



Non-Domestic Energy Assessment Procedure – Modelling Guide

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INTRODUCTION

The Non-Domestic Energy Assessment Procedure (NEAP) is the methodology for demonstrating compliance with specific aspects of the Technical Guidance Document - Part L of the Building Regulations. NEAP is also used to generate the Building Energy Rating (BER) and advisory report for new and existing non-domestic buildings. NEAP calculates the energy consumption and CO₂ emissions associated with a standardised use of a building. The energy consumption is expressed as kilowatt hours per square metre floor area per year (kWh/m².annum) and the CO₂ emissions expressed in terms of kilograms of CO₂ per square metre floor area per year (kg CO₂/m².annum). NEAP allows the calculation to be carried out by approved software packages or by the default calculation tool, Simplified Building Energy Model for Ireland (SBEMie), which is based on CEN standards and has been developed by BRE on behalf of the UK's Ministry of Housing, Communities, and Local Government (MHCLG). SBEMie, accompanied by a basic user interface, iSBEMie, calculates monthly energy use and CO₂ emissions based on building geometry, construction, use, and HVAC and lighting equipment. The purpose of SBEMie and its interface iSBEMie is to produce consistent and reliable evaluations of energy use in non-domestic buildings for Building Regulations compliance and Building Energy Rating purposes. Although SBEMie may assist in the design process, it is not primarily a design tool. SEAI gratefully acknowledges the co-operation of the UK authorities (MHCLG) in enabling the adaptation of the UK's SBEM and publication of SBEMie for official use in Ireland, within the framework of NEAP.

The Irish approval scheme and validation procedure of non-domestic building energy calculation software

a. Introduction

Non-domestic building energy calculation software packages to calculate building asset rating must be approved by the Sustainable Energy Authority of Ireland (SEAI) before they could be available for commercial use in the Republic of Ireland.

This document outlines details of the approval scheme and elaborates on the validation procedure necessary to achieve approval from SEAI. This will be relevant to the following non-domestic software classification:

- Dynamic Simulation Modelling (DSM)
- Interface for SBEMie

The approval scheme has two outcomes:

- i. An approval by SEAI that the software in its current state and form has met all compliance requirements and therefore is fit for commercial use
- ii. An application is deferred as it has not met all compliance requirements. In this case, recommendations will be provided as to how compliance can be achieved.

Submission criteria are as follows:

- The applicant software must already be approved for commercial use in England and Wales
- Relevant information requested have been provided
- Demonstrate that self-assessment has been carried out and a report is included to justify this.

Application that satisfies the listed criteria will be accepted and this will mark the start of the validation process. Otherwise SEAI will defer the application until outstanding issues are resolved.

b. Definition of software class

Two software classes are being validated and approved in this scheme and the following are their definitions:

- **Front-end Interface for the Simplified Building Energy Model engine (FI-SBEM)**
Front-end software that interfaces with the iSBEMie™ or SBEMie™ engine to calculate building Energy Performance Coefficient, Carbon Performance Coefficient and Building Energy Rating.
- **Dynamic Simulation Modelling (DSM)**
This primarily applies to building analysis software that can model the dynamic response of the building to parameters such as external environment, internal gains, and may also include the dynamic interactions of the building services. DSM software must be able to use the environmental conditions set by the CIBSE annual hourly weather tapes. This class of software will also have the capability to calculate Energy Performance Coefficient, Carbon Performance Coefficient and Building Energy Rating.

c. Required information when submitting an application

When applying to the approval scheme, the software vendor must supply the following:

- vendor company name, mailing address
- vendor representative name and contact detail (email address)
- software package name and version number
- software classification
- a separate application is required for each software that fits more than one classification, or for each software of the similar class but with different configurations
- confirmation that the software meets test specifications and guidance by undergoing a self- assessment procedure
- DSM software must meet or exceed the classification of dynamic modelling under CIBSE AM11.
- Approved Dynamic Simulation Model (DSM) software must automatically generate both the Notional and Reference buildings from information provided by the user for the Actual building.
- All software is expected to be developed in accordance with ISO 90003:2004 – ‘Guidelines for the application of ISO 9001:2000 to computer software’.

All the above information should be provided in the pro-forma supplied with the information package and included in the submission package.

d. Self-assessment procedure

Along with the test cases, the vendor will also receive a set of self-assessment procedures. The self- assessment procedure will ensure that the software test case outputs are compliant with a required set of guidelines before a submission is made. For each software class, the relevant document or input reference files will be provided, against which the vendor’s software output will be benchmarked.

A document summarising the relevant calculation output for each test cases will be provided. This should cover the annual primary energy consumptions and related emissions, Energy Performance Coefficient, Carbon Performance Coefficient, Renewable Energy Ratio, Building Energy Rating (BER), amongst other parameters.

A report summarising the outcome of the self-assessment must be produced and included in the application submission. The template for this is attached in the pro-forma included in the information package. An application will not be accepted until divergences from reference are resolved unless otherwise clearly

justified. This is to ensure smooth progress of the validation process.

e. Application and submission of deliverables

After the software tests are completed, an application must contain all the required deliverables listed below:

- Submission pro-forma or checklist
- BRIRL summary document (in *.pdf* format)
- Building Energy Rating (BER) Certificate (in *.pdf* format)
- Documentation of additional results from test models

f. Validation procedure

Submitted tests will first pass through a high-level sanity check to ascertain compliance of submission to specified guidelines. Passing the check, the application will be processed and the software test output will be validated. For the DSM software tests, agreement within stringent margins must be achieved with SEAI's reference results.

In cases where discrepancies are discovered in the software test output, the vendor will be contacted for consultation regarding outstanding issues. The vendors will be given two attempts, with duration of two weeks for each attempt, to resolve all the raised issues. Thereafter, the submission will be considered below compliance standards and hence will be deferred. A new application will be required for further attempt at obtaining SEAI software approval.

g. Recommendation

At the end of the validation process, if all criteria are met and Software Testing House is satisfied with the general outcome, recommendations will be forwarded to SEAI to approve the software. The decision by SEAI is final and any dispute raised will not be entertained by SEAI. SEAI will propagate the process by approving the software at its current form and sending out official notice of approval to the software vendor.

If the software does not meet requirements, a recommendation to defer the application will be forwarded to SEAI. SEAI again holds the final decision and a notice will be sent to the vendor. Where applicable, recommendations will be provided to the vendor as to how to proceed to improve the software to meet specifications and to achieve future compliance. To achieve compliance and approval in future, new application will be required.

h. Re-validation for re-approval

It is accepted that software packages undergo constant changes to incorporate fixes, upgrades and improvements over time. However, this exposes the software to potential unintended modification affecting its calculation. For this reason, software will need to be re-validated and then re-approved.

Conditions/changes that render the approval status void, hence requiring software to be re-validated are:

- major changes to software architecture, calculation engine, platform or software name
- changes initiated by vendor developer affecting calculation
- changes to guidance and specification requiring software packages to comply
- when self-validation fails

For minor changes, a self-validation procedure should be exercised. This requires the vendor to carry out the similar tests carry out in the original validation process on their latest software. The pro-forma should then be used to submit a report to SEAI to update of changes to software version number and to confirm that the changes have not affected its approval status. If self-validation fails, the vendor will have to make a full application

again.

i. Software validation tests and procedures

As the applicant software must already been approved for commercial use in England and Wales, a reduced version of the test cases has been introduced. Essentially, there are six test cases to assess the ability of the software to emulate the reference and the notional building in the actual building and its compliance with the Irish Part L.

j. Registration of Software

Once software has been recommended for approval, the software must meet the following:

- The xml produced by the software for upload onto the Non Domestic NAS database must contain access to all inputs into the model (Data Reflection Report/ inp file)
- A licence for the software must be made available to SEAI for validation of the software for duration of the validity of the software.

k. SBEM Constraints

Certain building features are not currently modelled explicitly in SBEM and so representing such features in an adequate way will require somewhat cumbersome data preparation work. This problem is not insurmountable and is most likely to arise where buildings and their systems have features that have properties which vary non linearly over periods of the order of an hour.

Example of building features where such issues can arise include:

- a. Buildings with ventilated double skin facades
- b. Light transfer between highly glazed internal spaces such as atria or light wells

Where these features are found, Energy Assessors can expect the need to pay more attention to manipulating input data and recording any assumptions made and their justifications.

It is recommended that users make full use of features such as the “multiplier” function and merging of all contiguous similar areas (see paragraph 171), in order to generally avoid creating more than 100-150 zones in SBEMie on computers running 32-bit Windows operating systems. However, there will be an optional 64-bit version of SBEMie available which can be used on computers running 64-bit Windows operating systems, and which should allow users to run the calculation for particularly large projects that cannot be processed, due to memory limitations, using the "original" 32-bit SBEMie engine (NB: The 64-bit of SBEMie will not run on computers with 32-bit Windows operating systems).

COMPLIANCE WITH BUILDING REGULATIONS

1. Regulation L5(a) of the 2017 Technical Guidance Document – Part L (TGD-L) requires that all new buildings other than dwellings limit the calculated primary energy consumption and Carbon Dioxide (CO₂) emissions to a Nearly Zero Energy Building level insofar as is reasonably practicable, when both energy consumption and CO₂ emissions, calculated using the Non-domestic Energy Assessment Procedure (NEAP), do not exceed the target values specified in the TGD-L.
2. The performance criteria are based on the relative values of the calculated primary energy consumption rate and CO₂ emission rate of a building being assessed, and similar calculated values for a Reference building. This section of the guide gives detailed specifications of the Reference building and defines the basis for setting the target values.
3. A minimum Renewable Energy Ratio must also be achieved to comply with Nearly Zero Energy Building requirements under Part L of the Building Regulations.

THE REFERENCE BUILDING

4. The Reference building must have the same size, shape, and zoning arrangements as the Actual building, with the same conventions relating to the measurement of dimensions (see section on Measurement and other conventions).
5. Each space must contain the same activity (and, therefore, the same activity parameter values) as proposed for the equivalent space in the Actual building. The activity in each space must be selected from the list of activities as defined in the NEAP Activity Database (see section on Defining internal gains and environmental conditions).
6. The Reference building must be given the same orientation and be exposed to the same weather data as the Actual building. For DSM software, the Reference building must be subject to the same site shading from adjacent buildings and other topographical features as are applied to the model of the Actual building.
7. Whatever system type (heating, ventilation, cooling) is specified in a zone in the Actual building must also be provided in the Reference building. Note that, in some zones, heating need not be provided, even though the NEAP Activity Database specifies a heating set-point. For example, the Actual building may contain an unheated stairwell or atrium space. The corresponding zones in the Reference building must also be unheated. However, if heating were provided to either of these spaces in the Actual building, then heating must correspondingly be specified in the Reference building, and then both buildings must heat those spaces to the heating set-point specified for the zone type in the NEAP Activity Database.
8. Any building services system not covered by the energy performance requirements in the Building Regulations or impacting on the environmental conditions within the building must be ignored in both the Actual and Reference buildings.

Activity glazing class

9. In the Reference building, the activity assigned to each zone determines whether it will have access to daylight through windows, roof-lights, or no glazing at all (i.e., no access to daylight), regardless of the type of glazing applied to the equivalent zone in the Actual building. The glazing class assigned to each NEAP activity is determined in the “activity” table from the NEAP Activity Database in the “DRIVER2A” field (*0 for activity with no daylight, i.e., unlit, 1 for side-lit activity, and 2 for top-lit activity*).

Building fabric

10. The U-values must be as specified in **Table 1**. All U-values must be calculated following the guidance in BR443¹. The Reference building's constructions conforming to these U-values are provided in APPENDIX A – CONSTRUCTION DETAILS FOR 2017 REFERENCE BUILDING of this document. In addition, the general guidance in the section on Constructions must be followed.

Table 1 Construction element U-values and thermal capacity for the Reference building		
Element	U-value (W/m²K)	Thermal capacity² (kJ/m²K)
Roofs ³ (irrespective of pitch)	0.15	88.3 (1.40 if metal-clad)
Walls	0.18	21.8 (1.40 if metal-clad)
Exposed and ground floors (subject to paragraph 17)	0.15	77.7
Windows and glazed doors*	1.4	-
Roof windows and roof-lights*	1.6	-
Pedestrian doors and high usage entrance doors	2.2	54.6
Vehicle access and similar large doors	1.5	2.1
Internal wall	1.80	8.8
Internal floor/ceiling	1.00	71.8 from above / 66.6 from below
*This is the overall U-value including the frame and edge effects, and it relates to the performance of the unit in the vertical plane so, for roof-lights, it must be adjusted for the slope of the roof (BR443 ¹). The roof-lights in the Reference building are assumed to be conical or domed, and hence, for the purposes of heat transfer calculations, their developed to projected ratio is set to 1.3 (as opposed to 1.0 for flat ones), i.e., the area of the roof-light is 1.3 times the area of the opening in the roof, and its U-value adjustment is taken as +0.3 W/m ² K if the roof is flat and +0.2 W/m ² K if the roof is pitched.		

11. Zones in the Reference building which use activity types flagged as involving metal cladding in the NEAP Activity Database will use metal-clad construction elements and the associated Psi values from **Table 2** for thermal bridges. Whether or not the activity involves metal cladding is determined in the “activity” table from the NEAP Activity Database in the “METAL_CLADDING” field (0 for activity with no metal-clad constructions, and 1 for activity with metal-clad constructions).

12. For SBEMie, the thermal capacity of the construction elements must be as defined in **Table 1**. For DSM software, the construction details in APPENDIX A – CONSTRUCTION DETAILS FOR 2017 REFERENCE BUILDING provide the necessary technical parameters to account for the effect of thermal capacity. The thermal mass of windows should be ignored.

¹ Conventions for U-value calculations, BRE, 2006.

² Thermal capacity calculation in EN ISO 13790:2004.

³ Any part of a roof having a pitch greater than or equal to 70° is considered as a wall.

13. The Reference building does not have curtain walling, even if there is curtain walling in the Actual building.
14. Smoke vents and other ventilation openings, such as intake and discharge grilles, must be disregarded in the Actual, Reference, and Notional buildings, and their area substituted by the relevant opaque fabric (i.e., immediately surrounding roof or wall).
15. For SBEMie and DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) must be allowed for by a method that satisfies BS EN ISO 14683, or by adding 10% to the standard area-weighted average U-values and be consistently applied to both Actual and Reference buildings. Note that the U-values as given in **Table 1** DO NOT include this allowance so the calculation tool must make the adjustment explicitly.
16. Where a method that satisfies BS EN ISO 14683 is used to take account of non-repeating thermal bridges, the Psi values for the Reference building will use the values from **Table 2**.

