11) and to produce Energy Performance Certificates and Building Energy Ratings. Although the data produced by the tool may be of use in the design process, SBEM is not intended as a building design tool.

Building Energy Performance and CO2 emissions

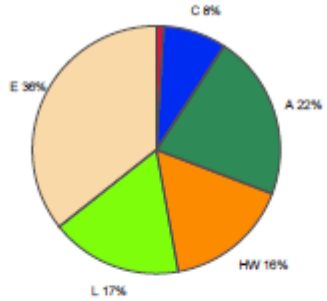


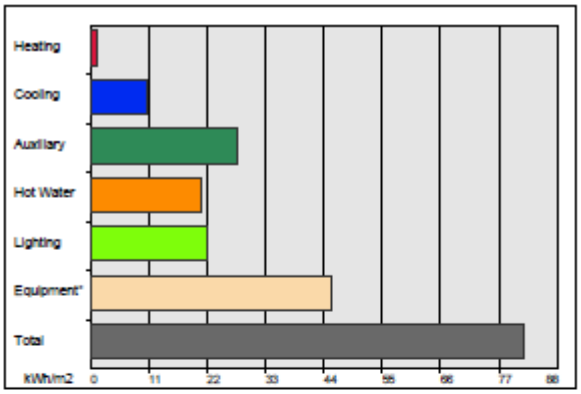
0 kgCO2/m2 displaced by the use of renewable sources.

Building area is 2900 m2

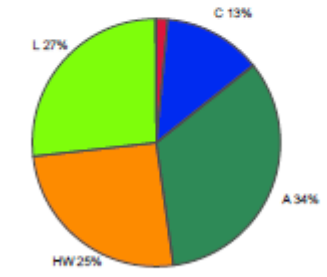
Annual Energy Consumption

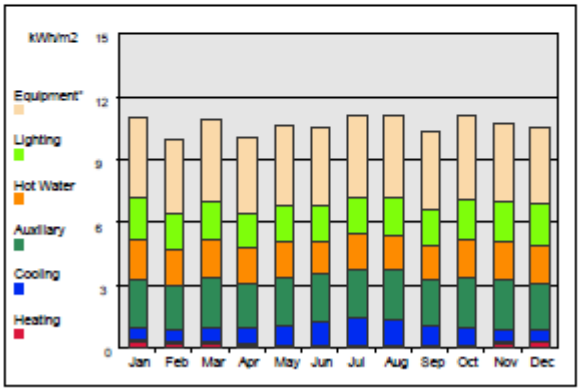
(Pie chart including Equipment end-use)





(Pie chart excluding Equipment end-use)





(*) Although energy consumption by equipment is shown in the graphs for information, this end-use has not been included in the total results of the building or the calculation of the ratings.

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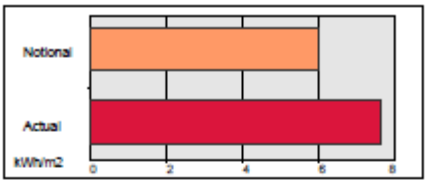
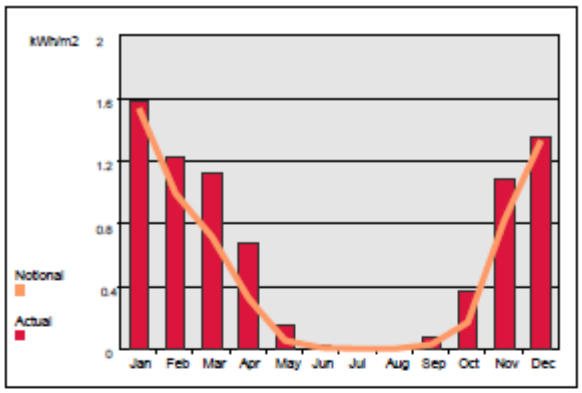
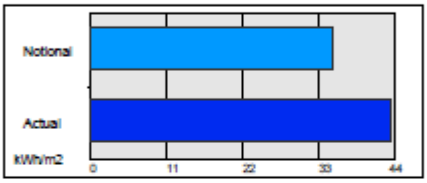
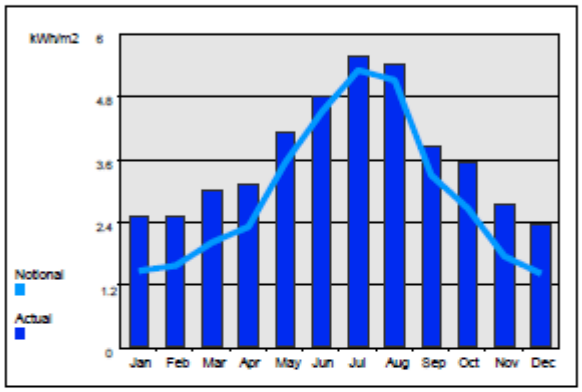
Annual Heating Demand