Table 2 Psi values for the Reference building (W/mK)		
Type of junction	Involving metal cladding	Not involving metal-cladding
Roof to wall	0.28	0.12
Wall to ground floor	1.0	0.16
Wall to wall (corner)	0.2	0.09
Wall to floor (not ground floor)	0.0	0.07
Lintel above window or door	1.0	0.30
Sill below window	0.95	0.04
Jamb at window or door	0.95	0.05

17. Special considerations apply to ground floors, where the U-value is a function of the perimeter/area ratio. The following adjustments must be made⁴:
- If the calculated value is greater than or equal to 0.15 W/m²K, the value of 0.15 W/m²K must be used in the Reference building.
 - If the calculated value is less than 0.15 W/m²K with no added insulation, this lower value must be used in the Reference building.
18. When modelling an extension, the boundary between the existing building and the extension must be disregarded (i.e., assume no heat transfer across it).
19. Zones in the Reference building will use the air permeability values from Table 3. The calculation method used to predict the infiltration rate must use the air permeability as the parameter defining the envelope leakage. For compliance and BER assessments, the same method must be used in the Actual, Reference, and Notional buildings. Acceptable methods include:
- The method specified in the SBEMie Technical Manual⁵, which is taken from EN 15242⁶.

⁴ This follows the guidance given in CIBSE Guide A (2006).

⁵ SBEMie Technical Manual will be available at [SEAI's website](#).

⁶ Ventilation for buildings – Calculation methods for the determination of air flow rates in buildings including infiltration, EN 15242, CEN/TC 156, 2006.

- b. Other methods that use a relationship between infiltration rate and air permeability and are set out in national or international standards or recognised Republic of Ireland/UK professional guidance documents which relate average infiltration rate to envelope permeability. An example of the latter would be tables 4.13 to 4.20 of CIBSE Guide A (2006).

Methods that use flow networks are not acceptable for compliance or BER purposes as there is no simple way to check that the permeability of the Reference building delivers the required permeability standard.

Table 3 Air permeability for the Reference building (m ³ /h per m ² of envelope area at 50 Pa)	
Gross internal area of the building	Side-lit, top-lit, or unlit activities
Less than or equal 250 m ²	5
Greater than 250 m ²	3

Areas of windows, doors, and roof-lights

20. The areas of windows, doors, and roof-lights in the Reference building must be determined as set out in the following sub-paragraphs and must also conform to the measurement conventions set out in the section on Measurement and other conventions.

- a. Copy the areas of high usage entrance, pedestrian, and vehicle access doors that exist in the corresponding element of the Actual building.
 - b. In the Reference building, high usage entrance, pedestrian, and vehicle access doors must be taken as being opaque (i.e., with zero glazing) and use the U-values in **Table 1**.
 - c. If the total area of these elements is less than the appropriate allowance for glazing from Table 4, the balance must be made up of windows or roof-lights as appropriate.
 - d. If the total area of the copied elements exceeds the allowance for glazing from Table 4, the copied areas must be retained but no windows or roof-lights added.
 - e. For DSM software, the shape of windows in side-lit activities should be modelled as a full facade width window with sill height of 1.1 m. Where doors have been copied across from the Actual building, the window will occupy the remaining facade width, and the height adjusted such that the total area of opening areas still satisfies Table 4.
21. Display windows in the Actual building are not copied across into the Reference building.

Table 4 Glazing in the Reference building				
Activity glazing class	Glazing area (glass + frame)	g-value (EN ISO 410)	Frame factor	Visible light transmittance
Side-lit	Exposed facades will have windows with area that is the lesser of either: 1.5 m high × full facade width OR 40% of exposed facade area	40%	10%	71%
Top-lit	12% of exposed roof area will be made up of roof-lights*	40%	30%	71%

Unlit	No windows or roof-lights	n/a
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*The number of roof-lights per roof element is determined using the following equation:

$$\text{Number of rooflights per roof element} = \frac{\text{roof element area}}{\left(\frac{1.68 \times \text{zone height}}{\cos(\text{angle of slope})}\right)^2}$$

The number of roof-lights should be rounded to the nearest integer and be greater than zero. Where the roof element is sloped, the zone height should be the height to the eaves or lowest point of the roof element.

22. DSM software are required to use the glass data provided in Table 5 to model the glazing specification required in Table 4, where T_{solar} is the direct solar transmittance, T_{visible} is the direct visible light transmittance, R_{solar} is the solar reflectance, and R_{visible} is the visible light reflectance. The subscripts 1 and 2 refer to the outer and inner surfaces of each pane of glass, respectively.

	Thickness	T_{solar}	$R_{\text{solar}1}$	$R_{\text{solar}2}$	T_{visible}	$R_{\text{visible}1}$	$R_{\text{visible}2}$	Emissivity 1	Emissivity 2
Outer pane	6mm	0.409	0.289	0.414	0.798	0.051	0.040	0.837	0.042
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.783	0.072	0.072	0.889	0.081	0.081	0.837	0.837

23. No glazed area should be included in basements. In semi-basements (i.e., where the wall of the basement space is mainly below ground level but part is above ground), the opening areas in Table 4 must apply to the above-ground part (note that in such situations, the 1.1 m sill height rule would not need to be followed), with zero glazing for the below-ground part.

HVAC system

24. Each space in the Reference building will have the same level of servicing as the equivalent space in the Actual building. In this context, “level of servicing” means the broad category of environmental control, summarised as follows:

- unheated
- heated only with natural ventilation
- heated only with mechanical ventilation
- heated and cooled (air-conditioned)
- heated and cooled with mixed-mode, where cooling only operates in peak season to prevent space temperatures exceeding a threshold temperature higher than that normally provided by a full air-conditioning system.

25. A space is only considered as having air-conditioning if the system serving that space includes refrigeration. Night cooling using mechanical ventilation is not air-conditioning. If the same mechanical ventilation system that is used for night cooling is also used to provide normal ventilation, then the space should be regarded as being mechanically-ventilated. Any boosted supply rate required to limit overheating must be ignored in the Reference and Actual buildings.

If the mechanical ventilation system only operates in peak summer conditions to control overheating, and during normal conditions ventilation is provided naturally, then the space must be regarded as naturally-ventilated, and the mechanical ventilation system can be ignored in both Reference and Actual buildings.

26. If a zone is naturally-ventilated, the modelling strategy must provide for enhanced natural ventilation in the Reference building to prevent overheating. If this is not done, heat will build up and artificially depress the demand for heating the next day, thereby making the energy target unrealistically harsh. For DSM software⁷, the following modelling strategy must be used in the Reference building. The strategy must increase the natural ventilation rate up to a maximum of 5 air changes per hour whenever the space temperature exceeds the heating set-point⁸ by 1°K. This enhanced ventilation must cease immediately the space temperature falls below the heating set-point. *By maintaining the increased natural ventilation until internal temperatures fall to the (high) heating set-point, the temperatures at start-up next day will be neither artificially high nor low.*
27. Humidity control is ignored in the Actual, Reference, and Notional buildings.
28. The system performance definitions follow the practice set out in EN 15243⁹:
- Auxiliary energy is the energy used by controls, pumps, and fans associated with the HVAC systems. It is the term described as “fans, pumps, controls” in Energy Consumption Guides such as ECG019¹⁰.
 - Heating Seasonal Coefficient of Performance (SCoP) is the ratio of the sum of the heating consumption of all spaces served by a system to the energy content of the fuels (or electricity) supplied to the boiler or other heat generator of the system. The SCoP includes boiler efficiency, heat losses in pipework, and duct leakage. It does not include energy used by fans and pumps (but does include the proportion of that energy which reappears as heat within the system). For DSMs, the ventilation supplied to the zone must be taken as the outdoor air temperature. For SBEMie, adjusted monthly average figures should be used as specified in the SBEMie Technical Manual⁵. Heating energy consumption is, therefore, calculated from the following expression:

Equation 1 *Heating energy consumption = Zones annual heating load / SCoP*

- The Seasonal System Energy Efficiency Ratio for cooling (SSEER) is the ratio of the sum of the sensible cooling consumption of all spaces served by a system to the energy content of the electricity (or fuel) supplied to the chillers or other cold generator of the system. The SSEER includes, inter alia, chiller efficiency, heat gains to pipework and ductwork, duct leakage, and removal of latent energy (whether intentional or not). It does not include energy used by fans and pumps (but does include the proportion of that energy which reappears as heat within the system). Electricity used by heat rejection equipment associated with chillers is accounted for in the SSEER (not as auxiliary energy). Electricity used within room air conditioners for fan operation is also included in the SSEER value since it is included in the standard measurement procedure for their EER. Electricity used by fossil-fuelled equipment and its ancillaries, including fans in unit heaters and gas boosters, is included in the auxiliary energy. For DSMs, the ventilation supplied to the zone must be taken as the outdoor air temperature. For SBEMie, adjusted monthly average figures should be used as specified in the SBEMie Technical Manual⁵. Cooling energy consumption is, therefore, calculated from the following expression:

⁷ Such an approach is not needed in SBEM, since the form of the model means that there is no feedback between overheating on one day and the energy demands on the next.

⁸ This guidance assumes that zone heat output is zero when the heating set-point is exceeded. If models use a proportional band to modulate heating output, the heating set-point in this context should be regarded as the temperature at the top of the proportional band, not its mid-point.

⁹ EN 15243, Ventilation for Buildings – Calculation of room temperatures and of load and energy for buildings with room conditioning systems, CEN, 2007

¹⁰ Energy use in offices, Energy Consumption Guide 19, Action Energy, 2003

Equation 2

$$\text{Cooling energy consumption} = \text{Zones annual cooling load} / \text{SSEER}$$

29. For the purposes of heating, cooling, and auxiliary energy calculations, the ventilation should operate on a flat profile that is on during the occupied period only, (i.e., each hour when the NEAP daily schedule for occupancy is greater than zero). The flow rate is determined by the product of the peak occupancy density and fresh air rate per person (both from the NEAP Activity Database). The profile is the same for both natural and mechanical ventilation and does not modulate with the occupancy profile.
30. The cooling, where applicable, and auxiliary energy must be taken to be powered by grid-supplied electricity.
31. In air-conditioning mode, the cooling SSEER is 3.6, which already takes account of 20% distribution losses and fan energy associated with heat rejection (i.e., SEER is 4.5), with the following exceptions:
- For zones in the Reference building which use activity types where at least one of the following associated conditions from the NEAP Activity Database happens to be true, the cooling SSEER is to be taken as 3.0:
 - Fresh air rate is > 40 litres/s per person
 - Illuminance level > 50000 Lux
 - Equipment heat gains > 100 W/m²
 - For zones in the Reference building which use healthcare activity types flagged as served by a “Terminal reheat (constant volume)” system in the NEAP Activity Database (in the “TR” field of the “activity” table), the SSEER is to be taken as 1.67.
32. Text regarding future free cooling facility to be added here.
33. In mixed-mode operation, the Reference building will have a cooling SSEER¹¹ of 2.7 with a cooling set-point of 27°C.
34. The space heating and hot water generators in the Reference building must be taken as boilers fuelled by natural gas, regardless of the heat source and fuel used by the equivalent systems in the Actual building.
35. Whether the HVAC specification is for heating only or heating & cooling, the Seasonal Coefficient of Performance (SCoP) for space heating in the Reference building is 81.9%, which already takes account of system losses of 10% (i.e., generator efficiency is 91%).
36. The Seasonal Coefficient of Performance (SCoP) for water heating in the Reference building is 86.45%, which already takes account of system losses of 5% (i.e., generator efficiency is 91%).
37. For hot water, the energy demand must be taken as that required to raise the water temperature from 10°C to 60°C based on the demands specified in the NEAP Activity Database. The Activity Database defines a daily total figure in l/m²per day for each activity type. If users of DSMs wish to distribute this demand over the day, then the daily total should be distributed according to the occupancy profile.
38. If the Actual building has a hot water storage cylinder, then so will the Reference building, using the same cylinder volume as in the Actual building, if this is specified, or a default volume calculated following the method described in the SBEMie Technical Manual⁵, if it is not. The storage cylinder in the Reference building will have 50 mm of factory insulation.

¹¹ Note that mixed-mode cooling is assumed to be provided by DX unit where the SSEER includes indoor and outdoor units, fans, pumps, and losses.

39. If the Actual building has a secondary circulation for hot water, then so will the Reference building, using the same loop length and pump power specified in the Actual building but with circulation losses of 8.62 W/m and time control.
40. In zones where hot water is drawn off, any deadleg length specified in the Actual building is copied over to the corresponding space in the Reference building.

Auxiliary energy

41. The auxiliary energy is the product of the auxiliary power density and annual hours of operation of the heating system as taken from the NEAP Activity Database (*i.e.*, the hours when the heating set-point is above the set-back temperature based on the daily/weekly/annual schedules or the “SYS_HEAT_T_HOURS_#” from the “activity_sbem_D1_ACU” table in the NEAP Activity Database).
42. The auxiliary power density is the sum of the pump and fan power density.
43. The pump power density for zones in the Reference building will depend on the HVAC system’s configuration in the Actual building so that it is 0.30 W/m² where the HVAC system provides heating only to the zone and 0.90 W/m² if it provides both heating and cooling, except for the activity types flagged as served by a “Terminal reheat (constant volume)” system in the NEAP Activity Database (paragraph 31.b), where the pump power density is 0.6 W/m² if the HVAC system provides heating only and 1.8 W/m² if it provides both and cooling (see paragraph 45 and **Table 9**).
44. For zones where the ventilation system also provides heating or heating & cooling, except those using activity types flagged as served by a “Terminal reheat (constant volume)” system in the NEAP Activity Database (paragraph 31.b), the fan power density is determined for each zone using the following equations:

Equation 3 $Fan\ power\ density = Lesser\ of\ (FPS_1, FPS_2)$

Equation 4 $FPS_1 = FAR_{max} \times SFP_{central} + SCR \times SFP_{terminal}$

Equation 5 $FPS_2 = Greater\ of\ (FAR_{max}, SCR) \times SFP_{central}$

For zones where the ventilation system also provides heating or heating & cooling and use activity types flagged as served by a “Terminal reheat (constant volume)” system in the NEAP Activity Database (paragraph 31.b), the fan power density is determined for each zone using the following equation:

Equation 6 $Fan\ power\ density = FPS_2$

where:

$$SFP_{central} = 1.80\ W\ per\ l/s^{12},\ and\ SFP_{terminal} = 0.30\ W\ per\ l/s$$

“FAR_{max}” is the peak fresh air supply rate (l/s/m²) that is set by the activity type in the NEAP Activity Database, while “SCR” is the space conditioning supply rate (*i.e.*, the air flow rate needed to condition the space, in l/s/m²), and is calculated as follows:

Equation 7 $SCR = Greater\ of\ (PSH, PSC) / (\rho \times C_p \times \Delta T)$

where:

$$\rho = 1.2\ kg/m^3,\ C_p = 1.018\ kJ/kgK,\ and\ \Delta T = 8K,$$

“PSH” is the peak space heating load, and “PSC” is the peak space cooling load (*i.e.*, in W/m² of floor area for each zone).

¹² If the activity in the space requires the use of higher levels of filtration, e.g., high efficiency particulate air (HEPA) filters, then the specific fan power is increased by 1.0 W per l/s to account for the increased pressure drop.

For both parameters, the effects of thermal mass will be ignored. The peak space heating load is the sum of the steady state peak fabric losses and infiltration load based on an external ambient of 0°C. The peak space cooling load is the sum of the individual peaks for occupancy, equipment, general lighting, display lighting, and solar. For SBEMie, the peak solar gain is calculated using the solar data for September from Table 2.30 of CIBSE Guide A (using the beam and diffuse solar for each hour between 06:30 and 18:30). The total solar gain for each room is calculated, and the peak hour is used. DSM software will use the peak solar calculated during simulation.

45. The Reference building benefits from variable speed pumping with multiple pressure sensors in the system, except in zones using the activity types flagged as served by a “Terminal reheat (constant volume)” system in the NEAP Activity Database (paragraph 31.b) which do not have variable speed pumping (see paragraph 43 and **Table 9**).
46. For zones where the ventilation system does not provide heating or cooling, the fan power density is the product of the fresh air supply rate for the activity type from the NEAP Activity Database and a specific fan power of 0.90 W per l/s¹² (supply & extract).
47. For zones with local mechanical exhaust where the fan is within the zone, the fan power density is the product of the user-defined exhaust rate and a specific fan power of 0.40 W per l/s. For zones where the mechanical exhaust is remote from the zone, the fan power density is the product of the user-defined exhaust rate and a specific fan power of 0.60 W per l/s. The exhaust fan energy will be an addition to the fan energy for supply & extract ventilation. Note that the user-defined exhaust rate is not considered in the air load calculations.
48. In zones with mechanical ventilation, the Reference building benefits from demand control of ventilation through variable fan speed control based on CO₂ sensors, except in zones using activity types flagged as served by a “Terminal reheat (constant volume)” system in the NEAP Activity Database (paragraph 31.b) which do not have demand control of ventilation.
49. The Reference building has no power factor³² correction and no monitoring and targeting with alarms for out-of-range values (see **Table 25**).

Lighting power density

50. The general lighting in the Reference building is based on lighting with efficacy of 65 luminaire lumens per circuit-watt, and the resulting power density (W/m²) will vary as a function of the geometry of each zone modelled, which will be determined using the following equation:

Equation 8
$$\text{Power density per 100 lux} = (1.79 + 0.007 \times R + 0.058 \times R^2) / MF$$

Where R is the ratio of the total wall area¹³ to the total floor area, where the maximum value for R is 8, and MF is the maintenance factor which, for the Reference building, is taken as 0.8. The power density per 100 lux is then multiplied by the illuminance level for the activity type, which is determined by the NEAP Activity Database, and divided by 100. This equation was derived using regression analysis of parametric results produced using lighting design software for a range of space geometries and lighting systems.

¹³ For the purposes of the lighting power density calculation, the total wall area includes exposed facades and internal partitions, but not virtual partitions/walls used to define perimeter zones in open plan areas. The floor area should exclude voids in the floor or virtual ceilings.

51. All zones in the Reference building which receive natural daylight directly (i.e., through glazing in the zone's own external envelopes) will be modelled with photo-electric dimming (as defined in the SBEMie Technical Manual⁵), without back-sensor control and with continuous (i.e., always on) parasitic power of 0.3 W/m².
52. Zones in the Reference building which do not receive natural daylight directly (i.e., through glazing in the zone's own external envelopes), but are flagged in the NEAP Activity Database as appropriate to have local manual control, will be modelled with local manual switching (as described in the SBEMie Technical Manual⁵), provided the floor area of the zone is less than 30 m². Otherwise, the general lighting is switched centrally based on the occupancy hours for the activity in the NEAP Activity Database. Whether or not the activity is appropriate to have local manual control is determined in the "activity" table from the NEAP Activity Database in the "BR_CHECK02" field (*1 for activity that is not appropriate to have local manual control, and 0 otherwise*).
53. Zones in the Reference building do not benefit from constant illuminance control¹⁸.
54. All zones in the Reference building will be modelled with occupancy sensing (as defined in the SBEMie Technical Manual⁵), if appropriate (i.e., if activity is flagged in the NEAP Activity Database as appropriate to have local manual control), in the form of a "Manual-on-Auto-off" system (i.e., lights are manually switched on and automatically switched off when no movement has been detected for a set time, e.g., 5-15 minutes) with a continuous (i.e., always on) parasitic power density of 0.3 W/m². Whether or not the activity is appropriate to have local manual control is determined in the "activity" table from the NEAP Activity Database using the "BR_CHECK02" field, as described in paragraph 52.
55. The display lighting, where applicable, in the Reference building is based on the display lighting power density from the NEAP Activity Database multiplied by 0.682 (i.e., adjustment between lamp efficacy of 22 and 15 lumens per circuit-watt). Daylight harvesting and local manual switching do not apply to display lighting in the Reference building (i.e., only affects general lighting).
56. The display lighting in the Reference building does not benefit from automatic time switch control.
57. Both general lighting and display lighting (where appropriate) will use the same operating profile as defined in the NEAP Activity Database for each activity.

Renewable Energy

58. The Reference Building will have a renewable energy contribution from photovoltaics based on the equivalent of 20% of the Reference building's primary energy use, i.e., the Reference building's RER = 0.2 (see paragraph 61).

LIMITATION OF PRIMARY ENERGY USE AND CO₂ EMISSIONS

The MPEPC, MPCPC, and Minimum RER

59. The calculated primary energy consumption rate of the proposed building is divided by that of the Reference building, the result being the Energy Performance Coefficient (EPC) of the proposed building. To demonstrate that an acceptable primary energy consumption rate has been achieved, the calculated EPC of the building being assessed should be no greater than the Maximum Permitted Energy Performance Coefficient (MPEPC), which is 1.0.
60. The calculated CO₂ emission rate of the proposed building is divided by that of the Reference building, the result being the Carbon Performance Coefficient (CPC) of the proposed building. To demonstrate that an acceptable CO₂ emission rate has been achieved, the calculated CPC of the building being assessed should be no greater than the Maximum Permitted Carbon Performance Coefficient (MPCPC), which is 1.15.
61. Regulation L5(b) of the 2017 TGD-L requires that a very significant proportion of the energy consumption to meet the performance of a building is provided by renewable energy sources. The Renewable Energy Ratio (RER) of the proposed building, as calculated in APPENDIX D – RENEWABLE ENERGY RATIO (RER), is the ratio of the primary energy from renewable energy sources to the proposed building's total primary energy consumption.
62. The requirement is that the EPC and CPC calculated for the proposed building do not exceed the MPEPC and MPCPC, respectively, and a minimum level for the RER is achieved according to the following expressions:

Equation 9 *If $EPC \leq 0.9$ and $CPC \leq 1.04$, then $RER \geq 0.1$*

Equation 10 *else, $RER \geq 0.2$*

THE ACTUAL BUILDING

63. The following paragraphs outline specific requirements for how the Actual building is modelled that apply to both SBEMie and DSM software.

Building fabric

64. Smoke vents and other ventilation openings such as intake and discharge grilles must be disregarded in the Actual, Reference, and Notional buildings, and their area substituted by the relevant (i.e., immediately surrounding) opaque fabric (roof or wall).

65. For SBEMie and DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) must be allowed for by a method that satisfies BS EN ISO 14683, or by adding 10% to the standard area-weighted average U-values and be consistently applied to both Actual and Reference buildings.

66. Where a method that satisfies BS EN ISO 14683 is used to take account of non-repeating thermal bridges in the Actual building, the user will have the option of either directly entering the relevant Psi values or using defaults as specified in **Table 6** (based on BRE IP 1/06¹⁴ values degraded by the greater of 0.04 W/mK or 50%). Where the user directly enters the Psi values, these values must have been calculated in compliance with 1.3.3.2 of the Department of Housing Planning and Local Government Part L Technical Guidance Document, indicating the way in which the detail should be constructed.

Table 6 Default Psi values for the Actual building (W/mK)		
Type of junction	Involving metal cladding	Not involving metal cladding
Roof to wall	0.42	0.18
Wall to ground floor	1.73	0.24
Wall to wall (corner)	0.38	0.14
Wall to floor (not ground floor)	0.04	0.11
Lintel above window or door	1.91	0.45
Sill below window	1.91	0.08
Jamb at window or door	1.91	0.09

67. The U-value typically quoted for a window, roof window, or roof-light is the overall U-value including the frame and edge effects, and it relates to the performance of the unit in the vertical plane so, for roof-lights, it must be adjusted for the slope of the roof (BR443¹) by +0.3 W/m²K if the roof is flat, and +0.2 W/m²K if the roof is pitched.

¹⁴ IP 1/06 Assessing the effects of thermal bridging at junctions and around openings in the external elements of buildings, BRE, 2006.

Lighting

68. Lighting is defined at zone level. The user sets the required general power density (W/m^2) to achieve the design illuminance in each zone provided that the design illuminance is equal to or greater than the activity's NEAP lighting level in the NEAP Activity Database. Where the design illuminance is less than the NEAP activity lighting level, the general power density will be automatically pro-rated to the NEAP activity lighting level. For example, an office with installed lighting load density of $6 \text{ W}/\text{m}^2$ that delivers 300 lux illuminance (i.e., $2 \text{ W}/\text{m}^2$ per 100 lux) would be adjusted to $8 \text{ W}/\text{m}^2$ for the purpose of compliance because the NEAP activity assumes 400 lux illuminance.

69. For Building Regulations compliance, the general lighting can be defined explicitly, by calculating and inputting the design/installed circuit power¹⁵, or by inference, but the resulting wattage in each zone must be reported in the BRIRL (compliance output document) summary. Where general lighting is defined by calculation, a maintenance factor should be applied that is appropriate to the lighting installation as defined in the Society of Light and Lighting (SLL) Lighting Handbook.

70. For general lighting, the following inference methods can be used in addition to the explicit method for Building Regulations compliance to define the general lighting:

Inference method 1 - User sets the lamp efficacy in lumens per circuit-watt and the light output ratio of the luminaire, to determine the efficacy of the lighting system in terms of luminaire lumens per circuit-watt, which can be pro-rated against the Reference lighting curve (*which is based on 65 luminaire lumens per circuit-watt*) defined by **Equation 8** to infer a power density for the general lighting. The user can also input the design illuminance in the zone, if known, and the power density will then be subject to be pro-rated following paragraph 68.

Inference method 2 - User assigns a lamp type to each zone based on **Table 7**, where the luminaire efficacy can be pro-rated against the Reference lighting curve (*which is based on 65 luminaire lumens per circuit-watt*) defined by **Equation 8** to infer a power density for the general lighting. The user can also input the design illuminance in the zone, if known, and the power density will then be subject to be pro-rated following paragraph 68.

¹⁵ The luminous efficacy can be derived for reporting by working backwards using **Equation 8**, the circuit power, and inference method 1 from paragraph 70.

Table 7 Lamp inference data		
Lamp type	Luminaire lumens per circuit-watt for all buildings¹⁶	
	Side-lit and unlit activities	Top-lit activity
LED	50.0	50.0
Tungsten and Halogen	7.5	9.0
Fluorescent - compact	22.5	27.0
T12 Fluorescent - halophosphate - low frequency ballast	25.0	30.0
T8 Fluorescent - halophosphate - low frequency ballast	27.5	33.0
T8 Fluorescent - halophosphate - high frequency ballast	32.5	39.0
T8 Fluorescent - triphosphor - high frequency ballast	36.3	43.5
Metal Halide	25.0	39.0
High Pressure Mercury	22.5	27.0
High Pressure Sodium	35.0	42.0
T5 Fluorescent - triphosphorcoated - high frequency ballast	37.5	45.0
Fluorescent (no details)	22.5	27.0

71. The general lighting in the Actual building will include the capability of modelling daylight harvesting, local manual switching (where appropriate¹⁷), and occupancy sensor control (as defined in the SBEMie Technical Manual⁵). It will also include the capability of modelling constant illuminance control (as defined in BS EN 15193:2007¹⁸) by reducing the general lighting power density by 10%, if applicable.
72. The daylight contribution from display windows should be included in the consideration of daylight harvesting.
73. Display lighting will be defined in terms of the average display lighting lamp efficacy for each zone, which will be pro-rated against an efficacy of 15 lamp lumens per circuit-watt to adjust the NEAP display lighting value associated with the activity in the NEAP Activity Database.
74. For Building Regulations compliance, any zone where the display lighting has efficacy less than 22 lamp lumens per circuit-watt will be reported in the BRIRL (compliance output document) summary as not meeting the standards of TGD-L.
75. There will be an option for assigning automatic time-switching control at zone level for display lighting in the Actual building that will result in the annual display lighting energy being reduced by 20%.
76. Both general lighting and display lighting (where appropriate) will use the same operating profile as defined in the NEAP Activity Database for each activity.

¹⁶ Luminous efficacy values were derived using a light output ratio of 0.5 for side-lit and unlit activities and 0.6 for top-lit activities, except in the case of LED, where a light output ratio of 1.0 was used for all activity classes.

¹⁷ Whether or not the activity is appropriate to have local manual control is determined in the "activity" table from the NEAP Activity database using the "BR_CHECK02" field, as described in paragraph 52.

¹⁸ BS EN 15193:2007 - Energy performance of buildings - Energy requirements for Lighting.