Annual Cooling Demand





A.7. Sample BRUKL Output Document in England

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

Accreditation test 1

As built

Date: Wed Jul 20 11:50:15 2022

Administrative information

Building Details

Address: 123 Any Avenue, Any City, AB1 2CD

Certification tool

Calculation engine: SBEM
Calculation engine version: v6.1.d.0
Interface to calculation engine: iSBEM
Interface to calculation engine version: v6.1.d
BRUKL compliance module version: v6.1.d.0

Certifier details

Name: Joe Bloggs
Telephone number: 99999999999
Address: 123 Any Street, Any City, AB1 2CD

Foundation area [m²]: 402.6

The CO_2 emission and primary energy rates of the building must not exceed the targets

The building does not comply with England Building Regulations Part L 2021

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	2.6	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	22.71	
Target primary energy rate (TPER), $kWh/m^2.annum$	7.82	
Building primary energy rate (BPER), $kWh/m^2.annum$	200.63	
Do the building's emission and primary energy rates exceed the targets?	BER > TER	BPER > TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	First surface with maximum value
Walls*	0.26	0.35	0.35	Office/s
Floors	0.18	0.25	0.25	Office/f
Pitched roofs	0.16	-	-	No heat loss pitched roofs
Flat roofs	0.18	0.25	0.25	Office/c
Windows** and roof windows	1.6	2	2	Office/s/g
Rooflights***	2.2	-	-	No external rooflights
Personnel doors^	1.6	-	-	No external personnel doors
Vehicle access & similar large doors	1.3	-	-	No external vehicle access doors
High usage entrance doors	3	-	-	No external high usage entrance doors

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
** Display windows and similar glazing are excluded from the U-value check. *** Values for rooflights refer to the horizontal position.
^ For fire doors, limiting U-value is 1.8 W/m²K
NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	10

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Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Office

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	3	3.5	-	1.8	0.75
Standard value	2.5*	4.5**	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps.

** Standard shown is for air-cooled chillers >=400 kW. For chillers <400 kW, limiting SEER is 4.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- HWS

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	-
Standard value	1	N/A

Zone-level mechanical ventilation, exhaust, and terminal units

ID	System type in the Approved Documents
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	Zone	Standard
Office	-	-	-	-	-	-	-	0.8	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	**Efficacy [lm/W]**	**Efficacy [lm/W]**	**Power density [W/m²]**
Standard value	95	80	0.3
Office	100	-	-

The spaces in the building should have appropriate passive control measures to limit solar gains in summer

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Office	NO (-2.2%)	NO

Regulation 25A: Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m^2]	402.6	402.6
External area [m^2]	1058.3	1058.3
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	10	3
Average conductance [W/K]	339.37	289.86
Average U-value [W/m^2K]	0.32	0.27
Alpha value* [%]	25.59	15.94

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
100	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	8.63	5.82
Cooling	11.44	4.57
Auxiliary	31.61	8.58
Lighting	6.51	5.1
Hot water	2.06	2.89
Equipment*	42.19	42.19
TOTAL**	**60.25**	**26.97**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	12.43	0
Wind turbines	2.76	0
CHP generators	0	0
Solar thermal systems	0.83	0
Displaced electricity	*15.19*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	199.85	127.76
Primary energy [kWh/m^2]	66.45	40.06
Total emissions [kg/m^2]	6.18	3.72

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	86.7	113.2	8.6	11.4	31.6	2.79	2.75	3	3.5
	Notional	55.3	72.4	5.8	4.6	8.6	2.64	4.4	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

A.8. Sample BRUKL Additional Details Report

Additional Details on Project Parameters as Input by the Certifier

Certifier's name: _____ Date: _____

Additional details on building fabric (constructions, glazing, and air permeability)

Item Reference	Specification Details

Additional details on space heating, cooling, and ventilation systems and controls

Item Reference	Specification Details

Additional details on water heating systems and storage

Item Reference	Specification Details

Additional details on lighting systems and controls

Item Reference	Specification Details

Other details

Item Reference	Specification Details

Notes:

(1) It is anticipated that two versions of the standardised report will be produced: the first before commencement of works (as designed) and the second after completion (as built). Text boxes under this section "Additional Details on Project Parameters as Input by the Certifier" should include a list of specifications to support the TER/BER calculation when provided together with the first version of the compliance report, or any changes to the list of specifications if provided along with the second version of the report.