Auxiliary energy

77. The following paragraphs outline how auxiliary energy should be calculated in both SBEMie and DSM software.
78. DSM software should not allow the user to directly set the auxiliary power density. The users of DSM software should only be allowed to define the HVAC systems type, specific fan powers, and associated controls (i.e., demand control of ventilation, variable speed pumping, etc.).
79. The auxiliary energy is the product of the auxiliary power density and annual hours of operation of the heating system from the NEAP Activity Database (i.e., the hours when the heating set-point is above the set-back temperature based on the daily/weekly/annual schedules or the "SYS_HEAT_T_HOURS_#" from the "activity_sbem_D1_ACU" table in the NEAP Activity Database).
80. The auxiliary power density is the sum of the pump and fan power density.
81. The pump power density for the Actual building will depend on the type of HVAC system and whether the pump has variable speed control. **Table 8** determines which HVAC system types need to account for pump power and whether the option of specifying variable speed pumping is made available to the user. **Table 9** gives the pump power densities for constant speed pumping as well as variable speed pumping.

HVAC system type	Pump power	Variable speed pumping allowed
Central heating using water: radiators	LTHW only	Yes
Central heating using water: convectors	LTHW only	Yes
Central heating using water: floor heating	LTHW only	Yes
Central heating with air distribution	None	No
Other local room heater - fanned	None	No
Other local room heater - unfanned	None	No
Unflued radiant heater	None	No
Flued radiant heater	None	No
Multiburner radiant heaters	None	No
Flued forced-convection air heaters	None	No
Unflued forced-convection air heaters	None	No
Single-duct VAV	Both LTHW and CHW	No
Dual-duct VAV	Both LTHW and CHW	No
Indoor packaged cabinet (VAV)	Both LTHW and CHW	Yes
Fan coil systems	Both LTHW and CHW	Yes
Induction system	Both LTHW and CHW	Yes
Constant volume system (fixed fresh air rate)	Both LTHW and CHW	No
Constant volume system (variable fresh air rate)	Both LTHW and CHW	No
Multizone (hot deck/cold deck)	Both LTHW and CHW	No
Terminal reheat (constant volume)	Both LTHW and CHW	No
Dual duct (constant volume)	Both LTHW and CHW	No
Chilled ceilings or passive chilled beams and displacement ventilation	Both LTHW and CHW	Yes
Active chilled beams	Both LTHW and CHW	Yes

Water loop heat pump	Both LTHW and CHW	No
Split or multi-split system	None	No
Single room cooling system	None	No

Table 9 Pump power density for Actual building (W/m ²)		
Pump configuration	LTHW only	Both LTHW and CHW
Constant speed pumping	0.6	1.8
Variable speed pumping with differential sensor across pump	0.5	1.5
Variable speed pumping with differential sensor in the system	0.4	1.1
Variable speed pumping with multiple pressure sensors in the system	0.3	0.9

82. For zones where the ventilation system also provides heating or heating & cooling, the fan power density is determined for each zone using one of the following equations as determined by **Table 10**:

Equation 11 $FPS_1 = FAR_{max} \times SFP_{central} + SCR \times SFP_{terminal}$

Equation 12 $FPS_2 = \text{Greater of } (FAR_{max}, SCR) \times SFP_{central}$

Equation 13 $FPS_3 = \text{Greater of } (SCR/5, FAR_{max}) \times SFP_{central}$

Equation 14 $FPS_4 = FAR_{max} \times SFP_{central}$

where:

“ FAR_{max} ” is the peak fresh air supply rate (l/s/m²) that is set by the activity type in the NEAP Activity Database, while “SCR” is the space conditioning supply rate (i.e., the air flow rate needed to condition the space, in l/s/m²), and is calculated as follows:

Equation 15 $SCR = \text{Greater of } (PSH, PSC) / (\rho \times C_p \times \Delta T)$

where:

$\rho = 1.2 \text{ kg/m}^3$, $C_p = 1.018 \text{ kJ/kgK}$, and $\Delta T = 8K$,

“PSH” is the peak space heating load, and “PSC” is the peak space cooling load (i.e., in W/m² of floor area for each zone). For both parameters, the effects of thermal mass will be ignored. The peak space heating load is the sum of the peak steady state fabric losses and infiltration load based on an external ambient of 0°C.

For SBEMie, the peak space cooling load is the sum of peak internal gains, which will include occupancy, equipment, general lighting, display lighting, and peak solar gains. The peak solar gain is calculated using the solar data for September from Table 2.30 of CIBSE Guide A (using the beam and diffuse solar for each hour between 06:30 and 18:30). The total solar gain for each zone is calculated and peak hour is used. DSM software are allowed to use the peak solar calculated during simulation.

83. The fan power density equations are assigned to HVAC systems based on **Table 10**.

Table 10 Assigning fan power equations to HVAC systems		
HVAC system type	iSBEMie ID	Fan power density
Fan coil systems	4	Equation 11
Indoor packaged cabinet (VAV)	32	
Central heating using air distribution	2	Equation 12
Constant volume system (fixed fresh air rate)	5	
Constant volume system (variable fresh air rate)	6	
Single-duct VAV	7	
Water loop heat pump	13	
Dual duct (constant volume)	15	
Multi-zone (hot deck/cold deck)	16	
Terminal reheat (constant volume)	17	
Dual-duct VAV	31	
Active chilled beams	12	Equation 13
Induction system	14	
Chilled ceilings or passive chilled beams and displacement ventilation	11	Equation 14

84. For zones where the ventilation system does not provide heating or cooling (but can include heat recovery), the fan power density is the product of the fresh air supply rate for the activity type from the NEAP Activity Database and the specific fan power defined by the user at zone level.
85. For zones with mechanical exhaust, the fan power density is the product of the user-defined exhaust rate and the specific fan power defined by the user. The exhaust fan energy will be an addition to the fan energy for supply & extract ventilation. Note that the user defined exhaust rate is not considered in the air load calculations.
86. For zones served by the HVAC systems listed in **Table 11**, additional fan energy is included to account for integral fans, using the ratio (to be input by the user) of associated fan power, in W per kW of heat output (delivered) by the heating system.

Table 11 Additional fan power for specific HVAC systems	
HVAC system type	iSBEMie ID
Central heating using water: convectors (<i>but only in case the system utilises fanned convectors</i>)	24
Other local room heater – fanned	3

87. Energy for other ancillary services in the building, such as secondary hot water circulation, de-stratification fans, forced circulation for solar water heating systems, etc., will be an addition to the fan and pump energy.

Demand Control of Ventilation

88. The Actual building will include the ability to model demand control of ventilation for zones with mechanical ventilation (but excluding exhaust-only systems) while for naturally-ventilated zones, there will be the option of

enhanced ventilation control (this refers to natural ventilation with BMS control, i.e., modifying the ventilation flow rate provided by natural means in the space based on some form of control). The details for implementing demand-controlled ventilation are outlined below.

89. For zones with mechanical ventilation (but excluding exhaust-only ventilation), the following options will be available to the user:
- No demand-controlled ventilation (*default option*)
 - Demand control based on occupancy density
 - Demand control based on gas sensors
90. If the option selected is either b) or c) from above, then the parameter “air flow regulation type” will become active with the following options available to the user:
- Damper control (*default option*)
 - Speed control
91. For zones with natural ventilation, the following options will be available to the user:
- No demand-controlled ventilation (*default option*)
 - Enhanced ventilation
92. Depending on user inputs, a modified demand control fresh air rate (FAR_{dc}) is determined from the NEAP fresh air rate (FAR_{max}) for the activity.

Equation 16
$$FAR_{dc} = C_{dc} \times FAR_{lower} + (1 - C_{dc}) \times FAR_{max}$$

where:

FAR_{max} is the ventilation rate per person from the NEAP Activity Database multiplied by the peak occupancy density during the occupied period (i.e., l/s/m²).

FAR_{min} is the ventilation rate per person from the NEAP Activity Database multiplied by the minimum occupancy density during the occupied period (i.e., this can be zero for some activities).

FAR_{lower} is the greater of either: FAR_{min} or $(0.6 \times FAR_{max})$

C_{dc} is a demand control coefficient and is determined based on the data in **Table 12**.

Table 12 Values for demand control coefficient	
Type of demand control	Demand control coefficient (C_{dc})
None	0
Control based on occupancy density	0.85
Control based on gas sensor	0.95
Enhanced natural ventilation	0.50

93. In addition to affecting the fresh air load (i.e., energy to heat and cool the fresh air), demand control of ventilation can also affect the auxiliary energy. Where the air flow regulation uses fan speed control (i.e., using variable speed fans),

the auxiliary energy calculation will use FAR_{dc} instead of FAR_{max} , but if the air flow regulation uses damper control, then the auxiliary energy calculation will not be affected.

LIMITING SOLAR GAINS IN SUMMER

94. This section describes how the solar gain limit should be checked in the Actual building (for the purposes of TGD-L).
95. The solar gain check will include any zone in the Actual building that is either mechanically-cooled or has an activity that is flagged in the NEAP Activity Database as being an occupied space for which the solar gain check is applicable. Whether or not the solar gain check is applicable to the activity is determined in the “activity” table from the NEAP Activity Database in the “SOLAR_GAIN_CHECK” field (*0 for activity with no solar gain check, and 1 for activity with solar gain check*).
96. The solar gain in the Actual building is calculated at the point of absorption into the internal surfaces of each zone and includes the solar gain absorbed in the glazing and/or blinds, which subsequently enters the space via conduction/radiation/convection.
97. The contribution of solar gain from display windows will be included in the solar gain limit check for zones that apply.
98. The solar gain limit is based on the solar gains through benchmark glazing types described in **Table 13**, and selected according to paragraph 102, aggregated over the period from April to September, and using the same weather data used for the EPC/CPC calculations.

Table 13 General description of benchmark glazing for setting solar gain limit

Benchmark glazing type	Description	Glazing dimensions/area
1	Vertical glazing facing east with 10% frame factor and g-value of 0.68	Height of 1 m and width equal to the total exposed facade* width of the zone being checked
2	Horizontal glazing with 25% frame factor and g-value of 0.68	Area equal to 10% of either the projected floor area or the exposed roof area (whichever is greater)
3	Horizontal glazing with 15% frame factor and g-value of 0.46	Area equal to 20% of either the projected floor area or the exposed roof area (whichever is greater)

*The exposed facade width should take into account opaque/translucent wall elements, as well as external doors, external windows, and curtain walling systems.

99. The treatment of solar gains entering a space will vary between DSM software so, for DSM software, it is necessary to define a standard test-space for each benchmark glazing type (Figure 1 to Figure 3) that meets the requirements of **Table 13**. This allows the pre-calculation of the benchmark aggregated solar gain as a function of facade length and exposed roof area (i.e., kWh/m and kWh/m² respectively). This means that each DSM will have 3 values for benchmark aggregated solar flux for each weather data set.
100. The standard test spaces will have solar absorptance of 0.5 for all internal surfaces. The external ground reflectance should be 0.2. The glazing should use the appropriate glass data provided in **Table 14** and **Table 15** (where T_{solar} is the direct solar transmittance, T_{visible} is the direct visible light transmittance, R_{solar} is the solar reflectance, and R_{visible} is the visible light reflectance. The subscripts 1 and 2 refer to the outer and inner surfaces of each pane of glass, respectively).

101. During validation, DSM software will be required to declare the benchmark aggregated solar flux values. Once approved by SEAI, the declared benchmark aggregated solar flux values cannot be changed unless re-validation is carried out.
102. The solar gain limit is calculated and checked on a zone-by-zone basis in the Actual building, using the following methods:
- a. For zones with side-lit or unlit activities:
 - For each zone with exposed facade area greater than zero, the limiting solar gain will be the aggregated solar flux for benchmark glazing type 1 multiplied by the exposed facade length.
 - For each zone with zero exposed facade area (i.e., an internal zone that receives second hand solar), the limiting solar gain will be the aggregated solar flux for benchmark glazing type 2 multiplied by either the projected floor area or the exposed roof area (whichever is greater).
 - b. For zones with top-lit activities:
 - For each zone where the height¹⁹ is less than 6 m, the solar gain limit will be the aggregated solar flux for benchmark glazing type 2 multiplied by either the projected floor area or the exposed roof area (whichever is greater).
 - For each zone where the height¹⁹ is greater than or equal to 6 m, the solar gain limit will be the aggregated solar flux for benchmark glazing type 3 multiplied by either the projected floor area or the exposed roof area (whichever is greater).
103. The total solar gain aggregated over the period from April to September for each zone in the Actual building, where this criterion applies, will have to be less than or equal to the limiting solar gain calculated based on the benchmark glazing types. For DSM software, the total solar gain should include external solar gain from all orientations and inclinations as well as any “second hand” solar gain from adjacent zones (i.e., via internal glazing/holes/virtual partitions).
104. The aggregated solar gain should not include the conduction gains via window frames or solar gains through opaque envelopment elements (e.g., sol-air temperature gains through the roof/walls).

Table 14 Glass properties to achieve g-value of 0.68									
	Thickness	T _{solar}	R _{solar1}	R _{solar2}	T _{visible}	R _{visible1}	R _{visible2}	Emissivity 1	Emissivity 2
Outer pane	6mm	0.783	0.072	0.072	0.889	0.081	0.081	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

¹⁹ For zones with pitch roofs, use the average height.

Table 15 Glass properties to achieve g-value of 0.46									
	Thickness	T _{solar}	R _{solar1}	R _{solar2}	T _{visible}	R _{visible1}	R _{visible2}	Emissivity 1	Emissivity 2
Outer pane	4mm	0.468	0.165	0.185	0.654	0.104	0.026	0.837	0.153
Cavity	12mm	Argon gas fill							
Inner pane	4mm	0.821	0.074	0.074	0.896	0.081	0.081	0.837	0.837

Figure 1 Isometric view of standard test-space for benchmark glazing type 1

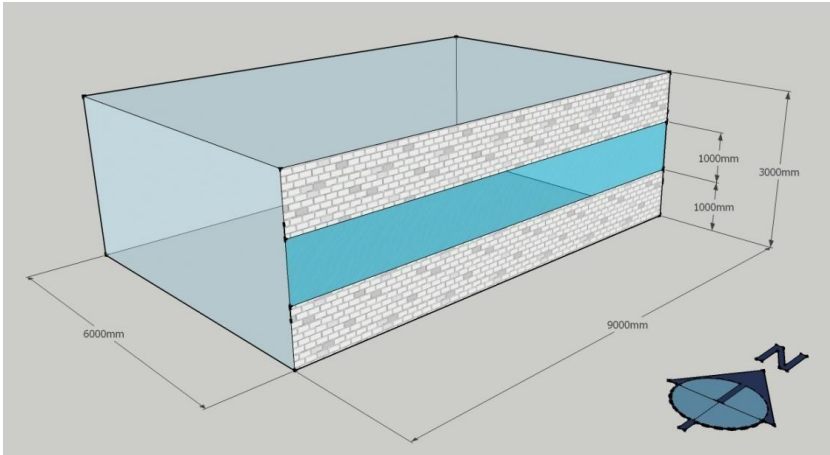


Figure 2 Isometric view of standard test-space for benchmark glazing type 2

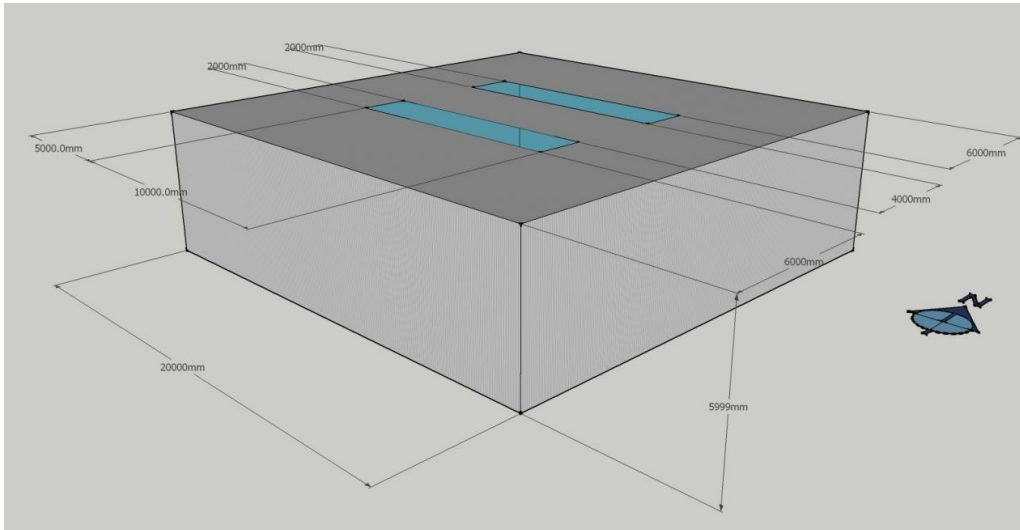
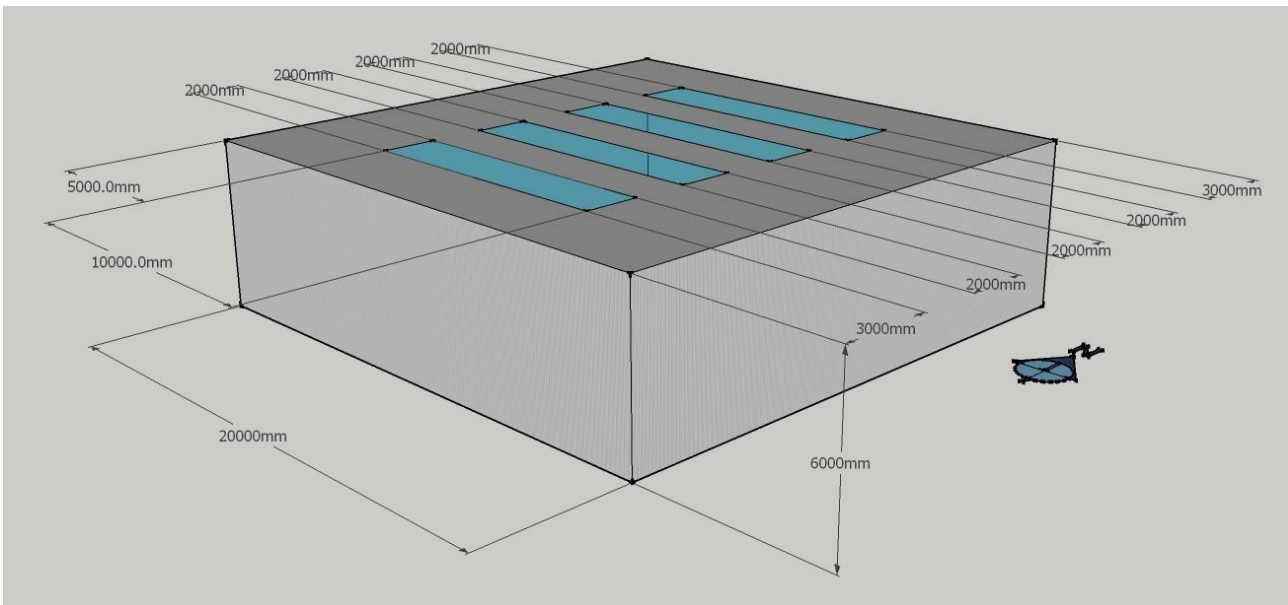


Figure 3 Isometric view of standard test-space for benchmark glazing type 3



LIMITING OVERHEATING

105. This section describes how the overheating limit should be checked in the Actual building (for the purposes of TGD-L).

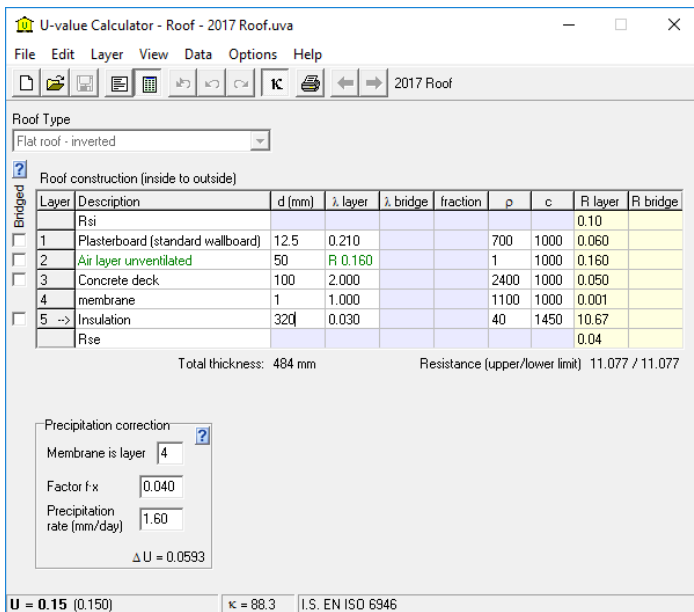
106. In order to provide a consistent assessment of the building's energy performance, the calculation procedure must always control the space temperature to the set-point defined for the relevant activity area in the NEAP Activity Database, irrespective of the control temperature prevailing in the building as it operates in practice. The control set-point will only vary according to the level of servicing provided, i.e., no cooling, mixed-mode, or full air-conditioning.

107. In buildings without mechanical cooling, the level of thermal comfort achieved will vary during the summer months and will differ from building to building. Consequently, under Part L of the Building Regulations, an overheating assessment should be carried out, with the degree of overheating assessed as shown in **Table 16**, and the overheating threshold temperature set at an operative temperature of 27°C. The automated analysis by the assessment software must be made on a zone by zone basis, in order to identify approximate areas of risk in naturally-ventilated spaces. It is recommended that the designer perform an overheating assessment in accordance with CIBSE TM 52 to ensure overheating is avoided for normally occupied, naturally-ventilated spaces in new buildings.

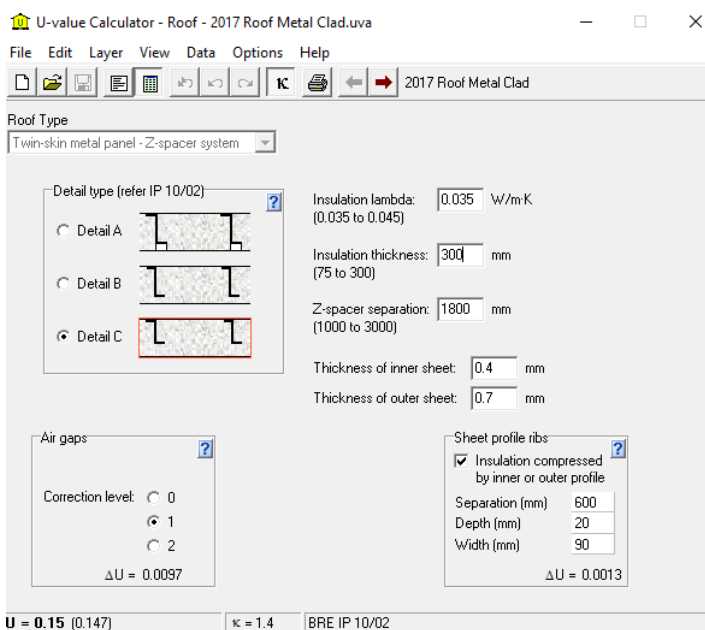
Table 16 Definition of overheating criteria		
Criterion	(a) SBEMie	(b) DSM
	Ratio (R_k) of cooling demand with temperature of 27°C to that with cooling set-point from the NEAP Activity Database	% occupied hours (β) exceeding 27°C operative temperature (occupied hours are where occupancy is greater than 20%)
Low risk	$R_k < 0.15$	$\beta < 0.5\%$
Moderate risk	$0.15 \leq R_k < 0.30$	$0.5\% \leq \beta < 1$
Significant risk	$0.30 \leq R_k < 0.50$	$1\% \leq \beta < 1.5\%$
High risk	$R_k \geq 0.50$	$\beta \geq 1.5\%$

APPENDIX A – CONSTRUCTION DETAILS FOR 2017 REFERENCE BUILDING

108. This section includes screen grabs from the BRE U-value calculator (version 2.02) that show the construction details used as the basis for the data for thermal capacity values in **Table 1**. These construction details are for use by DSM software to account for the effect of thermal capacity.
109. DSM software generally use less sophisticated methods for calculating the U-value of constructions (i.e., they do not take account of repeating thermal bridges due to fixings, etc.). Therefore, where appropriate, the thickness of the insulation layer should be adjusted to achieve the same U-value as specified in **Table 1**.
110. Roof construction details for the 2017 Reference building (not involving metal cladding).



111. Roof construction details for the 2017 Reference building (involving metal cladding).



112. External wall construction details for the 2017 Reference building (not involving metal cladding).

U-value Calculator - Wall - 2017 External Wall.uva

File Edit Layer View Data Options Help

Wall Type: Wall with rainscreen cladding

Wall construction (inside to outside)

Layer	Description	d (mm)	λ layer	λ bridge	fraction	ρ	c	R layer	R bridge
	Rsi							0.13	
1	Plasterboard (standard wallboard)	12.5	0.210			700	1000	0.060	
2	Cavity unventilated	50	R 0.180			1	1000	0.180	
3	Cement bonded particle board	12	0.230			1100	1000	0.052	
4	insulation	220	0.025			20	1030	8.800	
5	Cavity ventilated	50	R 0.130			1	1000		
6	rainscreen	3	50.00			7800	450		
	Rse							0.130 #	

Total thickness: 348 mm Resistance (upper/lower limit) 9.352 / 9.352

Rainscreen fixing brackets

Default ΔU

Fixing rails	Discrete brackets		
Total length (m)	0	Number per m²	2
Wall area (m²)	50.0	χ-value	0.036
Ψ-value	0.300		

ΔU = 0.0720

this resistance substitutes for R_{si} and the resistance of layers 5-6 because of the ventilated air layer (layer 5)

U = 0.18 (0.179) κ = 21.8 I.S. EN ISO 6946

113. External wall construction details for the 2017 Reference building (involving metal cladding).

U-value Calculator - Wall - 2017 External Wall Metal Clad.uva

File Edit Layer View Data Options Help

Wall Type: Twin-skin metal panel - Z-spacer system

Detail type (refer IP 10/02)

Detail A

Detail B

Detail C

Insulation lambda: 0.035 W/m·K (0.035 to 0.045)

Insulation thickness: 230 mm (75 to 300)

Z-spacer separation: 1800 mm (1000 to 3000)