(2) It is an important part of demonstrating compliance to make a clear connection between the products specifications included in this document and the data inputs required by the compliance software. It is suggested to give each data input (in the software) a reference code (as part of the name) that can be mapped against the reference used within this document.

(3) These free-text entry boxes allow the certifier to capture the specification of all the relevant items and so include the full details in an integrated output report.

A.9. Sample Specification Information Document for Welsh Building Regulations

BRUKL Output Document

Compliance with Wales Building Regulations Part L 2014

Llywodraeth Cymru
Welsh Government

Project name

Example building — As built

Date: Mon Sep 18 12:09:04 2017

Administrative information

Building Details

Address: 56 London Road, LONDON, SW23 1HA

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.4.a.0

Interface to calculation engine: iSBEM

Interface to calculation engine version: v5.4.a

BRUKL compliance check version: v5.4.a.0

Owner Details

Name: John Jones

Telephone number: 987654321

Address: 53 London Road, LONDON, SW23 1HA

Certifier details

Name: <insert name>

Telephone number: 99999999999

Address: <insert address>, <insert city>, XX XXX

Criterion 1: The calculated BER and BPEC for the building must not exceed the targets

The building does not comply with Wales Building Regulations Part L 2014

Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	39.3	
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	37	
Building Primary Energy Consumption (BPEC), $kWh/m^2.annum$	231	
Target Primary Energy Consumption (TPEC), $kWh/m^2.annum$	236.52	
Do the building's emissions and primary energy consumption exceed the targets?	BER > TER	BPEC =< TPEC

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.16	0.16	z0/01/e
Floor	0.25	0.1	0.25	z1/01/fe
Roof	0.25	0.15	0.15	z1/01/c
Windows***, roof windows, and rooflights	2.2	1.5	1.5	z0/04/n/g
Personnel doors	2.2	2	2	z0/03/w/d
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$] $U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- HVAC for the example building

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	3.9	4.6	-	0.8	0.75
Standard value	2.5*	2.55	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

1- HWS for the example building

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	0.85	-
Standard value	0.8	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	**System type in Non-domestic Building Services Compliance Guide**
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
z0/02	-	-	-	-	-	-	-	-	-	-	N/A
z1/02	-	-	-	-	-	-	-	-	-	-	N/A
z1/03	1.2	-	-	-	-	-	-	-	-	-	N/A
z0/01	-	-	-	-	-	-	-	-	-	-	N/A
z0/03	-	-	-	-	-	-	-	-	-	-	N/A
z1/01	-	-	-	-	-	-	-	-	-	-	N/A
z0/04	-	-	-	-	-	-	-	-	-	-	N/A
z0/06	-	-	-	-	-	-	-	-	-	-	N/A
z0/08	-	-	-	-	-	-	-	-	-	-	N/A
z1/05	-	-	-	-	-	-	-	-	-	-	N/A
z1/07	-	-	-	-	-	-	-	-	-	-	N/A
z1/09	-	-	-	-	-	-	-	-	-	-	N/A
z1/11	-	-	-	-	-	-	-	-	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
z0/07	-	-	-	-	-	-	-	-	-	-	N/A
z0/05	-	-	-	-	-	-	-	-	-	-	N/A
z1/04	-	-	-	-	-	-	-	-	-	-	N/A
z1/10	-	-	-	-	-	-	-	-	-	-	N/A
z1/08	-	-	-	-	-	-	-	-	-	-	N/A
z1/06	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
z0/02	-	86	-	212
z1/02	-	84	-	216
z1/03	-	177	-	107
z0/01	-	104	15	680
z0/03	-	392	15	4034
z1/01	140	-	-	2557
z0/04	-	105	15	230
z0/06	-	95	15	500
z0/08	-	107	15	226
z1/05	135	-	-	987
z1/07	142	-	-	447
z1/09	133	-	-	1001
z1/11	134	-	-	475
z0/07	-	110	15	148
z0/05	-	111	15	146
z1/04	141	-	-	154
z1/10	147	-	-	148
z1/08	147	-	-	148
z1/06	137	-	-	159

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
z0/01	N/A	N/A
z0/03	N/A	N/A
z1/01	N/A	N/A
z0/04	NO (-74.8%)	NO
z0/06	NO (-29.6%)	NO
z0/08	NO (-59.8%)	NO
z1/05	NO (-57.9%)	NO
z1/07	NO (-29.6%)	NO
z1/09	NO (-33%)	NO
z1/11	NO (-34.2%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
z0/07	NO (-33.6%)	NO
z0/05	NO (-46.1%)	NO
z1/04	NO (-46.1%)	NO
z1/10	NO (-33.6%)	NO
z1/08	NO (-31.3%)	NO
z1/06	NO (-39%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER and BPEC

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	2900	2900
External area [m^2]	4307.5	4307.5
Weather	CAR	CAR
Infiltration [m^3/hm^2@ 50Pa]	3	5
Average conductance [W/K]	993.58	1613.92
Average U-value [W/m^2K]	0.23	0.37
Alpha value* [%]	13.59	11.62

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
31	**A1/A2 Retail/Financial and Professional services**
16	**A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways**
53	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	1.16	7.69
Cooling	14.91	13.25
Auxiliary	21.34	17.24
Lighting	30.44	35.65
Hot water	22.9	23.9
Equipment*	45.24	45.24
TOTAL**	**90.74**	**97.73**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	0	6.36
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	1.2	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	211.83	202.34
Primary energy* [kWh/m^2]	231	236.52
Total emissions [kg/m^2]	39.3	37

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] No Heating or Cooling										
	Actual	306.5	3.2	0	0	4.3	0	0	0	0
	Notional	147.8	37.4	0	0	1.4	0	0	----	----
[ST] Single-duct VAV, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electricity										
	Actual	14.7	192.7	1.2	15.6	22.1	3.38	3.44	3.9	4.4
	Notional	23.7	179.4	8	13.8	18	0.82	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

A.10. Sample Specification Information Document for Scottish Building Regulations

SBEM Specification Information

Scottish Building Regulations 2022 Section 6 Guidance

Carbon Dioxide Emissions, Energy Consumption, U-Values, Air Permeability, and HVAC

Project name

Accreditation test 1

Date: Wed Jul 20 11:58:33 2022

Administrative information

Building Details

Address: 123 Any Avenue, Any City, AB1 2CD

Agent details

Name: Joe Bloggs

Telephone number: 99999999999

Address: 123 Any Street, Any City, AB1 2CD

Certification tool

Calculation engine: SBEM

Calculation engine version: v6.1.d.0

Interface to calculation engine: iSBEM

Interface to calculation engine version: v6.1.d

Compliance module version: v6.1.d.0

Foundation area [m²]: 402.6

1- The predicted CO_2 emissions and energy consumption

The building does not comply with Scottish Building Regulations 2022 Section 6

Target CO_2 emission rate (TER), $kgCO_2/m^2$annum	4.03	
Building CO_2 emission rate (BER), $kgCO_2/m^2$annum	25.38	
Target delivered energy rate (TDER), kWh/m^2annum	20.33	
Building delivered energy rate (BDER), kWh/m^2annum	156.45	
Do the building's emission and delivered energy rates exceed the targets?	BER > TER	BDER > TDER

2- The performance of the building fabric and the building services systems

Fabric element	$U_{a\text{-Limit}}$	$U_{a\text{-Calc}}$	$U_{i\text{-Limit}}$	$U_{i\text{-Calc}}$	First surface with maximum value
Walls	0.21	0.35	0.7	0.35	Office/s
Floors	0.18	0.25	0.7	0.25	Office/f
Roofs	0.16	0.25	0.35	0.25	Office/c
Windows* and roof windows	1.6	2	3.3	2	Office/s/g
Rooflights**	2.2	-	3.8	-	No external rooflights
Personnel doors	1.4	-	3.3	-	No external personnel doors
Vehicle access & similar large doors	1.5	-	3.3	-	No external vehicle access doors
High usage entrance doors	3	-	N/A	-	No external high usage entrance doors

$U_{a\text{-Limit}}$ = Limiting area-weighted average U-values [W/(m^2K)]
$U_{a\text{-Calc}}$ = Calculated area-weighted average U-values [W/(m^2K)]
$U_{i\text{-Limit}}$ = Limiting individual element U-values [W/(m^2K)]
$U_{i\text{-Calc}}$ = Calculated individual element U-values [W/(m^2K)]

* Display windows and similar glazing are excluded from the U-value check.
** Values for rooflights refer to the horizontal position.

Air Permeability	This building's value
m3/(h.m2) at 50 Pa	10

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Building services

For details on the standard values listed below, system-specific guidance, and additional regulatory requirements, refer to the Approved Documents.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Office

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.89	2.5	-	1.8	-
Standard value	0.93*	4.5**	N/A	2^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output and overall for multi-boiler systems. For single boiler systems >2 MW or any individual boiler in a multi-boiler system, limiting efficiency is 0.88.