Thickness of inner sheet: 0.4 mm

Thickness of outer sheet: 0.7 mm

Air gaps

Correction level: 0 1 2

ΔU = 0.0095

Sheet profile ribs

Insulation compressed by inner or outer profile

Separation (mm): 600

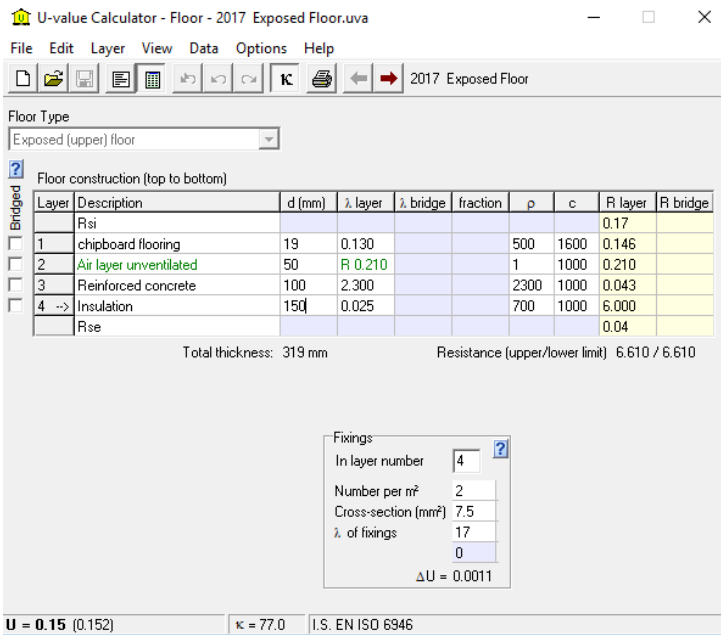
Depth (mm): 20

Width (mm): 90

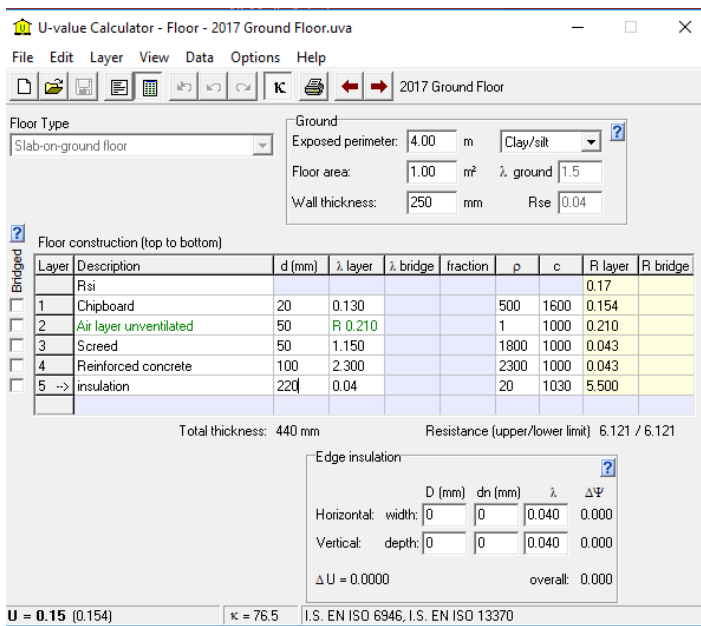
ΔU = 0.0022

U = 0.18 (0.182) κ = 1.4 BRE IP 10/02

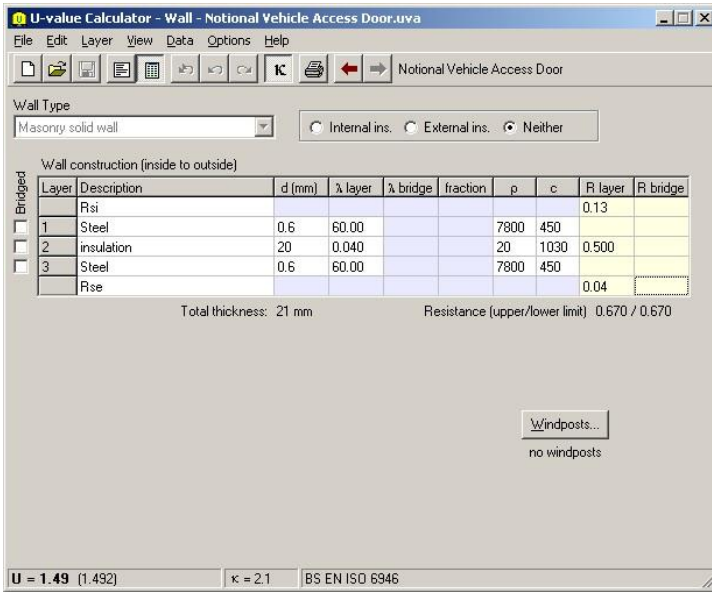
114. Exposed floor construction details for the 2017 Reference building.



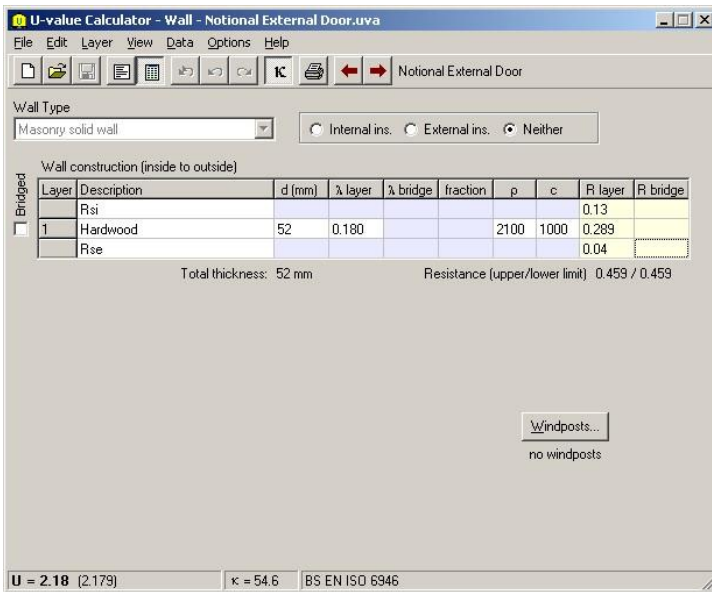
115. Ground floor construction details for the 2017 Reference building (note that the aspect ratio and edge insulation parameters have not been set as these details are intended only for determining the thermal capacity as viewed from inside).



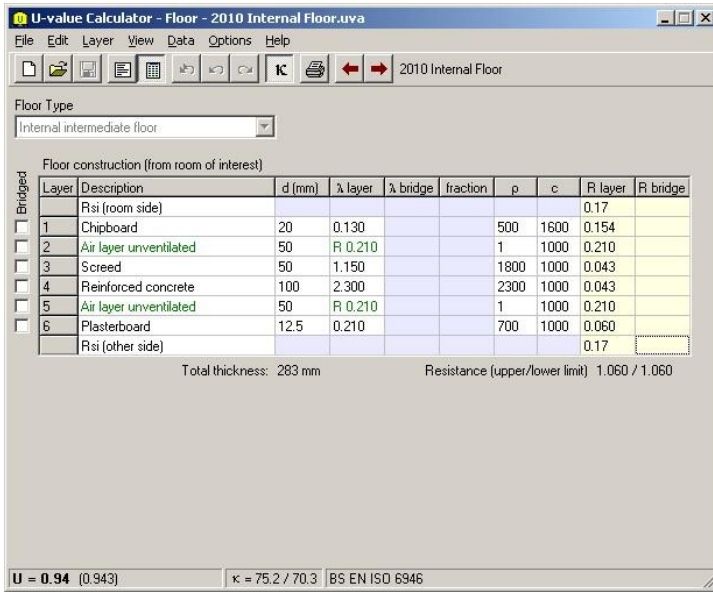
116. Vehicle access and similar large door construction details for the 2017 Reference building.



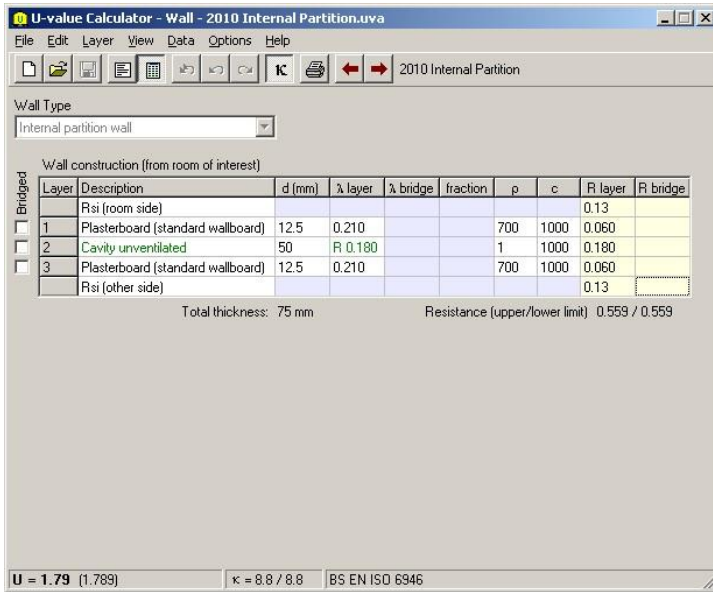
117. Pedestrian doors and high usage entrance doors construction details for the 2017 Reference building.



118. Internal floor/ceiling construction details for the 2017 Reference building.



119. Internal partition construction details for the 2017 Reference building.



APPENDIX B – THE NOTIONAL BUILDING

120. This section of the guide defines the Notional building, which is the basis of setting the energy rating scale for the Building Energy Ratings in the Republic of Ireland. The calculation of the Building Energy Rating (BER) follows the Non-Domestic Energy Assessment Procedure (NEAP). The BER is an indication of the energy performance of the building. It covers energy use for space heating and cooling, water heating, ventilation, and lighting, calculated on the basis of standard occupancy. The rating is expressed as a ratio of calculated primary energy use per floor area per year (kWh/m².annum) for the Actual building compared to that calculated for the Notional building.
121. BERs are intended to send market signals about the relative performance of comparable buildings. In order to provide this consistency, the Notional building must be the same irrespective of:
- Whether the Actual building is naturally-ventilated or air-conditioned²⁰.
 - The fuel choice in the Actual building.
122. The Notional building must have the same size, shape, and zoning arrangements as the Actual building, with the same conventions relating to the measurement of dimensions.
123. Each space must contain the same activity (and, therefore, the same activity parameter values) as proposed for the equivalent space in the Actual building. The activity in each space must be selected from the list of activities as defined in the NEAP Activity Database.
124. The Notional and Actual buildings must be given the same orientation and be exposed to the same weather data. For DSM software, the Notional building must be subject to the same site shading from adjacent buildings and other topographical features as are applied to the model of the Actual building.

Building fabric

125. The U-values must be as specified in **Table 17**. All U-values must be calculated following the guidance in BR443³. The general guidance beginning at paragraph 161 must be followed.

Element	U-value (W/m ² K)	Thermal capacity ² (kJ/m ² K)
Roofs ³ (irrespective of pitch)	0.16	12.0
Exposed walls	0.27	11.7
Floors and ground floors (subject to paragraph 128)	0.25	36.0
Windows, roof windows, roof-lights*, glazed doors, and curtain walling	2.20	-
External pedestrian doors	2.20	-
Vehicle access and similar large doors	1.50	-

²⁰ Spaces in the Notional building are all naturally-ventilated.

Internal walls	2.00	11.9
Internal windows	3.85	-
Internal floors/ceilings	1.24	8.6
<p>*This is the overall U-value including the frame and edge effects, and it relates to the performance of the unit in the vertical plane so, for roof-lights, it must be adjusted for the slope of the roof (BR443¹). The roof-lights in the Notional building are assumed to be conical or domed, and hence, for the purposes of heat transfer calculations, their developed to projected ratio is set to 1.3 (as opposed to 1.0 for flat ones), i.e., the area of the roof-light is 1.3 times the area of the opening in the roof, and its U-value adjustment is taken as +0.3 W/m²K if the roof is flat and +0.2 W/m²K if the roof is pitched.</p>		

126. Smoke vents and other ventilation openings such as intake and discharge grilles must be disregarded in the Notional building and their area substituted by the relevant (i.e., immediately surrounding) opaque fabric (roof or wall).

127. For SBEMie and DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) must be allowed for by adding 10% to the standard U-values. Note that the U-values as given in **Table 17** DO NOT include this allowance, and so the calculation tool must make the adjustment explicitly.

128. Special considerations apply to ground floors, where the U-value is a function of the perimeter/area ratio. The following adjustments must be made⁴:

- a. If the calculated value is greater than or equal to 0.25 W/m²K, the value of 0.25 W/m²K must be used in the Notional building.
- b. If the calculated value is less than 0.25 W/m²K with no added insulation, this lower value must be used in the Notional building.

129. When modelling an extension, the boundary between the existing building and the extension must be disregarded (i.e., assume no heat transfer across it).

130. The thermal capacity of the construction elements must be as defined in **Table 17**.

131. The air permeability of the Notional building must be 10 m³/h per m² of envelope area at 50 Pa. The calculation method used to predict the infiltration rate must use the air permeability as the parameter defining the envelope leakage. For compliance and BER assessments, the same method must be used in the Actual, Reference, and Notional buildings. Acceptable methods include:

- The method specified in the SBEMie Technical Manual⁵, which is taken from EN 152428.
- Other methods that use a relationship between the infiltration rate and air permeability and are set out in national or international standards or recognised Republic of Ireland/UK professional guidance documents which relate the average infiltration rate to the envelope permeability. An example of the latter would be tables 4.13 to 4.20 of CIBSE Guide A (2006).

Areas of windows, doors, and roof-lights

132. In SBEMie, the total solar energy transmittance (BS EN 410 g-value) and the light transmittance of glazing must be as given in **Table 18**. This data applies to windows, roof windows, and roof-lights. Appropriate values for intermediate orientations can be based on linear interpolation.

Table 18 Solar and light transmittances for glazing in the Notional building			
Orientation of glazing	Solar transmittance	Light transmittance	Notional glazing type
North, North-East, South, North-West	0.72	0.76	1
East, South-East, South-West, West	0.58	0.61	2
Horizontal	0.43	0.46	3

133. DSM software are required to use the glass data provided in **Table 19**, **Table 20**, and **Table 21** to determine the EN ISO 410 g-value. T_{solar} is the direct solar transmittance, T_{visible} is the direct visible light transmittance, R_{solar} is the solar reflectance, R_{visible} is the visible light reflectance. The subscripts 1 and 2 refer to the outer and inner surfaces of each pane of glass respectively.

Table 19 Glass properties for Notional glazing type 1									
	Thickness	T_{solar}	$R_{\text{solar}1}$	$R_{\text{solar}2}$	T_{visible}	$R_{\text{visible}1}$	$R_{\text{visible}2}$	Emissivity 1	Emissivity 2
Outer pane	6mm	0.821	0.074	0.074	0.913	0.082	0.082	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

Table 20 Glass properties for Notional glazing type 2									
	Thickness	T_{solar}	$R_{\text{solar}1}$	$R_{\text{solar}2}$	T_{visible}	$R_{\text{visible}1}$	$R_{\text{visible}2}$	Emissivity 1	Emissivity 2
Outer pane	6mm	0.655	0.068	0.068	0.735	0.079	0.079	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

Table 21 Glass properties for Notional glazing type 3									
	Thickness	T_{solar}	$R_{\text{solar}1}$	$R_{\text{solar}2}$	T_{visible}	$R_{\text{visible}1}$	$R_{\text{visible}2}$	Emissivity 1	Emissivity 2
Outer pane	6mm	0.437	0.052	0.055	0.551	0.060	0.063	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

134. The areas of windows, doors, and roof-lights in the Notional building must be determined as set out in the following sub-paragraphs and must also conform to the measurement conventions set out in the section on Measurement and other conventions.
- Subject to the following criteria, all external walls must have windows, and all roofs must have roof-lights.
 - Copy the areas of pedestrian doors, vehicle access doors, and display windows that exist in the corresponding element of the Actual building.
 - If the total area of these elements is less than the appropriate allowance from **Table 22**, the balance must be made up of windows or roof-lights as appropriate.
 - If the total area of the copied elements exceeds the allowance from **Table 22**, the copied areas must be retained but no windows or roof-lights added.
 - The areas as defined in **Table 22** represent the areas of openings in the wall or roof and comprise the area of the glass plus frame. The windows must have a frame factor of 10% (i.e., 90% of the area of the opening is glazed) and roof-lights a frame factor of 30%.
135. The U-value of display windows must be taken as 5.7 W/m²K in the Notional building with solar transmittance of 0.77, light transmittance of 0.87, and 10% frame factor.