** Standard shown is for air-cooled chillers >=400 kW. For chillers <400 kW, limiting SEER is 4.

^ Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

1- HWS

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	1	-
Standard value	1	N/A

Zone-level mechanical ventilation, exhaust, and terminal units

ID	System type in the Approved Documents
A	Local supply or extract ventilation units
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal balanced supply and extract ventilation system
E	Local balanced supply and extract ventilation units
F	Other local ventilation units
G	Fan assisted terminal variable air volume units
H	Fan coil units
I	Kitchen extract with the fan remote from the zone and a grease filter

NB: Limiting SFP may be increased by the amounts specified in the Approved Documents if the installation includes particular components.

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	2.3	2	0.5	0.5	0.4	1	Zone	Standard
Office	-	-	-	-	-	-	-	0.8	-	-	N/A

General lighting and display lighting	General luminaire	Display light source	
Zone name	Efficacy [lm/W]	Efficacy [lm/W]	Power density [W/m²]
Standard value	95	80	0.3
Office	39	-	-

3- The solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Office	YES (+3.6%)	NO

Consideration of high efficiency alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	402.6	402.6
External area [m²]	1058.3	1058.3
Weather	GLA	GLA
Infiltration [m³/hm²@ 50Pa]	10	4
Average conductance [W/K]	411.86	240.9
Average U-value [W/m²K]	0.39	0.23
Alpha value* [%]	21.08	19.18

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
100	**Offices and Workshop Businesses**
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
	Residential Institutions: Universities and Colleges
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
	Others: Miscellaneous 24hr Activities
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	59.11	15.14
Cooling	22.86	4.89
Auxiliary	35.56	10.4
Lighting	54.08	9.53
Hot water	2.91	2.89
Equipment*	42.19	42.19
TOTAL**	**174.52**	**42.84**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	11.19	22.52
Wind turbines	6.15	0
CHP generators	0	0
Solar thermal systems	0.7	0
Displaced electricity	*17.34*	*22.52*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	337.55	140.47
Primary energy [kWh/m²]	210.07	24.76
Total emissions [kg/m²]	25.48	4.03

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	176	161.6	59.1	22.9	35.6	0.83	1.96	0.89	2.5
	Notional	50.7	89.8	15.1	4.9	10.4	0.93	5.1	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

APPENDIX B: List of parameters required by iSBEM for compliance calculations

Form: General

Tab: General Information

Sub-tab: Project details

- Purpose of analysis
- Weather (location)
- Stage of analysis *(field not enabled for Scottish Building Regulations)*
- Shell and core building?
- S6 type of Building *(field enabled only for Scottish Building Regulations)*

Sub-tab: Special Considerations

- Is the building modular or portable?
    - Planned time of use in a single location
        - Is more than 70% of the external envelope to be created from sub-assemblies manufactured prior to the date the relevant building regulations come into force?
        - Is a 'TER/BER & TPER/BPER' calculation not available for a module constructed prior to the date on which the regulations came into force?
        - Date of manufacture.
        - Is the portable building a distress purchase?

Sub-tab: Regulation 25A

- In the design of this building, has consideration been given to the use of 'alternative energy systems', as defined in Regulation 25A (renewable energy systems, CHP, district heating/cooling, or heat pumps)?
    - Is evidence of such a feasibility assessment available for inspection?
    - Are renewable energy systems used in the proposed design solution?
    - Is CHP used in the proposed design solution?
    - Is district heating/cooling used in the proposed design solution?
    - Are heat pumps used in the proposed design solution?

Sub-tab: Building details

- Building type
- Name of project
- Building address
- City
- Postcode
- Location description

Sub-tab: Certifier's / Agent's details

Sub-form: Certifier's / Agent's details

- Name
- Telephone number
- Email address
- Address
- City
- Postcode

Form: Project Database

Tab: Construction for walls

Sub-tab: General

- Name of construction
- Does it involve metal cladding?
- Globally used in walls that connect zone to
- Definition of construction of walls using one of the following 3 options:
  1) Library
    - Category
    - Library

or

2) Inference procedures
   - Building sector
   - Building Regulations compliance
   - General description

or

3) Enter parameters manually
   - U-value [W/m²K]
   - κ_m [kJ/m²K]

Tab: Construction for roofs

Sub-tab: General

- Name of construction
- Does it involve metal cladding?
- Globally used in roofs that connect zone to
- Definition of construction of roofs using one of the following 3 options:

  1) Library
     - Category
     - Library

  or

  2) Inference procedures
     - Building sector
     - Building Regulations compliance
     - General description

  or

  3) Enter parameters manually
     - U-value [W/m²K]
     - κ_m [kJ/m²K]

Tab: Construction for floors

Sub-tab: General

- Name of construction
- Globally used in floors that connect zone to
- Definition of construction of floors using one of the following 3 options:

  1) Library
     - Category
     - Library

  or

  2) Inference procedures
     - Building sector
     - Building Regulations compliance
     - General description

  or

  3) Enter parameters manually
     - U-value [W/m²K] *or* $^1/_{R_f}$ [W/m²K] if uncorrected for insulation
     - κ_m [kJ/m²K]
     - Has the U-value been corrected to account for insulation to counter heat loss through floors in contact with the ground?

Tab: Construction for doors

Sub-tab: General

- Name of construction
- Definition of construction of doors using one of the following 3 options:

  1) Library
     - Category

- Library

or

2) Inference procedures
- Building sector
- Building Regulations compliance
- General description

or

3) Enter parameters manually
- U-value [W/m^{2}K]
- κ_m [kJ/m^{2}K]

Tab: Glazing

Sub-tab: General

- Name of construction
- Definition of construction of glazing using one of the following 3 options:

1) Library
- Category
- Library

or

2) Inference procedures
- Building Regulations compliance
- Number of panes
- Coating
- Frame material

or

3) Enter parameters manually
- U-value - for glazing in vertical inclination [W/m^{2}K]
- T-solar – for normal incidence
- L-solar – for normal incidence
- Has the U-value been adjusted for the horizontal orientation?

Form: Geometry

Tab: Project

Sub-tab: General & Geometry

- Global air permeability at 50pa [m^3/h.m^2]
- Building (clockwise) rotation [degrees]
- Global zone floor-to-floor height [m]
- Maximum number of storeys
- Building area [m^2]
- Foundation area [m^2] *(field enabled only for English and Scottish Building Regulations)*

Modified

Sub-tab: Thermal Bridges

- Global Psi value [W/mK] for junctions involving metal cladding for each of:
  - Roof-Wall
  - Wall-Ground floor
  - Wall-Wall (corner)
  - Wall-Floor (not ground floor)
  - Lintel above window or door
  - Sill below window
  - Jamb at window or door
- Global Psi value [W/mK] for junctions not involving metal cladding for each of:
  - Roof-Wall
  - Wall-Ground floor
  - Wall-Wall (corner)
  - Wall-Floor (not ground floor)
  - Lintel above window or door
  - Sill below window
  - Jamb at window or door

Tab: Zones

Sub-tab: General

- Zone name
- HVAC system which serves the zone
- Building type
- Activity type in the zone
- Zone area [m^2]
- Zone floor-to-floor height [m], or select global value
- Air permeability at 50pa [$m^3/h.m^2$] in the zone, or select global value
- Is this a shell area (in a shell and core building)?
- Zone multiplier
- Description of zone
- Define the following Psi values for thermal bridges in the zone or use global values?
    - Zone Psi value [W/mK] for junctions involving metal cladding for each of:
        - Roof-Wall
        - Wall-Ground floor
        - Wall-Wall (corner)
        - Wall-Floor (not ground floor)
        - Lintel above window or door
        - Sill below window
        - Jamb at window or door
    - Zone Psi value [W/mK] for junctions not involving metal cladding for each of:
        - Roof-Wall
        - Wall-Ground floor
        - Wall-Wall (corner)
        - Wall-Floor (not ground floor)
        - Lintel above window or door
        - Sill below window
        - Jamb at window or door

Tab: Envelopes

Sub-tab: General

- Envelope name
- Zone which envelope belongs to
- Type of envelope
    - Pitch angle [degrees] *(field enabled if envelope type is roof or floor/ceiling)*
    - Perimeter length [m] *(field enabled if envelope type is wall)*
- Envelope connects space to, or select global value
- Envelope construction
- Envelope area [m^2]
- Envelope orientation
- Is there a solar collector (SC) on this wall? *(field enabled if envelope type is wall)*
    - SC name
    - SC area [m^2]
- Definition of any thermal bridges in the envelope additional to global values
    - Thermal bridge multiplier
    - Thermal bridge length [m]
    - Thermal bridge Psi [W/mK]
    - Thermal bridge description

Tab: Doors

Sub-tab: General

- Door name
- Envelope which door is in
- Door type
- Door construction
- Door area [m^2]
- Definition of any thermal bridges in the door additional to global values

- Thermal bridge multiplier
- Thermal bridge length [m]
- Thermal bridge Psi [W/mK]
- Thermal bridge description

Tab: Windows & Rooflights

Sub-tab: General

- Window/Rooflight name
- Envelope which window/rooflight is in
- Glazing type
- Window/Rooflight projected area [m^2]
- Ratio of developed area to projected area of window/rooflight/roof window
- Roof opening type *(field enabled if selected envelope is a roof)*
- Is it a display window?
- Frame factor
- Aspect ratio
- Shading position on window/rooflight
  - Shading colour
  - Shading translucency
- Transmission factor due to fins and overhangs
- Is overhang a brise-soleil?
- Definition of any thermal bridges in the window/rooflight additional to global values
  - Thermal bridge multiplier
  - Thermal bridge length [m]
  - Thermal bridge Psi [W/mK]
  - Thermal bridge description