Table 22 Percentage opening areas in the Notional building		
Building type²¹	Windows (of exposed wall area)	Roof-lights (of exposed roof area)
Residential buildings (where people temporarily or permanently reside)	30%	20%
Places of assembly, offices and shops	40%	20%
Industrial and storage buildings	15%	20%

136. In addition, the following rules apply:
- The Notional building does not have any high usage entrance doors, even if these are present in the Actual building.
 - In the Notional building, pedestrian and vehicle access doors must be taken as being opaque (i.e., with zero glazing).
 - No glazed area should be included in basements. In semi-basements (i.e., where the wall of the basement space is mainly below ground level but part is above ground), the **Table 22** percentages must apply to the above-ground part, with zero glazing for the below-ground part.

HVAC system

137. The space heating and hot water service is always met by natural gas irrespective of whether a fuel other than natural gas is used in the Actual building or natural gas is even available in the locality of the Actual building.

²¹ Determined for each activity by the "BR_CHECK05" field in the "activity" table of the NEAP Activity Database.

138. The Notional building has a fixed servicing strategy regardless of the strategy adopted in the Actual building. Therefore:

- a. Each space is heated, as defined by the heating set-points defined in the NEAP Activity Database.
- b. The heating SCoP is 0.73.
- c. The auxiliary energy is the product of 0.61 W/m^2 and the annual hours of operation of the heating system from the NEAP Activity Database (*i.e.*, the hours when the heating set-point is above the set-back temperature based on the daily/weekly/annual schedules or the “SYS_HEAT_T_HOURS_#” from the “activity_sbem_D1_ACU” table in the NEAP Activity Database).
- d. Each space is cooled, based on the operating schedules defined by the NEAP Activity Database, with the cooling set-point fixed at 27°C irrespective of whether the particular space in the Actual building has cooling provision or not²². The cooling SSEER must be taken as 2.25 (this factor includes an allowance for fan energy when the system operates so no additional auxiliary energy need be determined).

A space that is not treated (i.e., no heating and no cooling) in the Actual building will not be heated or cooled in the Notional building. This means that all potential levels of servicing are accommodated on a single scale. If a particular accommodation type does not need air-conditioning (e.g., warehouse), then the cooling demand will be zero, and no energy demand will be calculated. If a particular accommodation type always needs cooling (e.g., a dealer room), then a base-line level of cooling will be calculated. 27°C has been chosen, rather than the usual comfort threshold of 28°C , because the calculations are based on the IWEC²⁷ weather data set (representing typical weather).

139. For zones with local mechanical exhaust where the fan is within the zone, the fan power density is the product of the user-defined exhaust rate and a specific fan power of 0.50 W per l/s. For zones where the mechanical exhaust fan is remote from the zone, the fan power density is the product of the user-defined exhaust rate and a specific fan power of 0.80 W per l/s. The exhaust fan energy will be an addition to the auxiliary energy from paragraph 138.c.

140. In the Notional building:

- a. No allowance should be made for heat recovery equipment.
- b. No allowance should be made for demand control of ventilation.

141. HWS overall system efficiency (including generation and distribution) must be taken as 45%. The energy demand must be taken as that required to raise the water temperature from 10°C to 60°C based on the demands specified in the NEAP Activity Database. The Activity Database defines a daily total figure in $\text{l}/(\text{m}^2 \cdot \text{day})$ for each activity type. If users of DSMs wish to distribute this demand over the day, then the daily total should be distributed according to the occupancy profile.

142. The Notional building must be assumed to have no power factor correction or automatic monitoring and targeting with alarms for out-of-range values.

Lighting power density

143. For general lighting:

- a. In office, storage, and industrial spaces, divide by 100 the illuminance defined for the space as given for the activity type in the NEAP Activity Database, then multiply by 3.75 W/m^2 per 100 lux. This includes all spaces that

²² If the space in the Actual building has a cooling system, then the calculation of the performance of the Actual building will be assessed by cooling the space to the cooling set-point temperature as defined in the NEAP Activity Database. User-specified cooling set-points are not allowed.

accommodate predominantly office tasks, including classrooms, seminar rooms, and conference rooms, including those in schools.

- b. For other spaces, divide the illuminance appropriate to the activity in the space from the NEAP Activity Database by 100, and then multiply by 5.2 W/m² per 100 lux.

Whether or not the activity is an office, storage, or industrial space is determined in the “activity” table from the NEAP Activity Database in the “BR_CHECK01” field (1 for activity that is an office, storage, or industrial space, and 0 for other spaces).

- 144. Zones in the Notional building that are flagged in the NEAP Activity Database as appropriate to receive local manual control²³, will be modelled with local manual switching (as described in the SBEMie Technical Manual⁵) provided the floor area for each zone is less than 30 m². Otherwise, the general lighting is switched centrally based on the occupancy hours for the activity in the NEAP Activity Database. Note that local manual switching only applies to general lighting (i.e., does not apply to display lighting).
- 145. For display lighting, take the display lighting density appropriate to the activity from the NEAP Activity Database.
- 146. The general lighting in the Notional building does not benefit from occupancy sensor control.
- 147. The display lighting in the Notional building does not benefit from automatic time-switch control.
- 148. Both general lighting and display lighting (where appropriate) will use the same operating profile as defined in the NEAP Activity Database for each activity.

Calculating the BER and CO₂ Emissions Indicator

- 149. It is not intended that the definition of the Notional building should change as TGD-L standards change since this would mean that the energy rating of a given building would also change, even if its energy efficiency had not been varied. Therefore, the Notional building is always as defined above.
- 150. The calculated primary energy consumption rate of the proposed building is divided by that of the Notional building, the result being the Building Energy Rating (BER) of the proposed building. The rating is also converted into an energy band/grade on an “A-G” scale (see section on Constructing the rating scale).
- 151. The calculated CO₂ emission rate of the proposed building is divided by that of the Notional building, the result being the CO₂ Emissions Indicator of the proposed building.

Constructing the rating scale

- 152. The A to G scale and energy labels corresponding to values of the BER are displayed in **Table 23**, with A1 being the most efficient and G being the least efficient.

²³ Whether or not the activity is appropriate to have local manual control is determined in the “activity” table from the NEAP Activity Database using the “BR_CHECK02” field, as described in paragraph 52.

Scale	Band
BER < 0.17	A1
0.17 ≤ BER < 0.34	A2
0.34 ≤ BER < 0.50	A3
0.50 ≤ BER < 0.67	B1
0.67 ≤ BER < 0.84	B2
0.84 ≤ BER < 1.00	B3
1.00 ≤ BER < 1.17	C1
1.17 ≤ BER < 1.34	C2
1.34 ≤ BER < 1.50	C3
1.50 ≤ BER < 1.75	D1
1.75 ≤ BER < 2.00	D2
2.00 ≤ BER < 2.25	E1
2.25 ≤ BER < 2.50	E2
2.50 ≤ BER < 3.00	F
3.00 ≤ BER	G

Reference values

153. The performance of a “Typical” building is used in calculating the payback for the recommendations that appear in the Advisory report which accompanies the BER report. This building’s performance is assumed to be equal to approximately twice the compliance target of 2008, i.e., it is equal to the performance of the 2017 Reference building multiplied by 2 and divided by 0.4 (where 0.4 represents the approximate improvement of 60% from the 2008 MPEPC & MPCPC to the 2017 MPEPC & MPCPC).

Technical information

154. The BER report must also display the following technical information about the Actual building:
- a. ‘Main heating fuel’, which, for the purposes of NEAP, is taken as the fuel which delivers the greatest total thermal output for space or water heating.
 - b. ‘Building environment’, which is taken as the servicing strategy which contributes the largest proportion of the building’s primary energy consumption.

APPENDIX C - INPUT DATA TO APPROVED TOOLS

155. This section of the guide describes generally-applicable approaches to data input and modelling strategies, and it applies equally to Building Regulations compliance and BER reports and also to the modelling of the Actual, Reference, and Notional buildings.

Defining internal gains and environmental conditions

156. In order to facilitate estimating energy performance on a consistent basis, a key part of the NEAP is an Activity Database that defines the activities in various types of space in different classes of building²⁴. One of these standard activities must be assigned to each space in the building²⁵.

157. A 2017 version of the NEAP Activity Database has been updated from 2010 to accompany the 2017 version of the NEAP Modelling Guide. The key changes to the new activity database are as follows:

- Activities re-organised into use-classes, as defined by the UK's Town and Country Planning (Use Classes) Order 1987, as amended;
- Addition of new flags to indicate whether an activity is side-lit, top-lit, or unlit;
- Activities that were previously repeated under multiple building types were rationalised;
- Addition of new activities.

158. The database provides standard occupancy, temperature set-points, outdoor air rates, and heat gain profiles for each type of space in the building so that buildings with the same mix of activities will differ only in terms of their geometry, construction, building services, and weather location. Thus, it is possible for the Building Regulation L5(a) compliance test and BERs to compare buildings on the basis of their intrinsic potential performance, regardless of how they may actually be used in practice.

159. The key fields of information in the database are as follows:

- a. Occupancy times and density;
- b. Total metabolic rate and percentage which is latent (water vapour);
- c. Set-point temperature and humidity in heating and cooling modes; *DSM software will use air temperature as the basis for temperature set-points for the Actual, Reference, and Notional buildings.*
- d. Set-back conditions for unoccupied periods;
- e. Sensible and latent heat gain from other sources;
- f. Outside air requirement;
- g. Level of illuminance for general lighting and the power density for display lighting;
- h. Hot water demand;
- h. Type of space for glazing, lighting, and ventilation classification within Building Regulations compliance;

²⁴ The NEAP Databases (Activity, Construction, and Glazing) will be available for download from [SEAI's website](#).

²⁵ For example, in a school, these activities might be teaching classrooms, science laboratories, gymnasiums, eating areas, food preparation, staff room, circulation spaces or toilets. The parameter values vary between building types – e.g. offices in schools are not the same as those in office buildings.

- i. A marker indicating whether the activity requires high efficiency filtration, thereby justifying an increased SFP allowance for that space to account for the increased pressure drop.

160. If there is not an activity in the database that reasonably matches the intended use of a space, then this could be raised with the database managers (see SEAI's website for details), and an appropriate new activity may be proposed. This will be subject to peer review prior to formal acceptance into the database. Note that it is NOT acceptable for users to define and use their own activities. Consistent and auditable activity schedules are an important element of the compliance and BER processes, and so only approved activity definitions can be used for these purposes²⁶. If a special-use space is present in the Actual building, and no appropriate activity is available in the database, it is accepted that time pressures may preclude waiting for the specific activity definition to be developed, peer reviewed, and approved. In such situations, the Energy Assessor must select the closest match from the approved existing database. Because compliance and BER assessments are both based on the performance of the Actual building in comparison to that of a Reference/Notional building, the impact of this approximation should be minimised.

Constructions

161. The thermal performance of construction elements must take account of thermal bridges:
- a. Repeating thermal bridges must be included in the calculated plane element U-value as detailed in BR443¹. Simulation tools that use layer-by-layer definitions will need to adjust thicknesses of insulation layers to achieve the U-value that accounts for the repeating thermal bridges.
 - b. Non-repeating thermal bridges should be dealt with either by a method that satisfies BS EN ISO 14683 or by adding 10% to the standard area-weighted average U-values and be consistently applied to both Actual and Reference buildings.
162. Available on SEAI's website are databases of calculated U-values, etc. (NEAP Construction Database and NEAP Glazing Database), and for consistency, all implementations of the NEAP should preferably use these databases. It is accepted that a required construction may not always exist in the NEAP Database. In such cases, alternative sources of data may be used, but the person submitting for Building Regulations approval must declare this and demonstrate how the values were derived.
163. When using the software tool to generate a BER, the performance parameters for some constructions may not be known. In such situations, the parameters must be inferred based on the data provided in the NEAP Construction Database. This is an important aspect of ensuring consistency in energy rating calculations, and so all software tools must adopt these procedures. This will be checked as part of the approval process.

Low and zero carbon systems

164. The following approach must be followed when calculating the impact of on-site electrical generation for both Building Regulation calculations and BER reports as applied to non-dwellings.
- a. Calculate the annual electrical energy used by the building irrespective of source of supply. Multiply that energy use by the grid-supplied primary energy factor and CO₂ emission factor.

²⁶ Clearly, designers may wish to use alternative bespoke schedules for particular design assessments, but these exist outside the compliance/BER assessments framework.

- c. Calculate the electricity generated by the on-site system and multiply that by the grid-displaced primary energy factor and CO₂ emission factor, irrespective of the proportion of the electricity that is used on site and how much is exported.
- d. The electricity-related primary energy and CO₂ emissions used to establish the building's primary energy rate and CO₂ emission rate, respectively, are the net figures, i.e., 'a minus b' above.
- e. Any fuel used in generating the electricity (e.g., in a CHP engine) is added (at its appropriate primary energy factor and CO₂ emission factor) along with any other fuels used in the building (at their respective primary energy and CO₂ emission factors) to arrive at the total building primary energy and CO₂ emissions.

Weather location

165. In order to calculate the reaction of the building and systems to the variable loads imposed by the external environment, the NEAP needs an input of weather data. A standard weather set has been adopted, based on the Dublin IWEC²⁷ weather file, which must be used for all Building Regulations compliance and BER calculations for non-domestic buildings in the Republic of Ireland.

Zoning rules

166. The way a building is sub-divided into zones will influence the predictions of energy performance. Therefore, this guide defines zoning rules that must be applied when assessing a building for the purposes of Building Regulations compliance or BER assessments. The following procedure defines the approach to zoning for HVAC and lighting that must be followed.

167. The zoning arrangement must mimic the control strategy in the Actual building, and the same zoning arrangement must then be applied in the Reference and Notional buildings. In the Actual building, zoning is defined by the extent of the control systems that modulate the output of the HVAC and lighting systems. Mapping the physical control zones into modelling zones should be the starting point for the zoning procedure. Any further adjustment to the zoning should only be:

- a. As specified in the following general guidance (see paragraphs 168 to 172); or
- b. Where specific limitations are imposed by the modelling tool that is being used (e.g., where a tool only permits each modelled zone to comprise one thermal zone and one lighting zone).

Zone types

168. A thermal zone is an area that:

- a. Has the same heating and cooling set-points; and
- b. The same ventilation provisions; and
- c. Has the same plant operating times; and
- d. Has the same set-back conditions; and
- e. Is served by the same type(s) of terminal device; and

²⁷ Obtained from the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE) at www.ashrae.org.