Form: Building Services

Tab: Global and Defaults

Sub-tab: Project building services

- Do the lighting systems have provision for metering?
  - Is there monitoring and targeting with alarms for out-of-range values? *(field enabled if lighting systems have provision for metering)*
- Electric power factor
- Has a LENI calculation been carried out for the building?
- Is this a new district heating network? *(field enabled only for English Building Regulations)*
- The CO_2 emission factor for the district heating network *(field enabled only if the heat source and fuel type of any of the HVAC systems is set to be district heating)*
- The primary energy factor for the district heating network *(field enabled only if the heat source and fuel type of any of the HVAC systems is set to be district heating)*

Tab: HVAC Systems

Sub-tab: General

- HVAC system name
- HVAC system type
  - Heat recovery in ventilation system *(field enabled if there is mechanical ventilation at HVAC level)*
    - Heat recovery seasonal efficiency
    - Variable heat recovery efficiency?

Sub-tab: Heating System

- Heat source
- Fuel type for heat generator
- Does this heating system also use CHP? *(field enabled if applicable for system)*
- Heat generator seasonal efficiency
- Heat generator radiant efficiency *(field enabled if HVAC is a radiant system)*
- Does this heating system also use CHP?
- Does the heating system qualify for ECA *(relevant only if default efficiency value is used)*?

- Was the heating system installed in or after 1998 *(relevant only if default efficiency value is used)*?
- Do the convectors have fans? *(field enabled if applicable for system)*
- Ratio of fan power to heating output [W/kW] *(field enabled if applicable for system)*

Sub-tab: Cooling System *(enabled only if HVAC system provides cooling)*

- Generator type
- Generator kW
- Fuel type for cooling generator
- Seasonal energy efficiency ratio for cooling generator
- Nominal energy efficiency ratio for cooling generator
- Does the cooling system qualify for ECA *(relevant only if default efficiency value is used)*?
- Does the system have mixed-mode operation strategy?

Sub-tab: System adjustment *(enabled only if there is mechanical ventilation at HVAC level)*

- Has the ductwork been leakage tested?
  - CEN classification it meets
- Does the AHU meet CEN leakage standards?
  - CEN classification it meets
- Specific fan power [W/(l/s)]
- Variable speed pumping?
  - Type

Sub-tab: Metering Provision

- Does the HVAC system have provision for metering?
  - Is there monitoring and targeting with alarms for out-of-range values? *(field enabled if HVAC system has provision for metering)*

Sub-tab: Bi-valent Systems

- Heat source
- Fuel type for heat generator
- Heat generator seasonal efficiency
- Proportion of heating load provided by heat generator

Tab: HWS

Sub-tab: General

- HWS name
- HWS generator type
  - Fuel type for HWS generator *(field enabled if hot water is not generated by HVAC system)*
  - Heat generator seasonal efficiency for HWS *(field enabled if hot water is not generated by HVAC system)*
  - Was the HWS installed later than 1998 *(relevant only if default efficiency value is used)*? *(field enabled if hot water is not generated by HVAC system)*

Sub-tab: Storage & Secondary Circulation

- Is the system a storage system?
  - Storage volume [litres]
  - Insulation type on storage vessel
    - Insulation thickness [mm]

  or
  - Storage losses [MJ/month]
  - Does the system have secondary circulation?
    - Circulation losses [W/m]
    - Pump power [kW]
    - Loop length [m]
    - Is there time control on the secondary circulation?

Sub-tab: Bi-valent Systems

- Heat generator type
- Fuel type for heat generator
- Heat generator seasonal efficiency
- Proportion of water heating load provided by heat generator

Sub-tab: Showers

- Name of shower type served by this HWS
- Number of abovementioned shower type served by this HWS

Tab: SE Systems

Sub-tab: Collector Parameters

- SES name
- HWS which SES is in
- SES area [m^2]
- SES multiplier
- SES orientation
- SES inclination [degrees]
- Do you know the collector performance parameters according to EN 12975-2?
    - Zero-loss collector efficiency factor
    - Collector heat loss coefficient [W/m^2K]
    - Temperature dependence of heat loss coefficient [W/m^2K]
    - Incidence angle modifier of collector

Sub-tab: Solar Storage & Collector Loop

- Solar storage volume [litres]
- Solar pre-heating type
    - Insulation type on storage vessel
        - Insulation thickness [mm]
- Do you know the heat transfer rate of the heat exchanger(s) in the collector loop?
    - Heat transfer rate [W/K]
- Do you know the overall heat loss coefficient of all pipes in the collector loop?
    - Heat loss coefficient [W/K]

Sub-tab: Auxiliary Energy & Distribution Losses

- Are the distribution pipes between the solar energy system and the back-up system insulated? *(field enabled only if the solar pre-heating type is a separate solar cylinder)*
- Circulation system
    - Do you know the nominal power of the pumps?
        - Nominal power of the pumps [W]

Tab: PV Systems

Sub-tab: General

- PVS name

either

- PVS type
- PVS area [m^2]

or

- PVS peak power
- PVS multiplier
- PVS orientation
- PVS inclination [degrees]
- PVS overshading
- PVS ventilation strategy

Tab: Wind Generators

Sub-tab: General

- Wind generator name
- Terrain type
- Horizontal axis?
    - Diameter of blades [m]
- Other axis?
    - Area swept by blades [m^2]
- Hub height [m]
- Wind generator power [kW]

Tab: CHP Generator

Sub-tab: General

- Fuel type
- Heat efficiency
- Electrical efficiency
- CHPQA Quality Index
- % of building space heat supplied by CHP
- % of building hot water supplied by CHP
- Is it a tri-generation system?
    - % of building space cooling supplied by CHP
    - Chiller efficiency

Tab: Solar Collectors

Sub-tab: General

- SC name
- SC type
- SC control type
- SC shading factor
- TSC type
- TSC operation
- TSC absorptivity
- NTSC collector height [m]
- NTSC air temperature coefficient [K/(W/m^2)]
- Air flow rate coefficient

Sub-tab: Air flows

- Is SC provided with independent fan?
    - SC supply specific fan power [W/(l/s)]
- SC design air flow rate [m^3/s]

Tab: Showers

Sub-tab: General

- Shower name
- Type of shower
- Shower above a bath?
- Shower fitted with a WWHRS?
    - Heat recovery seasonal system efficiency of WWHRS
    - WWHRS uses a pump?
        - Nominal power of pump [W]

Tab: Zones

Sub-tab: HVAC, HWS, and Lighting systems

- HVAC system which services the zone
- Are there de-stratification fans in the zone?
- HWS which serves the zone
- Dead leg length for HWS in the zone [m]

Sub-tab: Ventilation

- Zonal ventilation system – natural or mechanical *(field enabled if there is no mechanical ventilation at HVAC level)*
    - Specific fan power for supply & extract [W/(l/s)] (*field enabled if there is mechanical ventilation at zone level)*
    - Demand-controlled ventilation?
        - Flow regulation type
- Does activity require high pressure drop air treatment?

Sub-tab: Ventilation (cont.)

- Heat recovery in the zone ventilation (*field enabled if there is mechanical ventilation at zone level)*
    - Heat recovery seasonal efficiency
    - Variable heat recovery efficiency?
- Specific fan power for system terminal units [W/(l/s)] (*field enabled if HVAC serving the zone is 'Fan coil systems' or 'Indoor packaged cabinet (VAV)')*

Sub-tab: Exhaust

- Is there mechanical exhaust in the zone?
    - Flow rate of mechanical exhaust [l/s.m^2]
    - Specific fan power for exhaust [W/(l/s)]
    - Fan within zone, remote from zone, or remote from zone with grease filter?

Sub-tab: Lighting

- Design illuminance [lux]
- Provide information on lighting using one of the following 3 options:

  1) Full lighting design
      - Total wattage [W]

  or

  2) Lighting chosen but calculation not carried out
      - Light source lumens per circuit wattage
      - Light output ratio

  or

  3) Lighting parameters not available
      - Lamp type
- Are air-extracting luminaries fitted?

Sub-tab: Lighting Controls

- Type of lighting controls in the zone
    - Local manual switching?
    - Photoelectric?
        - Dimming or switching?
        - Type of sensors?
        - Different sensor for back of zone?
    - Constant illuminance control?
        - Parasitic power for photoelectric control and/or constant illuminance control
    - Do you want SBEM to perform automatic daylight zoning for lighting controls?
        - Percentage area of zone where lighting is controlled by daylight.
- Type of occupancy sensing in the zone
    - Parasitic power for occupancy sensing

Sub-tab: Display Lighting

- Does display lighting use efficient light sources? *(field enabled for activities with display lighting)*
    - Light source lumens per circuit wattage for display lighting
- Is there time-switching for display lighting? *(field enabled for activities with display lighting)*

Sub-tab: SC

- Name of SC system providing pre-heated air to this zone
- Percentage of the total air pre-heated by the SC system that is provided to this zone