- f. Is served by the same primary plant; and
- g. Where the output of each type of terminal device is controlled in a similar manner.

169. A lighting zone is an area that:

- a. Has the same lighting requirement (levels and duration); and
- b. Is served by the same type(s) of lamp/luminaire combination; and
- c. Where the output of the lighting system is controlled in a similar manner; and
- d. Has similar access to daylight, i.e., the zone is bounded with fenestration having similar glazing ratio, light transmittance, and orientation. This means that where benefit is being taken of daylight-linked controls (manual or automatic), a given lighting zone must not extend beyond ~6 m from the perimeter.

170. For the purposes of modelling, a thermal zone can contain multiple lighting zones (e.g., daylight control at the perimeter with manual switching in the interior), but a lighting zone cannot extend across the boundary of a thermal zone. If this does occur in the Actual building, the relevant lighting zone must be subdivided into multiple smaller zones. The boundaries of these smaller zones are defined by the boundaries of the thermal zones.

Combining adjoining thermal zones

171. Adjoining thermal zones (horizontally or vertically²⁸) may be combined into a single larger zone provided that:

- a. The zones are all the same in terms of the characteristics defined in paragraph 168 above; and
- b. The zones all have the same combination of activities inside them; and
- c. The zones all have the same combination of lighting zones within them; and
- d. The zones all have the same exposure to the external environment in terms of glazing percentages, glazing types, and orientation.

172. Where adjoining thermal zones are combined, then the partitions that separate the physical spaces must be included in the thermal zone in order to properly represent the thermal storage impact.

Fuel emission and primary energy factors

173. The CO₂ emission factors and primary energy²⁹ factors for the fuels will be as defined in **Table 24**.

Table 24 Fuel CO ₂ emission and primary energy factors for non-domestic buildings		
Fuel type	kgCO ₂ /kWh	kWh/kWh
Natural gas	0.203	1.1
LPG	0.232	1.1
Biogas	0.025	1.1
Fuel oil	0.272	1.1

²⁸ If combining zones vertically, the zone height input should be that of a single zone, not the vertical sum of the zones' heights.

²⁹ The primary energy is considered to include the delivered energy plus an allowance for the energy 'overhead' incurred in extracting, processing, and transporting a fuel or other energy carrier to the building.

Coal	0.361	1.1
Anthracite	0.361	1.1
Manufactured smokeless fuel (inc. Coke)	0.392	1.2
Dual fuel (mineral + wood)	0.289	1.1
Biomass	0.025	1.1
Grid supplied electricity	0.409	2.08
Grid displaced electricity	0.409	2.08
Waste heat ³⁰	0.018	1.05

HVAC

174. For the Actual building, DSMs may represent HVAC systems explicitly but will be required to report system seasonal performance parameters as an aid to checking (see section on The Irish approval scheme and validation procedure of non-domestic building energy calculation software).

175. For DSM software that model HVAC with temperature control bands, the activity cooling/heating set-points from the NEAP Activity Database should be used as the mid-band point, and the control band should be $\pm 0.5^\circ\text{K}$ or less.

Lighting

176. Lighting calculations for “As Designed” compliance checks should assume a space maintenance factor of 0.8, which corresponds to a clean space that is maintained every 3 years (*EN 12464*).

177. For Part L compliance, the lighting power density for activities such as storage warehouses and retail spaces, which have racking/shelving, should be adjusted to ignore these elements (as the Reference building does not take these into account).

178. For Part L compliance, the lighting power density for activities which require special light fittings (e.g., intrinsically safe/anti-ligature luminaires), or where full spectrum daylight lamps are required (e.g., for medical purposes), should be adjusted to compensate for the de-rated output so that there is a fair comparison against the Reference building. Such adjustments need to be clearly documented and justified to Building Control.

Adjustment factors

179. In order to eliminate discrepancies between approved calculation tools with regards to the stage at which to apply adjustment factors for enhanced management and control features from **Table 25**, the following approach should be followed if adjustments are applicable:

- a. Apply the adjustment factor due to power factor correction to the CO₂ emissions and primary energy consumption which are attributed to grid-supplied electricity in the building.
- b. Apply the adjustment factor due to automatic monitoring and targeting with alarms for out-of-range values to the energy consumption attributed to the lighting or HVAC system with the M&T feature.

³⁰ This includes waste heat from industrial processes and power stations.

Table 25 Enhanced management and control features	
Feature	Adjustment factor
Automatic monitoring and targeting with alarms for out-of-range values ³¹	0.050
Power factor correction to achieve a whole building power factor > 0.90 ³²	0.010
Power factor correction to achieve a whole building power factor > 0.95	0.025

Measurement and other conventions

180. In order to provide consistency of application, standard measurement conventions must be used. These apply to both DSMs and third-party software interfaces to SBEMie, although some parameters may only relate to the latter. These conventions are specified in **Table 26** below:

Table 26 Measurement and other conventions	
Parameter	Definition
Zone Area	Floor area of zone 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. Used to multiply area-related parameters in databases. NB: If the zone has any virtual boundaries, e.g., no walls in certain orientations, the area of the zone is that delimited by the 'line' defining the virtual boundary.
Envelope Area	Area of vertical envelopes (walls) = $h \times w$, where: h = floor to floor height, i.e., including floor void, ceiling void, and floor slab. For top floors, h is the height from the floor to the average height of the structural ceiling. w = horizontal dimension of wall. Limits for that horizontal dimension are defined by type of adjacent walls. If the adjacent wall is external, 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: Areas of floors, ceilings, and flat roofs are calculated in the same manner as the zone area. Area for an exposed pitched roof (i.e., without an internal horizontal ceiling) will be the inner pitched surface area of the roof.
Window Area	Area of the structural opening in the wall/roof; the area, therefore, includes the area of glass + frame.

³¹ Automatic monitoring and targeting with alarms for out-of-range values 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.

³² The power factor adjustment can be taken only if the whole building power factor is corrected to the level stated. The two levels of power factor correction are alternative values, not additive.

HWS Deadleg Length	Length of the draw-off pipe to the outlet in the space (only used for zones where the water is drawn off). 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. Assumes that HWS circulation maintains hot water up to the boundary of the zone, or that the pipe runs from circulation or storage vessel within the zone.
Flat Roof	Roof with pitch of 10° or less. If greater than 10°, the roof is a pitched roof.
Pitched Roof	Roof with pitch greater than 10° and less than or equal to 70°. If the pitch is greater than 70°, it must be considered a wall.
Glazed door	When doors have more than 50% glazing, then the light/solar gain characteristics must be included in the calculation. This is achieved by defining these doors as windows and accounting for the opaque part in the frame factor parameter.
Curtain walling	Fully-glazed curtain walling systems should be modelled as glazing, where the spandrel area (i.e., non-vision areas) can be accounted for in the frame factor.

APPENDIX D – RENEWABLE ENERGY RATIO (RER)

181. The software should have the ability to calculate the Renewable Energy Ratio as described in this section.
182. The regulated energy use within the building is calculated as follows:
- Calculate the monthly regulated electrical energy used by the building irrespective of source of supply.
 - Calculate the monthly regulated energy use from other fuels (including any fuel used in generating on-site electricity (e.g., in a CHP engine))
183. For the calculation of the regulated energy use for the purposes of the RER, activities from the NEAP Activity Database will be capped as follows:
- Fresh air rate is ≤ 10 litres/s per person
 - Illuminance level ≤ 400 Lux
 - Equipment heat gains ≤ 11.77 W/m²
184. The ‘high-efficiency alternative systems’ are as defined in the recast EPBD2 (renewable energy systems, CHP, district heating/cooling, or heat pumps renewables). The primary energy associated with each of the renewables for the purposes of the RER is calculated as follows:

- Photovoltaic system: Calculate the electricity generated by the on-site system, *Generated Electricity_{PV}*, in kWh. The generated electricity is then multiplied by the primary energy factor of the PV to determine the total and renewable primary energy contribution.

Equation 17
$$E_{p, pv, ren} = \text{Generated Electricity}_{PV} \times F_{p, pv, ren}$$

Equation 18
$$E_{p, pv, tot} = \text{Generated Electricity}_{PV} \times F_{p, pv, ren} + \text{Generated Electricity}_{PV} \times F_{p, pv, nren}$$

- Wind turbine: Calculate the electricity generated by the on-site system, *Generated Electricity_{Wind}*, in kWh. The generated electricity is then multiplied by the primary energy factor of the Wind Energy to determine the total and renewable primary energy contribution.

Equation 19
$$E_{p, wind, ren} = \text{Generated Electricity}_{wind} \times F_{p, wind, ren}$$

Equation 20
$$E_{p, wind, tot} = \text{Generated Electricity}_{wind} \times F_{p, wind, ren} + \text{Generated Electricity}_{wind} \times F_{p, wind, nren}$$

- Solar thermal energy system: Calculate the useful thermal energy contribution by the on-site system, *Generated Heat_{SES}* in MJ. This energy is then converted into kWh. This energy is then multiplied by the primary energy factor to determine the total and renewable primary energy contribution.

Equation 21
$$E_{p, solar, ren} = (\text{Generated Heat}_{SES} / 3.6) \times F_{p, ses, ren}$$

Equation 22
$$E_{p, solar, tot} = (\text{Generated Heat}_{SES} / 3.6) \times F_{p, ses, ren} + (\text{Generated Heat}_{SES} / 3.6) \times F_{p, ses, nren}$$

- Biomass system: Calculate the delivered energy use by the biomass-fuelled on-site system, *Energy Consumption_{biomass}*, and multiply that by the primary energy factor of the biomass fuel to determine the total and renewable primary energy contribution.

Equation 23
$$E_{p, biomass, ren} = \text{Generated Heat}_{biomass} \times F_{p, biomass, ren}$$

Equation 24
$$E_{p, biomass, tot} = \text{Generated Heat}_{biomass} \times F_{p, biomass, ren} + \text{Generated Heat}_{biomass} \times F_{p, biomass, nren}$$

- e. Biogas system: Calculate the delivered energy use by the biogas-fuelled on-site system, *Energy Consumption_{biogas}*, and multiply that by the primary energy factor of the biogas fuel to determine the total and renewable primary energy contribution.

Equation 25
$$Ep_{biogas,ren} = \text{Generated Heat}_{biogas} \times Fp_{biogas,ren}$$

Equation 26
$$Ep_{biogas,tot} = \text{Generated Heat}_{biogas} \times Fp_{biogas,ren} + \text{Generated Heat}_{biogas} \times Fp_{biogas,nren}$$

- f. Heat pump: The environmental renewable contribution is calculated based on the heating, *Htg Demand* and hot water, *DHW Demand*, demand provided by the heat pump minus the energy consumed by the heat pump:

Equation 27
$$\text{Environmental Energy} = (\text{Htg Demand}_{HP_space} - \text{Consumed Energy}_{HP_space}) + (\text{DHW Demand}_{HP_water} - \text{Consumed Energy}_{HP_water})$$

where:

Htg Demand_{HP_space} = space heating provided by the heat pump

DHW Demand_{HP_water} = hot water heating provided by the heat pump

Consumed Energy_{HP_space} = Consumed energy by the space heating heat pump

Consumed Energy_{HP_water} = Consumed energy by the water heating heat pump

Equation 28
$$Ep_{HP,ren} = \text{Environmental Energy} \times Fp_{HP,ren}$$

Equation 29
$$Ep_{HP,tot} = \text{Environmental Energy} \times Fp_{HP,ren} + \text{Environmental Energy} \times Fp_{HP,nren}$$

- g. CHP plant: Calculate the heat demand from the CHP plant for space and water heating, *Heat Demand_{CHP}*, in kWh, and use the following equation:

Equation 30
$$\text{Saved Energy} = \text{Heat Demand}_{CHP} \times [(PEF_{gas} / 0.86) + ((CHP_{eff_elec} \times PEF_{elec}) / CHP_{eff_heat}) - (PEF_{gas} / CHP_{eff_heat})]$$

where:

PEF_{gas} = primary energy factor of natural gas.

PEF_{elec} = primary energy factor of electricity.

CHP_{eff_elec} = electrical efficiency of the CHP plant (entered as a factor), defined as the annual electrical output divided by the gross calorific fuel input.

CHP_{eff_heat} = heat efficiency of the CHP plant (entered as a factor), defined as the annual heat output divided by the gross calorific fuel input.

Equation 31
$$Ep_{CHP,ren} = \text{Saved Energy} \times Fp_{CHP,ren}$$

Equation 32
$$Ep_{CHP,tot} = \text{Saved Energy} \times Fp_{CHP,ren} + \text{Saved Energy} \times Fp_{CHP,nren}$$

- h. District Heating (other): Calculate the heat provision from the District Heating plant for space and water heating, *Heat Provision_{DH}*, in kWh. Based on the renewable and non-renewable primary energy factor submitted by the assessor.

Equation 33
$$Ep_{DH,ren} = \text{Heat Provision}_{DH} \times Fp_{DH,ren}$$

Equation 34
$$Ep_{DH,tot} = \text{Heat Provision}_{DH} \times Fp_{DH,ren} + \text{Heat Provision}_{DH} \times Fp_{DH,nren}$$

- i. Process Energy: Calculate the surplus primary energy associated with the process load in kWh, and use the following equation:

Equation 35 $PROCESS_{RER} = \text{Primary Energy Exported} - \text{Primary Energy Used}.$

Equation 36 $Ep_{, Process, ren} = PROCESS_{RER} \times Fp_{, Process, ren}$

Equation 37 $Ep_{, Process, tot} = PROCESS_{RER} \times Fp_{, Process, ren} + PROCESS_{RER} \times Fp_{, Process, nren}$

185. The Renewable Energy Ratio is calculated as the sum of the primary energy from renewable energy sources, E_{Pren} , divided by the total primary energy use including renewable energy, E_{ptot} .

	Renewable Primary Energy Factor, $Fp_{, ren}$	Non Renewable Primary Energy Factor $Fp_{, nren}$	Total Primary Energy Factor $Fp_{, tot}$
Photovoltaics	Grid Electricity	0	Grid Electricity
Wind	Grid Electricity	0	Grid Electricity
Solar Thermal	1	0	1
Biomass	1	0.1	1.1
Biogas	1	0.1	1.1
Heat Pump (Environmental Energy)	1	0	1
CHP (Saved Energy)	1	0	1
District Heating	District Heating Supplier	District Heating Supplier	District Heating Supplier
Process Energy	1	0	1